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education

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

HALF - YEARLY EXAMINATIONS

JUNE 2020

MARKS : 150

TIME : 3 hours

This question paper consists of 16 pages and 1 data sheet.

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INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK**.
2. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEET.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

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SECTION A

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter A, B, C or D next to the question number (1.1 to 1.10) in your ANSWER BOOK.

1.1 The linear momentum of an object is a ...

A vector quantity with the same direction as the velocity of the object.

B scalar quantity with the same direction as the velocity of the object.

C vector quantity with direction opposite to that of the velocity of the object.

D scalar quantity with direction opposite to that of the velocity of the object. (2)

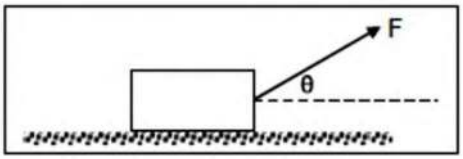
1.2 A small object mass ***m***, on the surface of the planet Mars mass ***M***, experiences a gravitational acceleration *g*. The radius of the Mars is ***r*** and the universal gravitational constant is represented by ***G***. Which ONE of the following combinations can be used to determine the magnitude of ***g on Mars***?

A	**r**	**M**
B	**r**	**m**
C	**G**	**M**
D	**G**	**m**

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1.3 A force *F* applied at an angle θ to the horizontal is pulling a heavy block of weight *w* along a rough, horizontal floor at a CONSTANT velocity. The block stays in contact with the floor. The coefficient of kinetic friction is μ



Which ONE of the following combinations is correct regarding the magnitudes of the forces, or force components, on the block?

	HORIZONTAL	VERTICAL
A	Fcos θ < μN	N = w
B	Fcos θ = μN	Fsinθ + N = w
C	Fcos θ = μN	N = w
D	Fcos θ > μN	Fsin θ + N = w

1.4 Projectile motion is when an object is moving ...

A vertically upwards or vertically downwards at a constant speed.

B vertically upwards or vertically downwards at changing acceleration.

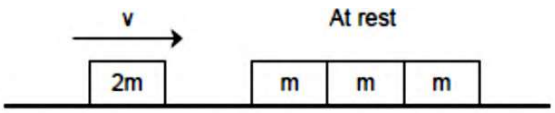
C and the only force acting on it, is the force of gravity.

D and the two forces acting on it, are the force of gravity and air resistance. (2)

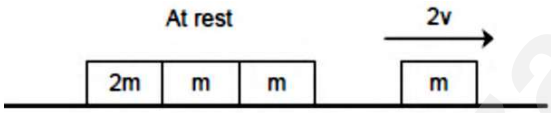
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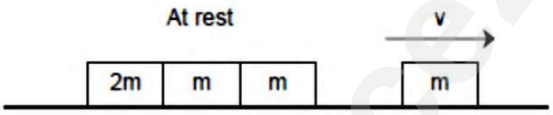
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1.5 Three separate, identical blocks are in contact with each other in a straight line. They are at rest on a smooth, horizontal surface. Each of these blocks has a mass ***m***. Another block with the same dimensions, but with mass **2*m***, moving at a velocity ***v***, collides ELASTICALLY and in the same straight line with the three stationary blocks.

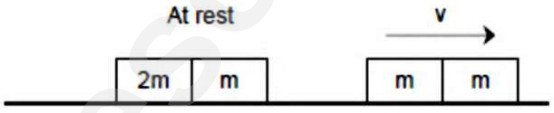


Which one of the following diagrams represents the situation immediately after the collision?

A


B


C


D


(2)

1.6 A car, moving at a constant velocity with kinetic energy *K*, undergoes a displacement ***x*** in time ***t.*** If the car's kinetic energy changes to 2*K*, it will undergo a displacement of … in the same time at the new constant velocity.

A 4***x***

B 2***x***

C $\sqrt{2}\,\boldsymbol{x}$

D $\frac{1}{\sqrt{2}}\,\boldsymbol{x}$

(2)

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1.7 Which one of the following would result in you hearing a lower pitch than that of a single note played by a trumpet player who is standing on a stage?

A Play the sound much louder through headphones.

B Run away from the trumpet player.

C Run towards the trumpet player.

D Cover your ears.

1.8 Two small, metallic spheres, **P** and **Q**, on insulated stands carry identical negative charges. The distance between their centres is *d* and the magnitude of the force exerted by **Q** on **P** is ***F***. The distance is then changed to ***½d***. What is the magnitude of the new force exerted by **Q** on **P** in terms of ***F***?

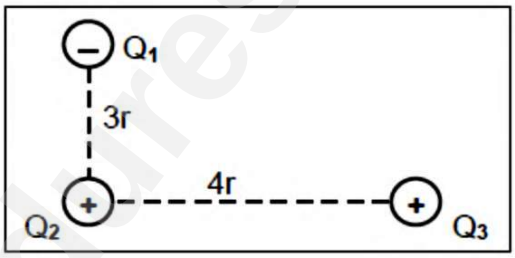
A ¼**F**

B ½**F**

C 2**F**

D 4**F** (2)

1.9 Three point charges, $\mathbf{Q_1}$ (negative), $\mathbf{Q_2}$ (positive) and $\mathbf{Q_3}$ (positive), are kept stationary at right angles with respect to one another as indicated below.

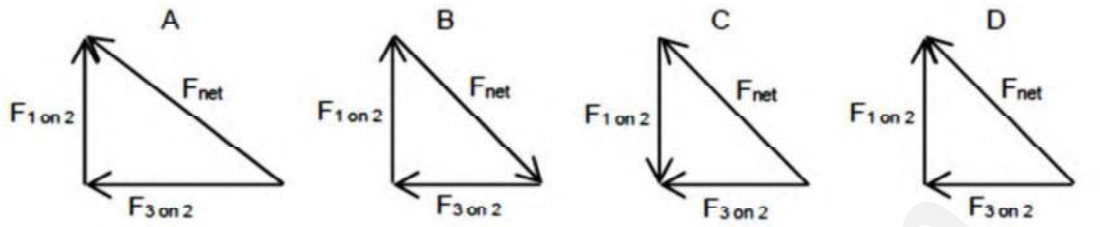


The magnitude of the charge on $\mathbf{Q_1}$ is nine times that of $\mathbf{Q_2}$ ($\mathbf{Q_1} = 9\mathbf{Q_2}$). The magnitude of the charge on $\mathbf{Q_3}$ is sixteen times that of $\mathbf{Q_2}$ ($\mathbf{Q_3} = 16\mathbf{Q_2}$). The distances between $\mathbf{Q_1}$ and $\mathbf{Q_2}$ and between $\mathbf{Q_3}$ and $\mathbf{Q_2}$ are 3*r* and 4*r* respectively.

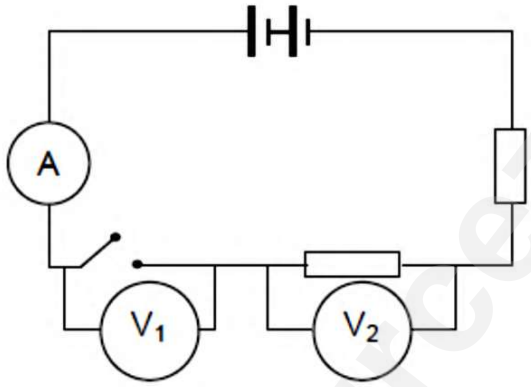
Which ONE of the following vector diagrams is the best representation of the net (resultant) electrostatic force on $\mathbf{Q_2}$ due to the presence of $\mathbf{Q_1}$ and $\mathbf{Q_3}$?

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1.10 The battery in the circuit diagram below has an emf of 12 V and negligible resistance. Two voltmeters, **V_1** and **V_2**, are connected as shown. What are the readings on **V_1** and **V_2** when the switch is open?



	V_1 (V)	V_2 (V)
A	12	12
B	0	12
C	12	0
D	0	0

(2)

[20]

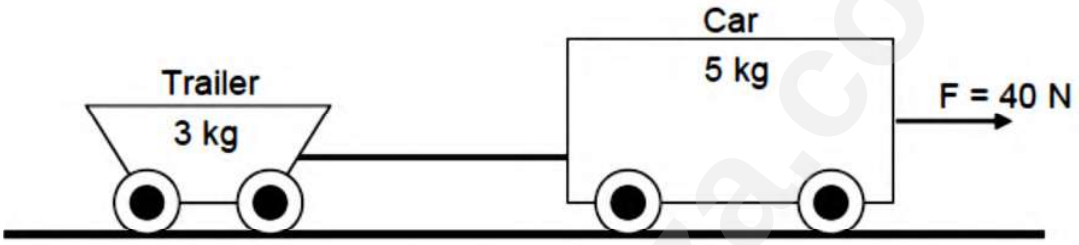
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SECTION B

QUESTION 2

2.1 A toy trailer, mass 3 kg, is connected to a toy car, mass 5 kg, by means of a light, inelastic string. A horizontal force of 40 N is then applied to the car and the velocity of the car and trailer increase uniformly in a straight line to the right. Both vehicles experience frictional forces while they are moving. The frictional force on the car has a magnitude of 4,9 N.



2.1.1 Write down *Newton's second law of motion* in words. (2)

2.1.2 What type of frictional force do the vehicles experience? (1)

2.1.3 Show by means of a calculation that the frictional force on the trailer has a magnitude of 2,94 N if the coefficient of friction is 0,1. (2)

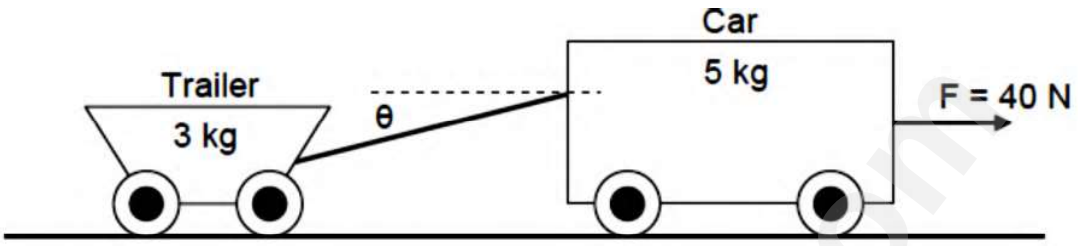
2.1.4 Calculate the magnitude of the acceleration of the system. Write down separate equations for the two moving objects using Newton's second law of motion and then calculate the acceleration. (5)

2.1.5 Calculate the force exerted by the string ON THE CAR. (3)

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The string is disconnected from the car and reconnected at a higher point to make an angle θ with the horizontal. The horizontal force of 40 N is again applied to the car to accelerate the system from rest as before.



2.1.6 Draw a free-body diagram, with labels, of all the forces acting on the CAR. (5)

With the string in the new position, is the frictional force on the ...

2.1.7 trailer greater than, the same as or less than 2,94 N? (1)

2.1.8 car greater than, the same as or less than 4,9 N? (1)

2.2 The planet Mars has an approximate mass and radius of 6,39 x 10^{23} kg and 3,39 x 10^{3} km respectively. Calculate the approximate magnitude of the gravitational acceleration on the surface of Mars. (4)

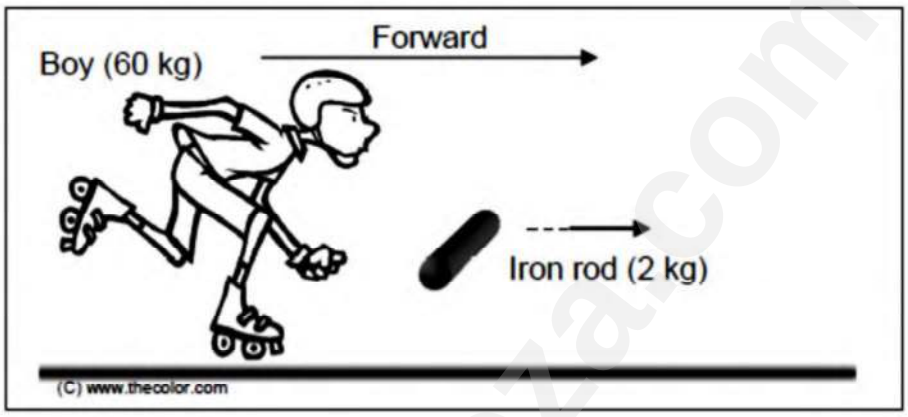
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QUESTION 3

A boy mass 60 kg on roller-skates, holds an iron rod of mass 2 kg in his hands. He is moving **forward** on a frictionless, horizontal surface at a speed of 1,5 $m \cdot s^{-1}$. In order to slow himself down, he throws the iron rod **horizontally away** from himself, in the **forward** direction, at a speed of 4 $m \cdot s^{-1}$. Ignore the effects of all types of friction.



3.1 State in words, the *principle of conservation of linear momentum*. (2)

3.2 Calculate the boy's velocity immediately after he has thrown the iron rod. (5)

3.3 Will the boy's speed, under the following conditions, BE LESS THAN, THE SAME AS or GREATER THAN the answer calculated in QUESTION 3.2?

3.3.1 He throws the iron rod forward, but at a speed of LESS than 4 $m \cdot s^{-1}$. (1)

3.3.2 He throws the iron rod VERTICAL UPWARDS at a speed of 4 $m \cdot s^{-1}$. (1)

[9]

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QUESTION 4

4.1 A player throws a cricket ball vertical upwards with an initial speed of 4,5 m•s^{-1} and catches it again at the same height from where it was projected. The table below shows the velocity of the ball at different times during the interval t = 0 s to t = 2,5 s. UPWARD is taken as the POSITIVE DIRECTION.

Time (s)	**0**	**0,5**	**1,0**	**1,5**	**2,0**	**2,5**
Velocity (m•s^{-1})	**14,5**	**10,0**	**4,0**	**-0,5**	**-5,5**	**-10,5**

4.1.1 Use the tabulated data to draw a velocity-time graph of the ball's motion. Use the graph paper that is provided at the end of this question paper. Plot the points and draw the BEST-FIT graph (5)

4.1.2 Use THE GRAPH to calculate the displacement of the ball from t = 1,5 s to t = 2,5 s. EQUATIONS OF MOTION MAY NOT BE USED. (4)

4.1.3 Under which condition can you consider the cricket ball to be a projectile? (1)

4.2 A ball with a mass of 0,5 kg is fired vertical upwards from a platform, which is 14 m above the ground. The ball leaves at an initial speed of 40 m•s^{-1}, at a height of 1 m above the platform. Ignore air resistance.

4.2.1 Calculate the maximum height the cannonball reaches above the ground. (5)

4.2.2 Calculate how long it takes to reach the maximum height. (3)

4.2.3 The total time elapsed from launching until it hits the ground can be calculated with the equation $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$.

Use THIS EQUATION ONLY (NO OTHER ONE IN ADDITION TO THIS) and substitute the relevant values in order to determine the time. It is not necessary to solve the equation; just show the equation and the substitutions. (3)

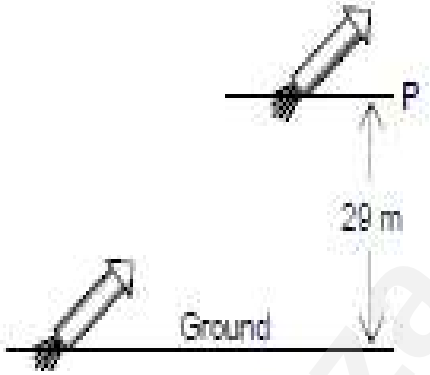
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QUESTION 5

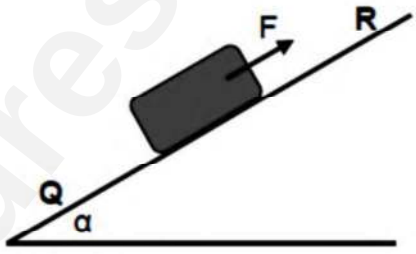
5.1 A 0,20 kg rocket in a fireworks display is launched from rest from the ground and follows a straight flight path to reach point **P**, as shown in the figure below. Point **P** is 29 m above the starting point. In the process, 425 J of work is done on the rocket by the NON-CONSERVATIVE force generated by the burning propellant. Ignore air resistance and the mass lost due to the burning propellant.



5.1.1 Explain what a n*on-conservative* force is. (2)

5.1.2 Calculate the speed of the rocket at point **P**. (6)

5.2 A constant force **F** is applied to a crate to move it upwards along a frictionless, inclined plane. Force **F** is parallel to the inclined plane and the mass of the crate is 25 kg. When the crate reaches point **Q**, it's speed is 12 $m \cdot s^{-1}$, and 10,8 $m \cdot s^{-1}$ when it reaches point **R**, which is 3,5 m further up the incline. The incline makes an angle $\alpha = 30°$ with the horizontal.



5.2.1 Draw a free-body diagram, with labels, of the forces acting on the crate while it is moving. (3)

5.2.2 State the WORK – ENERGY THEOREM in words (2)

5.2.3 Is mechanical energy conserved during this motion? Write down YES or NO and briefly explain your answer. (2)

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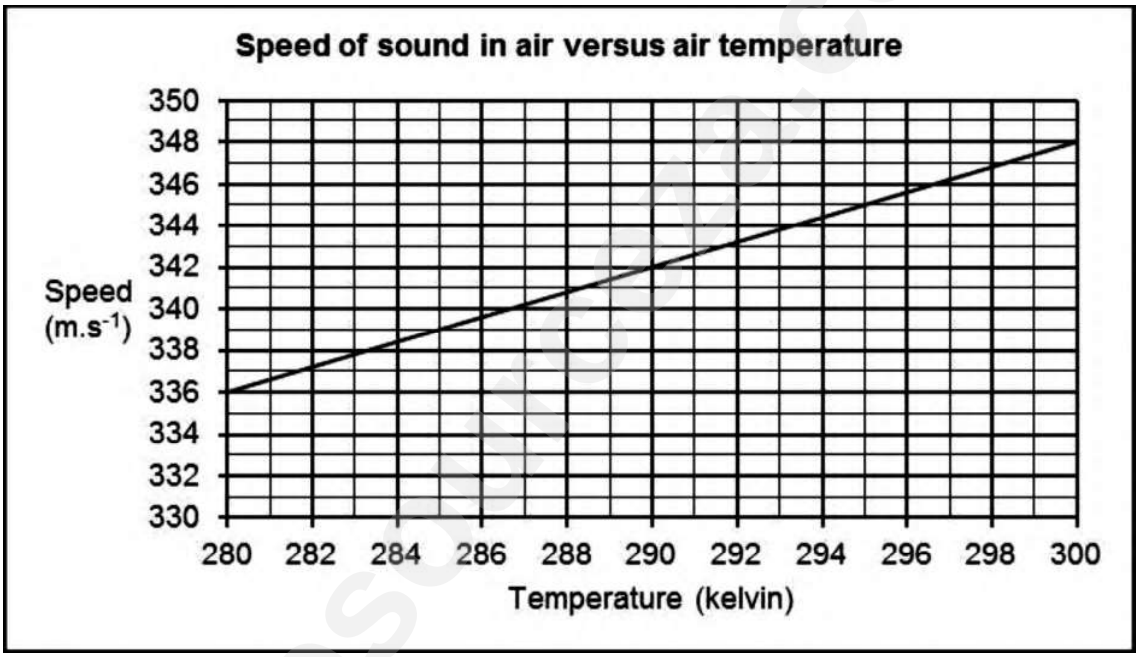
5.2.4 Give a reason why the normal force does not do any work on the crate during its motion. (1)

5.2.5 Use ENERGY PRINCIPLES to calculate the magnitude of force *F*. (6)

[21]

QUESTION 6

The speed of sound in air depends among others on the air temperature. The following graph shows this relationship.



6.1 Which one of temperature or speed is the dependent variable? (1)

6.2 The gradient of this graph is equal to 0,6 $m \cdot s^{-1} \cdot K^{-1}$. With how much does the speed, in $m \cdot s^{-1}$, increase for every 5 K increase in temperature? (1)

6.3 Two experiments are done to verify the Doppler effect. In the first experiment, an object approaches a stationary observer **X** at a constant speed of 57,5 $m \cdot s^{-1}$. The object is equipped with a siren that emits sound waves at a fixed frequency of 1 000 Hz. The motion takes place in still air at a temperature of 295 K.

6.3.1 State *Doppler Effect* in words. (2)

6.3.2 What is the speed of sound, in $m \cdot s^{-1}$, in air at 295 K?
HINT: Use the graph (1)

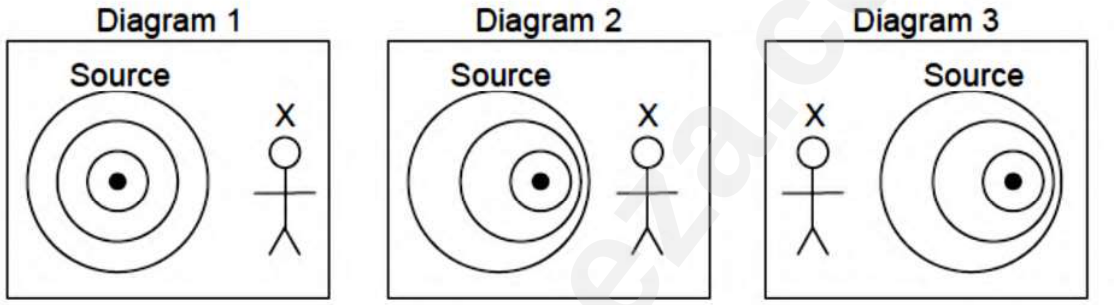
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6.3.3 Calculate the frequency measured by observer **X**. (5)

6.3.4 In the second experiment, the object moves away from observer **X** at the same constant speed as before. What should the air temperature, in kelvin, be to make it a fair test between the two experiments? (1)

6.4 Consider the three diagrams below. Each one represents the source (with the siren) and observer **X**. Two of the diagrams are applicable on the abovementioned experiments.



6.4.1 Which diagram is applicable to experiment 2? (1)

6.4.2 Which diagram is NOT applicable to any of the experiments? Give a reason for your answer. (2)

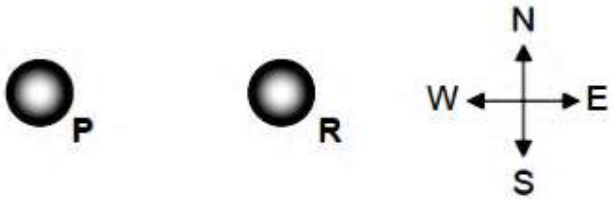
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QUESTION 7

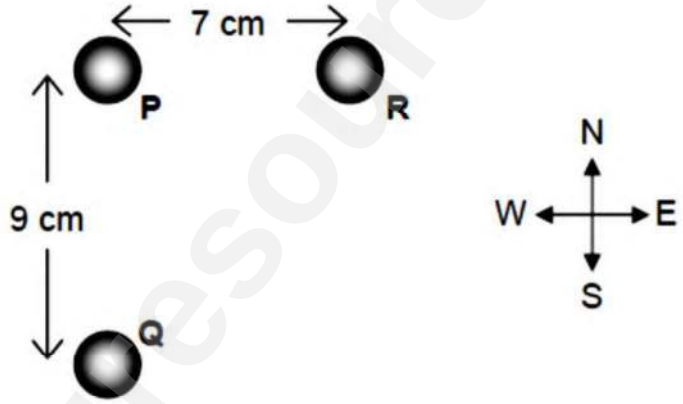
Two identical, small, metallic spheres, **P** and **R**, carry electric charges of -20 µC and +30 µC respectively. They are placed on the east-west axis of a compass as shown in the diagram below.



7.1 Define *electric field at a point* in words. (2)

7.2 Draw an electric field pattern for the two charges, **P** and **Q**. (3)

The centre of **P** is 7 cm from the centre of **R**. A third identical sphere, **Q**, is then placed as shown below, with its centre 9 cm away from the centre of **P**. **P** and **Q** are placed on the north-south axis of a compass and **Q** carries a charge of -45 µC.



7.3 State *Coulomb's law* in words. (2)

7.4 Draw a free-body diagram, with labels, of all the electrostatic forces acting on **P** as a result of **Q** and **R**. (2)

7.5 Calculate the net electrostatic force experienced by **P** as a result of **Q** and **R**. (8)

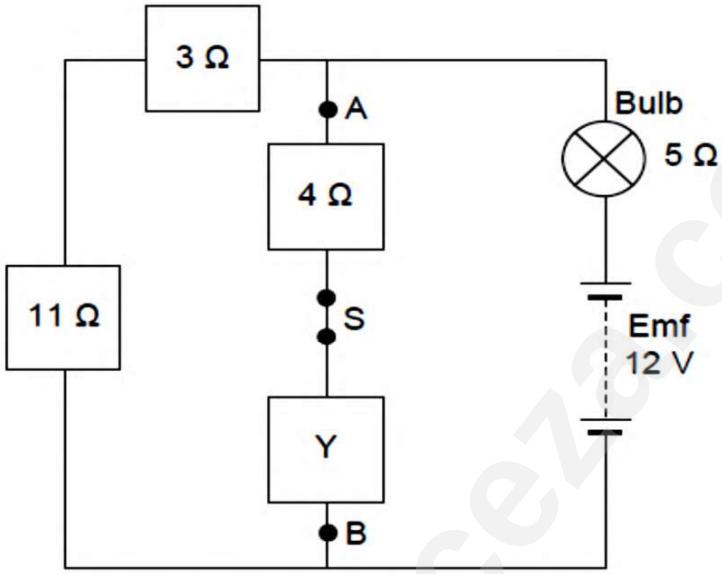
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QUESTION 8

A learner wants to use a 12 V battery, with negligible internal resistance, to operate a bulb. He uses the circuit below to obtain the desired potential difference for the bulb to glow. The resistance of the bulb is 5 Ω. When switch **S** is closed as shown, the bulb glows at its MAXIMUM POWER of 5 W.



8.1 Explain in words what it means if the battery has *an emf of 12 V*. Refer to energy and charge, with relevant values, in your answer. (2)

8.2 State Ohm's Law in words (2)

8.3 Calculate the current in the bulb. (3)

8.4 Calculate the resistance of resistor **Y**. (7)

8.5 Calculate the cost to operate the bulb for a period of 1 400 minutes if one unit of electricity (1 kWh) costs R1,80. (3)

8.6 Switch **S** is now OPENED.

8.6.1 Will the bulb still function at maximum power? Write down either YES or NO and explain your answer without doing any calculations. (4)

8.6.2 How does the potential difference across **A** and **B** compare with its value when switch **S** was closed? Choose your answer from GREATER THAN, LESS THAN, EQUAL TO or ZERO. (2)

[23]

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DATA FOR PHYSICAL SCIENCES GRADE 12

PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12

VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS / TABEL 1: FISIESE KONSTANTES

NAME / NAAM	SYMBOL / SIMBOOL	VALUE / WAARDE
Acceleration due to gravity *Swaartekragversnelling*	g	$9{,}8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	G	$6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3{,}0 \times 10^{8}\ m{\cdot}s^{-1}$
Planck's constant *Planck se konstante*	h	$6{,}63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant *Coulomb se konstante*	k	$9{,}0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$
Charge on electron *Lading op electron*	e^-	$-1{,}6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9{,}11 \times 10^{-31}\ kg$
Mass of Earth *Massa van Aarde*	M	$5{,}98 \times 10^{24}\ kg$
Radius of Earth *Radius van Aarde*	R_E	$6{,}38 \times 10^{6}\ m$

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TABLE 2: FORMULAE / TABEL 2: FORMULES

MOTION / BEWEGING

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/of $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE / KRAG

$F_{net} = ma$	$p = mv$
$f_{s(max)} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

WORK, ENERGY AND POWER / ARBEID, ENERGIE EN DRYWING

$W = F\Delta x\cos\theta$	$U = mgh$ or/of $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/of $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/of $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/of $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = F\cdot v_{av}$ / $P_{gem} = F\cdot v_{gem}$	

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/of $E = h\frac{c}{\lambda}$

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$E = W_o + E_{k(max)}$ or/of $E = W_o + K_{(max)}$ where/waar

$E = hf$ and/en $W_o = hf_o$ and/en $E_{k(max)} = \frac{1}{2}mv^2_{max}$ or/of $K_{(max)} = \frac{1}{2}mv^2_{max}$

ELECTROSTATICS / ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ OR/OF $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS / ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (ε) = I (R + r) emk (ε) = I(R + r)
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

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ALTERNATING CURRENT / WISSELSTROOM

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{ave} = V_{rms} I_{rms}$ / $P_{gemiddeld} = V_{wgk} I_{wgk}$
	$P_{ave} = I_{rms}^2 R$ / $P_{gemiddeld} = I_{wgk}^2 R$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{ave} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$

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education

Department:
Education
PROVINCE OF KWAZULU-NATAL

PHYSICAL SCIENCES: CHEMISTRY (P2)

JUNE EXAMINATION

2020

NATIONAL SENIOR CERTIFICATE

GRADE 12

Time: 3 hours

Marks: 150

NB. This question paper consists of 15 pages and 4 Data Sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of NINE questions, FIFTEEN pages and FOUR data sheets.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. You are advised to use the attached DATA SHEETS.
11. Write neatly and legibly.
12. Answer ALL the questions in the ANSWER BOOK.

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QUESTION 1 MULTIPLE CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter A, B, C or D next to the question number in the ANSWER BOOK, e.g. 1.11 A

1.1 The number of isomers for C_4H_{12} is:

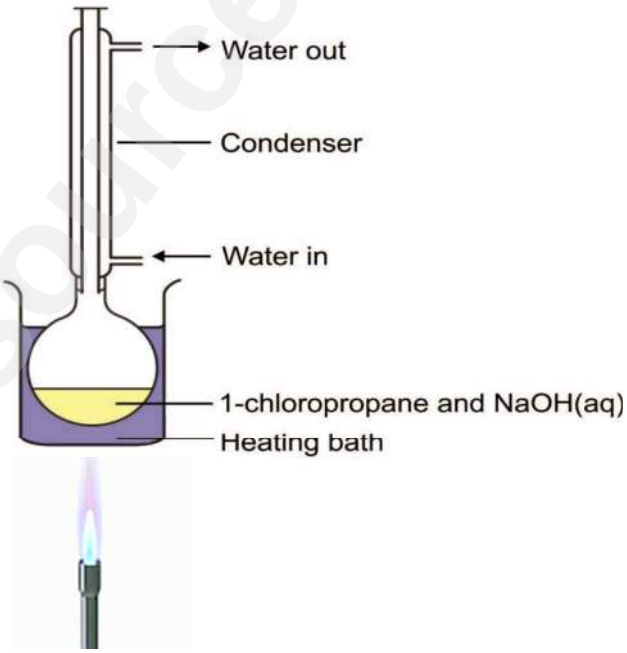
A. 5

B. 4

C. 3

D. 2 (2)

1.2 1-chloropropane is heated under reflux with an aqueous solution of sodium hydroxide as shown in the diagram.



The TYPE of reaction taking place above, is

A. Addition

B. Hydrolysis

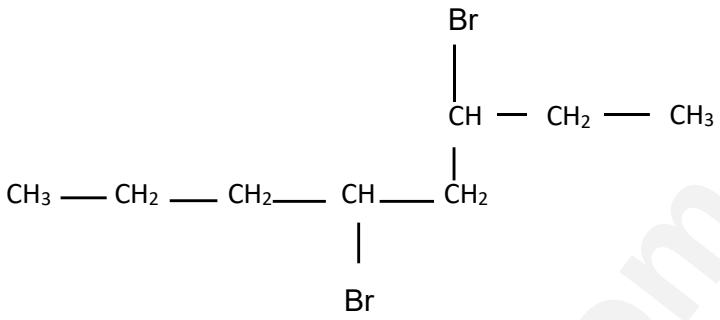
C. Elimination

D. Hydrohalogenation (2)

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1.3 The condensed structural formula of an organic compound is shown below:



Which ONE of the following is the correct IUPAC name of this compound?

A. 4,6-dibromooctane

B. 4-bromo-5-bromo-5-propylpentane

C. 3,5-dibromooctane

D. 2-bromo-1-bromo-1-propylpentane (2)

1.4 When methanol reacts with methanoic acid, the molecular formula of the organic product formed is:

A. $H_4C_3O_2$

B. H_2O

C. $H_4C_2O_2$

D. $H_3C_3O_2$ (2)

1.5 Which ONE of the following will DEFINITELY NOT INCREASE the rate at which oxygen is produced in the following reaction?

$$2H_2O_2(aq) \rightleftharpoons 2H_2O(\ell) + O_2(g) \qquad \Delta H > 0$$

A. Increase in temperature

B. Increase in pressure

C. Increasing the concentration of H_2O_2

D. Adding a suitable catalyst (2)

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1.6 Hydrogen bromide decomposes according to the following equation:

$$2HBr(g) \rightleftharpoons H_2(g) + Br_2(g) \qquad Kc = 0,006 \text{ at } 420K$$

2mol of each of HBr, H_2 and Br_2 were placed in a sealed container and heated to 420K. When equilibrium is established it was found that:

A. the number of moles of HBr would be unchanged.

B. the number of moles of Br_2 would have decreased.

C. the value of Kc would have increased to 1.

D. the number of moles of gas would have decreased. (2)

1.7 The expression for the equilibrium constant (K_C) of a hypothetical reaction is given as follows:

$$\mathbf{Kc = \frac{[D]^2[C]}{[A]^3}}$$

Which ONE of the following equations represents this reaction?

A. $3A(\ell) \rightleftharpoons C(aq) + 2D(aq)$

B. $3A(s) \rightleftharpoons C(g) + 2D(g)$

C. $3A(aq) + B(s) \rightleftharpoons C(aq) + 2D(aq)$

D. $3A(aq) + B(s) \rightleftharpoons C(g) + D_2(g)$ (2)

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1.8 Two learners, X and Y, prepared hydrogen gas in the laboratory by adding hydrochloric acid to an excess of magnesium.

The equation for the reaction is:

$$Mg\ (s) + 2HCl\ (aq) \longrightarrow MgCl_2\ (aq) + H_2\ (g)$$

Each learner was given the same mass of Mg and the same volume of HCl. Their results were tabulated as follows:

	Time (minutes)	**1**	**2**	**3**	**4**
Learner X	Volume of H_2 (cm^3)	20	30	35	35
Learner Y	Volume of H_2 (cm^3)	30	35	40	40

The reasons for the different volumes that X and Y obtained are:
Y used …

A. a catalyst and a higher concentration of HCl than X.

B. a catalyst and a higher temperature than X.

C. a catalyst and powdered magnesium. (2)

D. powdered magnesium and a higher temperature than X.

1.9 A 10cm^3 sample of a strong acid has a pH of 4. Addition of 990 cm^3 of pure water to this sample will form a solution of pH of …

A. 2,0

B. 4,0

C. 5,5

D. 6,0 (2)

1.10 Which one of the indicator ranges below is most suitable in the titration of ethanoic acid and sodium hydroxide.

A. 3,1-4,4

B. 6,0-7,6

C. 8,4-10,0

D. 10,0-14,0 (2)

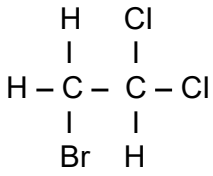
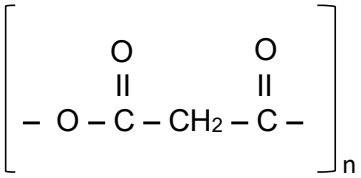
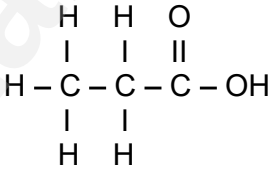
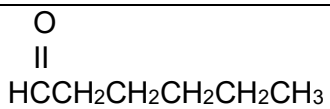
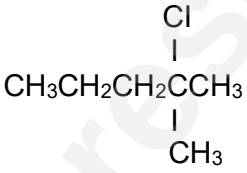
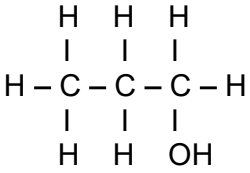
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QUESTION 2 (Start on a new page)

The letters A to F in the table below represent six organic compounds. Use the information in the table to answer the questions that follow.

A		**B**	3-methylpentan-2-one
C		**D**	
E	C_6H_8	**F**	
G		**H**	

2.1 Write down the letter from the table that represents the following:

2.1.1 An unsaturated hydrocarbon. (1)

2.1.2 Two compounds that are FUNCTIONAL ISOMERS of each other. (2)

2.1.3 A tertiary haloalkane. (1)

2.1.4 An aldehyde (1)

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2.2 Write down the:

2.2.1 IUPAC name of compound **A.** (2)

2.2.2 IUPAC name of compound **F.** (2)

2.2.3 IUPAC name of a POSITIONAL ISOMER of **H**. (1)

2.2.4 the FUNCTIONAL group of compound **D**. (2)

2.2.5 GENERAL FORMULA of homologous series of compound **G.** (2)

2.3 Identify the letter of the polymer in the table. (1)

2.4 Name **and** define the type of polymerization that the compound identified in 2.3 has undergone. (3)

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QUESTION 3 (Start on a new page)

The table below compares melting point, boiling point and vapour pressure of organic compounds with different functional groups with regards to type and strength of intermolecular forces between molecules.

Compound	Molecular formula	Molecular mass $g.mol^{-1}$)	Melting point °C)	Boiling point (°C)	Vapour pressure (KPa at 20°C)
A. Ethane	C_2H_6	30	-183	-89	3 750
B. Chloroethane	C_2H_5Cl	64,5	-136	12	132,4
C. Ethanol	C_2H_5OH	46	-89	78	5,8
D. Ethanoic acid	C_2H_5COOH	60	16	118	1,6

3.1 Define melting point. (2)

3.2 By referring to the **type and strength** of intermolecular forces, explain the following:

3.2.1 The differences in the boiling point between compound A and B. (3)

3.2.2 The differences in the melting point between compound C and D. (3)

3.3 Explain the relationship between boiling point and vapour pressure, by referring to the trend of compound A and D in the table. (2)

[10]

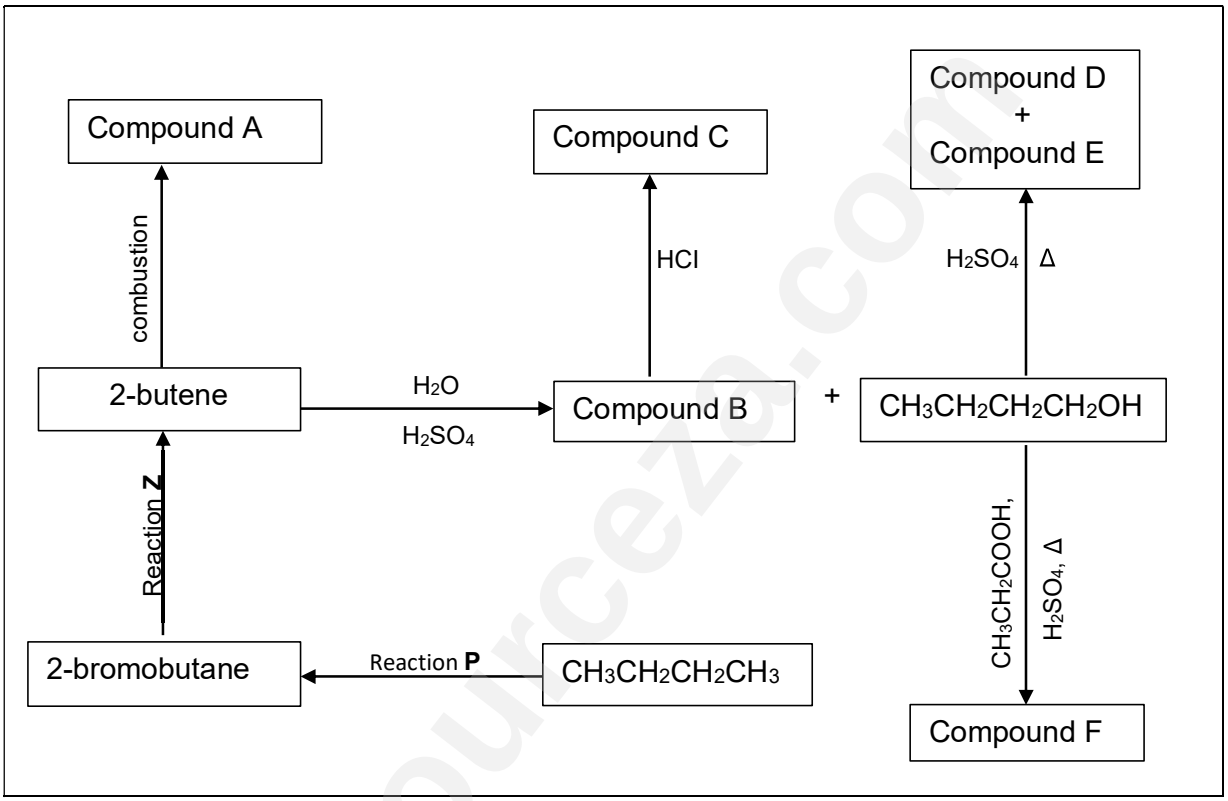
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QUESTION 4 (Start on a new page)

Study the following flow diagram that illustrates reactions of organic compounds.



4.1 Using MOLECULAR FORMULAE, write a balanced equation showing the formation of compound **A**. (3)

4.2 Write down the reaction conditions for:

4.2.1 Reaction P (2)

4.2.2 Reaction Z. (2)

4.3 Study the formation of compound **B**:

4.3.1 Write down the IUPAC name and STRUCTURAL FORMULA of compound **B**. (3)

4.3.2 Name the homologous series to which compound B belongs. (1)

4.3.3 Is compound **B** a primary, secondary or tertiary product? Give a reason for your answer. (2)

4.3.4 Name the TYPE of reaction that results in the formation of compound **B**. (1)

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4.4 Write down the STRUCTURAL FORMULA of compound C. (2)

4.5 Name the TYPE of reaction where compound C is formed. (1)

4.6 Write down the IUPAC name of *organic* compound D. (2)

4.7 Write down the STRUCTURAL FORMULA for inorganic product E. (2)

4.8 Write down the IUPAC name and draw the STRUCTURAL FORMULA of compound **F**. (3)

4.9 Name the TYPE of reaction that results in the formation of product **F.** (1)

[25]

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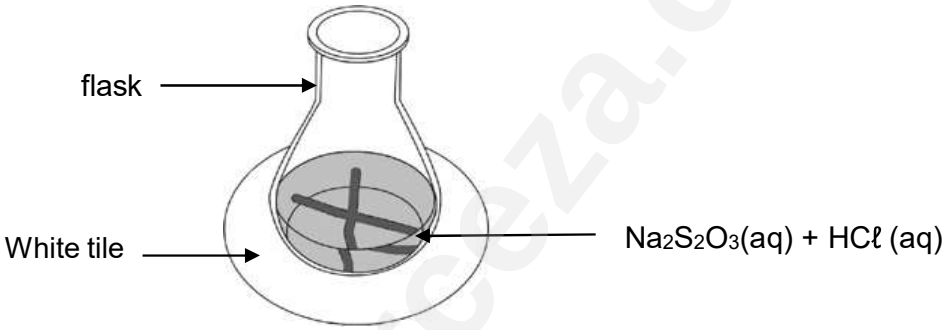
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QUESTION 5 (Start on a new page)

The reaction between dilute hydrochloric acid and sodium thiosulphate ($Na_2S_2O_3$) is used to investigate one of the factors that influences reaction rate. The balanced equation for the reaction is:

$$Na_2S_2O_3(aq) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + S(s) + H_2O(\ell) + SO_2(g)$$

The hydrochloric acid solution is added to the sodium thiosulphate solution in a flask. The flask is placed over a cross drawn on a sheet of white paper, as shown in the diagram below. The time that it takes for the cross to become invisible is measured to determine the reaction rate.



Four experiments, A to D, are conducted during this investigation. The volumes of reactants used in each of the four experiments and the times of the reactions are summarised in the table below.

Experiment	Volume of $Na_2S_2O_3(aq)$ (cm^3)	Volume of $H_2O(\ell)$ (cm^3)	Volume of $HC\ell(aq)$ (cm^3)	Time (s)
A	25	0	5	50,0
B	20	5	5	62,5
C	15	10	5	83,3
D	10	15	5	125,0

5.1 Define *reaction rate*. (2)

5.2 State TWO factors that can affect the rate of the above reaction. (2)

5.3 Write down the NAME of the product that causes the cross to become invisible. (1)

5.4 Write down an investigative question for this investigation. (2)

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5.5 In which experiment (A, B, C or D) is the reaction rate the highest. (2)

5.6 Use the collision theory to explain the difference in reaction rate between experiments B and D. (3)

5.7 Experiment D was carried out in a sealed container. If the volume of $SO_2(g)$ collected was $50cm^3$, calculate the reaction rate in $cm^3.s^{-1}$. (3)

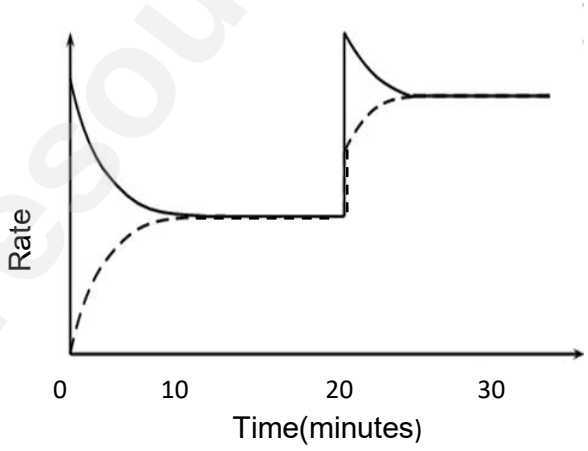
5.8 The original $Na_2S_2O_3$ solution was prepared by dissolving 100g of crystals in 250ml of water in a volumetric flask. Calculate the mass of the sulphur, S, that will form in experiment A if the $Na_2S_2O_3$ is limiting. (7)

[22]

QUESTION 6 (Start on a new page)

6.1 Methanol vapour is sealed in a closed container and it reaches equilibrium after 10 minutes at a temperature of 400K. After 20 minutes, the temperature is increased to 600K. Study the graph of rate verses time for the reaction and answer the questions.

$$2CH_2OH(g) \leftrightarrows 2CO(g) + 3H_2(g)$$



6.1.1 Is the above reaction homogenous or heterogeneous at equilibrium? Give reason for your answer. (2)

6.1.2 Write down a balanced equation for the reaction represented by the dotted line. (2)

6.1.3 Provide a reason for the decrease in reaction rate represented by the solid line between the times, 0 minutes and 10 minutes. (1)

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6.1.4 Is the reaction represented by the dotted line exothermic or endothermic? Give a reason for your answer. (3)

6.1.5 By referring to the graph explain what is happening between 10 and 20 minutes. (2)

6.1.6 How does the value of Kc compare between the 18th and 28th minute? Write only INCREASES, DECREASES OR REMAINS THE SAME. (1)

6.1.7 Draw a sketch graph showing the addition of a catalyst to the above reaction after 30 minutes. (4)

6.2 Sulphur trioxide is formed industrially during the Contact Process. This reaction is an example of dynamic equilibrium:

$$2\ SO_2\ (g) + O_2(g) \rightleftarrows 2\ SO_3\ (g) \qquad \Delta H = -197\ kJ.mol^{-1}$$

6.2.1 State Le Chatelier's principle. (2)

6.2.2 Use Le Chatelier's principle to determine what happens to the concentration of SO_3 when:
[Write only INCREASE, DECREASE, NO CHANGE]

6.2.2.1 temperature is increased. (1)

6.2.2.2 pressure is increased. (1)

6.2.3 0,3 moles of $SO_2(g)$ is mixed with an unknown mass of $O_2(g)$ in a sealed 10 dm^3 container. When equilibrium is reached at a certain temperature, it is found that 0,2 moles of SO_3 (g) is present. If the equilibrium constant (Kc) for the reaction at the temperature of 300K is 4, calculate the initial mass of O_2 that was present in the container. (8)

[27]

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QUESTION 7 (Start on a new page)

7.1 Define a Bronsted Lowry acid. (2)

7.2 A group of learners wish to identify element X, in weak base X_2CO_3.
They first dissolve 0,795g of X_2CO_3 in 250 ml volumetric flask with water to prepare a standard solution.
They then titrate this solution with 0,5 mol.dm^{-3} hydrochloric acid.
The results of their titration is found in the table below.

$$X_2CO_3\,(aq) + 2HCl\,(aq) \longrightarrow 2XCl(aq) + H_2O(aq) + CO_2(g)$$

	Volume of Acid(cm^3)	Volume of base(cm^3)
	14,8	12,5
	15,2	12,8
	15,1	11,9
	14,9	12,8
Average:	**15,0 cm^3**	**12,5 cm^3**

Identify element X in the equation by means of a suitable calculation. (8)

7.3 A learner spills a little hydrochloric acid on concentration 5 mol.dm^{-3} by accident on the laboratory desk. She quickly neutralizes the acid by sprinkling small amounts of sodium hydrogen carbonate on it. When all the acid was neutralized, he noticed that bubbles of carbon dioxide stops forming after 7g of sodium hydrogen carbonate was sprinkled.

$$NaHCO_3(aq) + 2HCl\,(aq) \longrightarrow 2NaCl(aq) + H_2O(aq) + CO_2(g)$$

7.3.1 Calculate the volume of hydrochloric acid that was spilled (in cm^3) if all the sodium hydrogen carbonate reacted with the acid. (6)

7.3.2 The learner dilutes some of the 5 mol.dm^{-3}, acid to 0,1 mol.dm^{-3}. Calculate the volume of the 5 mol.dm^{-3},hydrochloric acid needed to prepare 1 dm^3 of diluted acid. (3)

7.4 In a separate experiment the learner takes 3.68 g of an impure sample $NaHCO_3$ and adds it to distilled water to make up a 275cm^3 solution. During the titration he found that 25 cm^3 of this solution neutralized 23,5 cm^3 of a 0,11 mol.dm^{-3} solution of HCl.

7.4.1 If the concentration of the base at endpoint was 0,052 mol.dm^{-3}, calculate the percentage purity of the $NaHCO_3$ sample. (6)

7.4.2 Calculate the pH of the HCl solution. (3)

[28]

TOTAL: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2019

MARKS: 150

TIME: 3 hours

PHYSICAL SCIENCES: Paper 1

10841E

X05

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INSTRUCTIONS AND INFORMATION

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3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 A car is moving at a **constant velocity**.

Which ONE of the following statements about the forces acting on the car is CORRECT?

A The net force acting on the car is zero.

B There are no forces acting on the car.

C The weight of the car is equal to the normal force acting on the car.

D There is a non-zero net force acting on the car. (2)

1.2 A ball is projected vertically upwards. Ignore air resistance.

Which ONE of the following statements about the acceleration of the ball at its maximum height is CORRECT?

The acceleration is equal to …

A zero.

B *g* and is directed downwards.

C *g* and is directed upwards.

D *g* and is directed horizontally. (2)

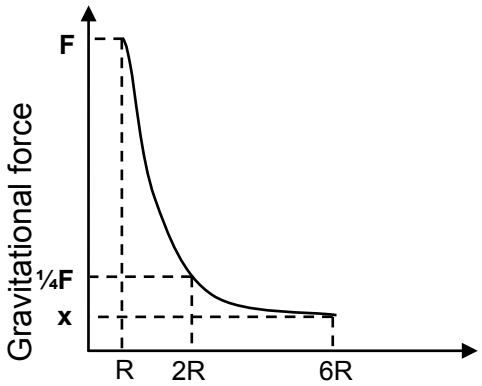
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1.3 The graph below, not drawn to scale, shows the relationship between the gravitational force on a given mass and its distance from the centre of Earth.

The magnitude of the force on the mass at a distance R from the centre of Earth is **F**.



Which ONE of the following is the CORRECT representation of the magnitude of force **x** shown on the graph?

A 6**F**

B 12**F**

C $\frac{1}{6}$**F**

D $\frac{1}{36}$**F** (2)

1.4 Ball M, moving at speed ***v*** to the right, collides with a stationary ball N on a smooth horizontal surface. Immediately after the collision, ball M comes to rest and ball N moves to the right with speed ***v***.

Which ONE of the following statements about the collision of the balls is CORRECT?

A Total momentum is conserved and the masses of the balls are unequal.

B Total kinetic energy is conserved and the masses of the balls are unequal

C Total momentum and total kinetic energy are conserved and the masses of the balls are equal.

D Total momentum is conserved but total kinetic energy is not conserved and the masses of the balls are equal. (2)

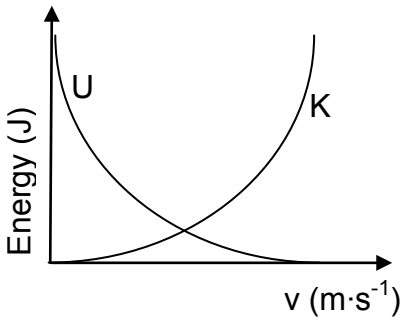
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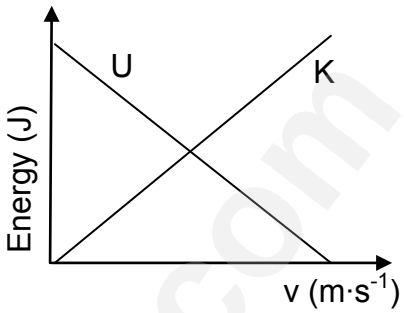
1.5 A small stone is dropped from rest and undergoes free fall.

Which ONE of the graphs below shows the CORRECT relationship between the gravitational potential energy (U) and speed *v* and the kinetic energy (K) and speed *v*, respectively, for the stone? The graphs are NOT drawn to scale.

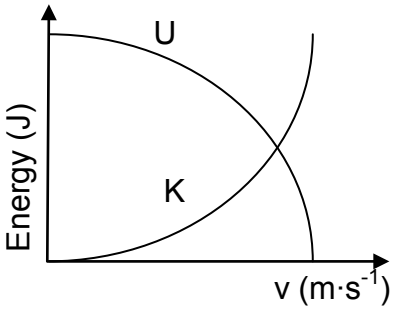
A



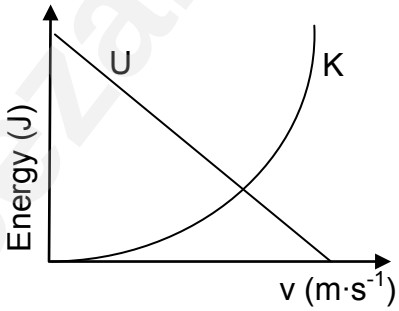
B



C



D



(2)

1.6 A stationary passenger at a railway station listens to a train approaching at constant speed.

Which ONE of the following is CORRECT for the sound of the approaching train heard by the stationary passenger?

A Lower pitch, lower frequency

B Higher pitch, lower frequency

C Higher pitch, higher frequency

D Lower pitch, higher frequency (2)

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1.7 Particle P has charge Q and particle R has charge 2Q. They are separated by a small distance, *r*.

Which ONE of the statements below about the electrostatic forces, F_{PR}, which P exerts on R and F_{RP}, which R exert on P, is CORRECT?

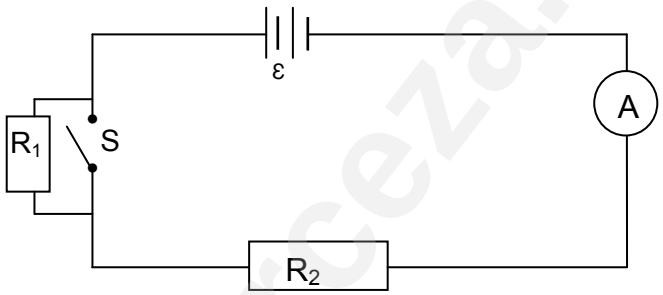
A $F_{PR} = ½F_{RP}$

B $F_{PR} = F_{RP}$

C $F_{PR} = 2F_{RP}$

D $F_{PR} = -F_{RP}$ (2)

1.8 A battery of emf ε and negligible internal resistance is connected in a circuit, as shown below. The resistances of R_1 and R_2 are high.



Which ONE of the following combinations about the ammeter readings will be CORRECT when switch S is open and when switch S is closed?

	SWITCH OPEN	SWITCH CLOSED
A	Ammeter reads only the current in R_1	Ammeter reads only the current in R_2
B	Ammeter reads only the current in R_2	Ammeter reads the current in both R_1 and R_2
C	Ammeter reads the current in both R_1 and R_2	Ammeter reads the current in both R_1 and R_2
D	Ammeter reads the current in both R_1 and R_2	Ammeter reads the current in R_2 only

(2)

1.9 The direction of the induced current in the coil of a generator depends on the …

A length of the coil.

B speed of rotation of the coil.

C direction of the magnetic field.

D strength of the magnetic field. (2)

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1.10 The work function of zinc is greater than that of magnesium.

Which ONE of the following statements about the threshold frequencies of the metals is CORRECT?

A The threshold frequency of zinc is greater than that of magnesium.

B The threshold frequency of zinc is smaller than that of magnesium.

C Both zinc and magnesium have the same threshold frequency.

D The threshold frequencies of zinc and magnesium are independent of their work functions. (2)

[20]

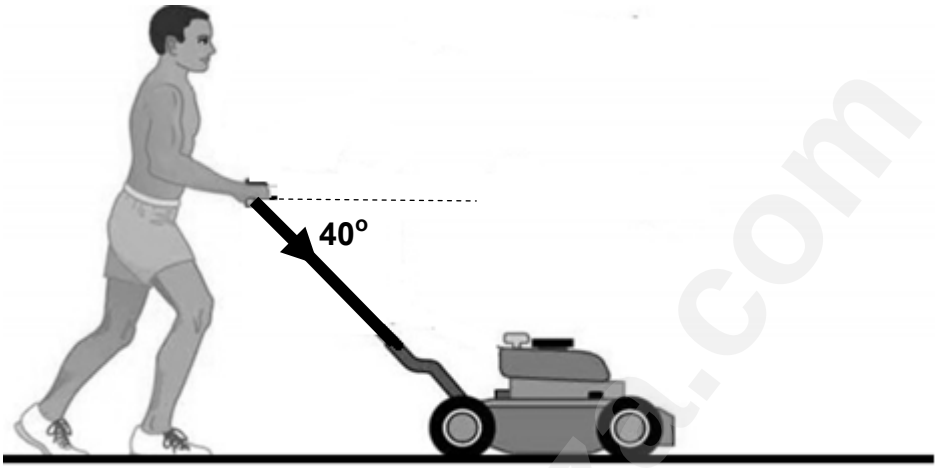
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QUESTION 2 (Start on a new page.)

2.1 A person pushes a lawn mower of mass 15 kg at a **constant speed** in a straight line over a flat grass surface with a force of 90 N. The force is directed along the handle of the lawn mower. The handle has been set at an angle of 40° to the horizontal. Refer to the diagram below.



2.1.1 Draw a labelled free-body diagram for the lawn mower. (4)

2.1.2 Why is it CORRECT to say that the moving lawn mower is in equilibrium? (1)

2.1.3 Calculate the magnitude of the frictional force acting between the lawn mower and the grass (3)

The lawn mower is now brought to a stop.

2.1.4 Calculate the magnitude of the constant force that must be applied through the handle in order to accelerate the lawn mower *from rest* to 2 $m \cdot s^{-1}$ in a time of 3 s. Assume that the frictional force between the lawn mower and grass remains the same as in QUESTION 2.1.3. (6)

2.2 Planet **Y** has a radius of 6 x 10^5 m. A 10 kg mass weighs 20 N on the surface of planet **Y**.

Calculate the mass of planet **Y**. (4)
[18]

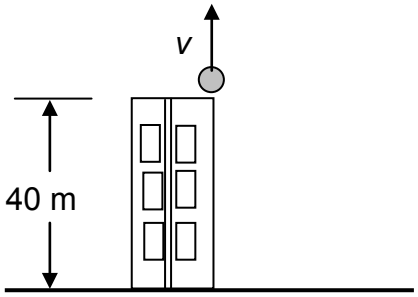
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QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards, with velocity *v*, from the edge of a roof of a 40 m tall building. The ball takes 1,53 s to reach its maximum height. Ignore air resistance.



3.1 Define the term *free fall*. (2)

3.2 Calculate the:

3.2.1 Magnitude of the initial velocity *v* of the ball (3)

3.2.2 Maximum height reached by the ball above the edge of the roof (3)

3.3 Take the edge of the roof as reference point. Determine the position of the ball relative to the edge of the roof after 4 s. (3)

3.4 Will any of the answers to QUESTIONS 3.2 and 3.3 change if the height of the building is 30 m? Choose from YES or NO.

Give a reason for the answer. (3)
[14]

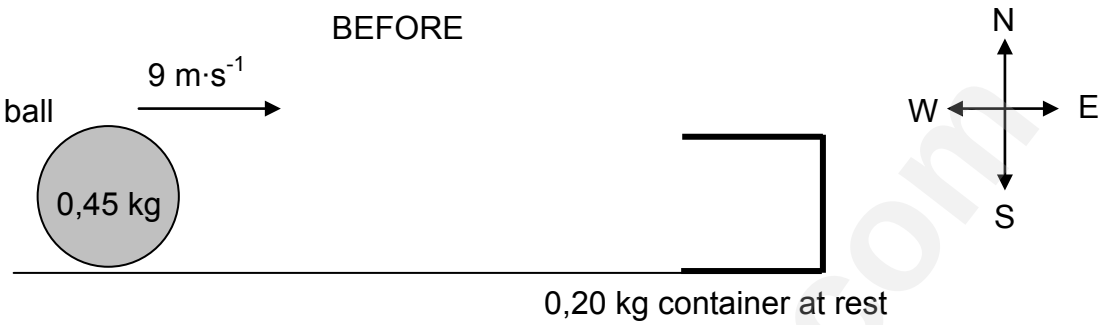
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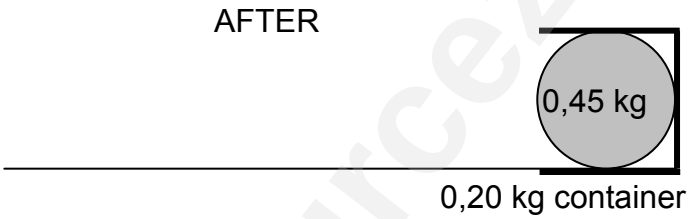
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QUESTION 4 (Start on a new page.)

A soccer player kicks a ball of mass 0,45 kg to the east. The ball travels horizontally at a velocity of 9 $m \cdot s^{-1}$ along a straight line, without touching the ground, and enters a container lying at rest on its side, as shown in the diagram below. The mass of the container is 0,20 kg.



The ball is stuck in the container after the collision. The ball and container now move together along a straight line towards the east. Ignore friction and rotational effects.



4.1 State the principle of conservation of linear momentum in words. (2)

4.2 Calculate the magnitude of the velocity of the ball-container system immediately after the collision. (4)

4.3 Determine, by means of a suitable calculation, whether the collision between the ball and container is elastic or inelastic. (5)

[11]

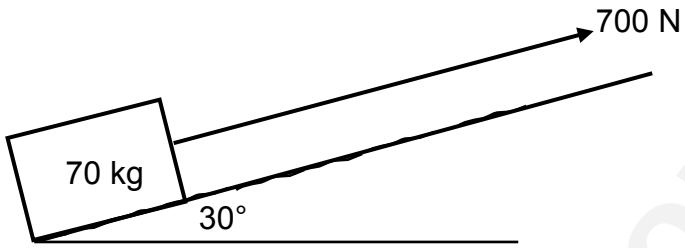
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QUESTION 5 (Start on a new page.)

A 70 kg box is initially at rest at the bottom of a ROUGH plane inclined at an angle of 30° to the horizontal. The box is pulled up the plane by means of a light inextensible rope, held parallel to the plane, as shown in the diagram below. The force applied to the rope is 700 N.



5.1 What is the name given to the force in the rope? (1)

5.2 Give a reason why the mechanical energy of the system will NOT be conserved as the box is pulled up the plane. (1)

The box is pulled up over a distance of 4 m along the plane. The kinetic frictional force between the box and the plane is 178,22 N.

5.3 Draw a labelled free-body diagram for the box as it moves up the plane. (4)

5.4 Calculate the work done on the box by the frictional force over the 4 m. (3)

5.5 Use energy principles to calculate the speed of the box after it has moved 4 m. (5)

5.6 When the box is 4 m up the incline, the rope accidentally breaks, causing the box to slide back down to the bottom of the inclined plane.

What will be the total work done by friction when the box moves up and then down to the bottom of the inclined plane? (1)

[15]

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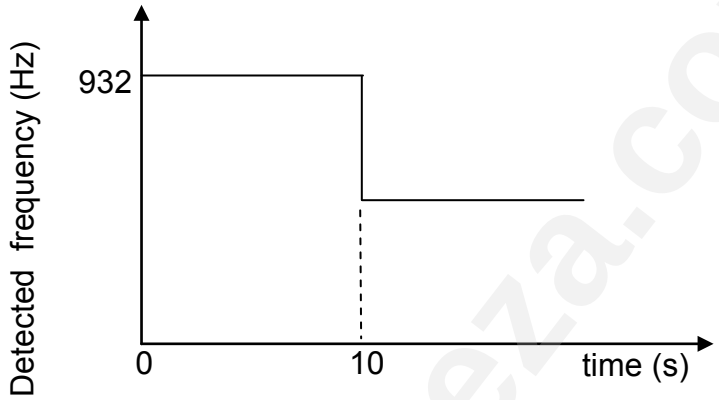
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QUESTION 6 (Start on a new page.)

6.1 A patrol car is moving at a constant speed towards a stationary observer. The driver switches on the siren of the car when it is 300 m away from the observer.

The observer records the detected frequency of the sound waves of the siren as the patrol car *approaches*, *passes* and *moves away* from him.

The information obtained is shown in the graph below.



6.1.1 Calculate the speed of the patrol car. (2)

6.1.2 State the Doppler effect. (2)

6.1.3 The detected frequency suddenly changes at t = 10 s. Give a reason for this change. (2)

Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1.4 Calculate the frequency of the sound emitted by the siren. (4)

6.2 State TWO applications of the Doppler effect. (2)
[12]

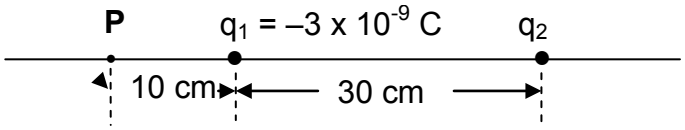
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QUESTION 7 (Start on a new page.)

Two point charges, q_1 and q_2, are placed 30 cm apart along a straight line. Charge $q_1 = -3 \times 10^{-9}$ C. Point **P** is 10 cm to the left of q_1, as shown in the diagram below. The **net** electrostatic field at point **P** is **zero.**



7.1 Define the term *electric field at a point*. (2)

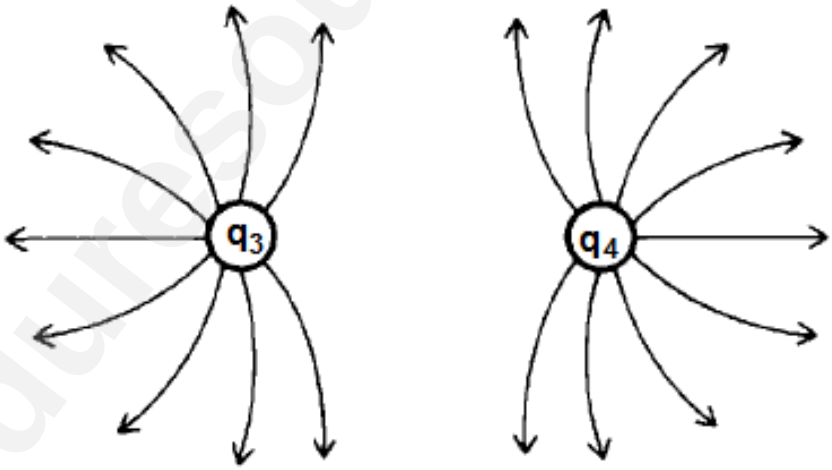
7.2 State, giving reasons, whether point charge q_2 is positive or negative. (3)

7.3 Calculate the magnitude of charge q_2. (4)

7.4 State Coulomb's law in words. (2)

7.5 Calculate the magnitude of the electrostatic force exerted by charge q_1 on charge q_2. (3)

7.6 The two charges are now brought into contact with each other and are then separated. A learner draws the electric field pattern for the new charges q_3 and q_4 **after** contact, as shown below.



Is the diagram CORRECT? Give a reason for the answer. (2)
[16]

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QUESTION 8 (Start on a new page.)

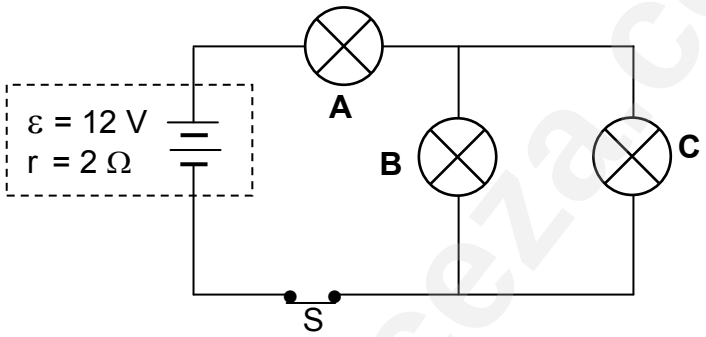
8.1 Three identical light bulbs, **A**, **B** and **C**, are each rated at 6 W, 12 V.

8.1.1 Define the term *power*. (2)

8.1.2 Calculate the resistance of EACH bulb when used as rated. (3)

The light bulbs are connected in a circuit with a battery having an emf (ε) of 12 V and internal resistance (*r*) of 2 Ω. Refer to the diagram below.

Assume that the resistance of each light bulb is the same as that calculated in QUESTION 8.1.2. Switch S is closed.

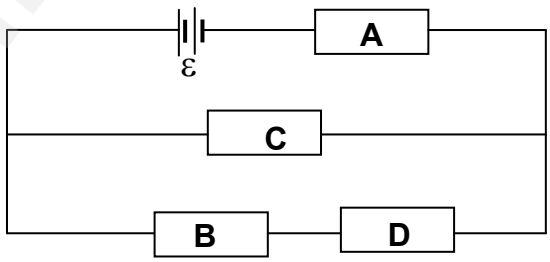


8.1.3 Calculate the total current in the circuit. (5)

8.1.4 Calculate the potential difference across light bulb **C**. (3)

8.1.5 Explain why light bulb **C** in the circuit will NOT burn at its maximum brightness. (3)

8.2 Resistors **A**, **B**, **C** and **D** are connected to a battery having emf (ε) and negligible internal resistance, as shown in the diagram below.



8.2.1 Give a reason why the current in resistor **A** is greater than that in resistor **C**. (2)

8.2.2 Resistor **C** is removed. How will the current in resistor **B** compare to the current in **A**? Give a reason for the answer. (2)

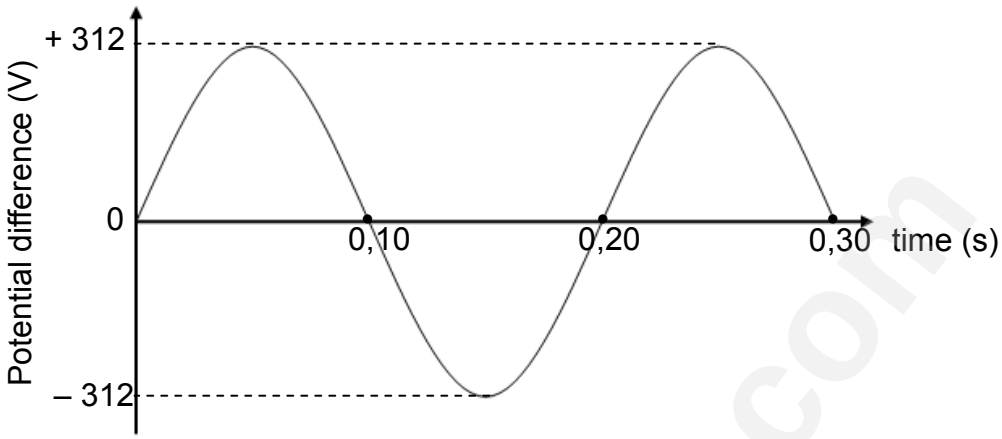
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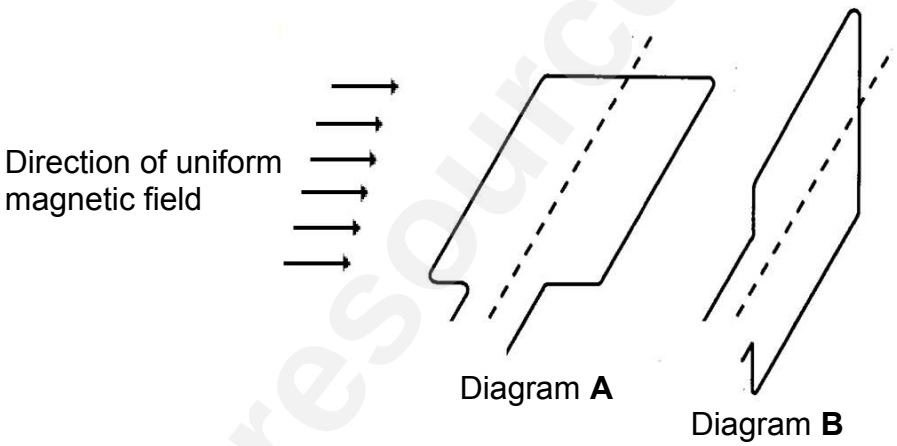
QUESTION 9 (Start on a new page.)

The diagram below shows the voltage output of a generator.



9.1 Does this generator have split rings or slip rings? (1)

9.2 Which ONE of the diagrams below, **A** or **B**, shows the position of the generator's coil at time = 0,10 s?



(1)

9.3 Calculate the root mean square (rms) voltage for this generator. (3)

9.4 A device with a resistance of 40 Ω is connected to this generator.

Calculate the:

9.4.1 Average power delivered by the generator to the device (3)

9.4.2 Maximum current delivered by the generator to the device (4)

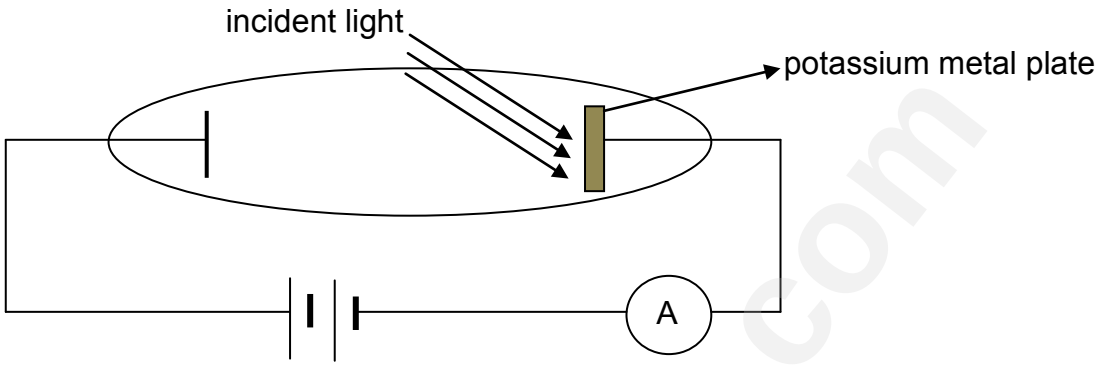
[12]

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QUESTION 10 (Start on a new page.)

A potassium metal plate is irradiated with light of wavelength 5 x 10^{-7} m in an arrangement, as shown below. The threshold frequency of potassium is 5,55 x 10^{14} Hz.



10.1 Define the term *threshold frequency*. (2)

10.2 Calculate the energy of a photon incident on the metal plate. (3)

10.3 Using a suitable calculation, prove that the ammeter will show a reading. (4)

10.4 The intensity of the light is now increased. Explain why this change causes an increase in the ammeter reading. (3)

[12]

TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6\ m$
Mass of the Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24}\ kg$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8\ m{\cdot}s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9\ N{\cdot}m^2{\cdot}C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$

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TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^{\,2} = v_i^{\,2} + 2a\Delta x$ or/*of* $v_f^{\,2} = v_i^{\,2} + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or /*of* $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(max/maks)}$ or/*of* $E = W_0 + K_{max/maks}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max/maks)} = \frac{1}{2}mv^2_{max/maks}$ or/*of* $K_{max/maks} = \frac{1}{2}mv^2_{max/maks}$	

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ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or / *of* $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf (ε) = $I(R + r)$ emk (ε) = $I(R + r)$
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{ave} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{ave} = I_{rms}^2R$ / $P_{gemiddeld} = I_{wgk}^2R$ $P_{ave} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: CHEMISTRY (P2)

2019

MARKS: 150

TIME: 3 hours

PHYSICAL SCIENCES: Paper 2

10842E

X05

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INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 Which ONE of the following is a SECONDARY alcohol?

A Ethanol

B Butan-1-ol

C Butan-2-ol

D 2-methylbutan-1-ol (2)

1.2 Which ONE of the following will RAPIDLY decolourise bromine water?

A CH_3CHCH_2

B $CH_3CH_2CH_3$

C CH_3COOCH_3

D CH_3CH_2COOH (2)

1.3 A FUNCTIONAL ISOMER of ethyl propanoate is …

A C_4H_9CHO.

B $C_5H_{11}OH$.

C C_4H_9COOH.

D $CH_3(CH_2)_3CHO$. (2)

1.4 Consider the balanced equation for a chemical reaction below.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

The activation energy of the forward and reverse reactions are 156 $kJ \cdot mol^{-1}$ and 175 $kJ \cdot mol^{-1}$ respectively.

The heat of reaction, in $kJ \cdot mol^{-1}$, for this reaction is …

A –19.

B +19.

C +331.

D –331. (2)

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1.5 The reaction given below reaches equilibrium in a closed container. The K_c value is 0,04 at a certain temperature.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \triangle H < 0$$

Which ONE of the following factors will change the K_c value to 0,4?

A Increase in pressure

B Decrease in pressure

C Increase in temperature

D Decrease in temperature (2)

1.6 Which ONE of the following statements best describes a state of dynamic equilibrium?

A The limiting reagent has been used up.

B The forward and reverse reactions have stopped.

C The rates of the forward and reverse reactions are equal.

D The concentration of products equals the concentration of reactants. (2)

1.7 During a titration to determine the concentration of an acid using a standard base, a learner pipettes the base into a conical flask. She then uses a small amount of water to rinse the inside of the flask so that all the base is part of the solution in the flask.

How will the extra water added to the flask affect the results of this titration?

The concentration of the acid …

A cannot be determined.

B will be lower than expected.

C will be higher than expected.

D will be the same as expected. (2)

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1.8 The standard reduction potentials for two substances used to set up a galvanic cell are as follows:

$Sn^{2+} + 2e^- \rightleftharpoons Sn$ $E^\theta = -0,14$ V

$Cu^{2+} + 2e^- \rightleftharpoons Cu$ $E^\theta = 0,34$ V

Which ONE of the following combinations gives the substances formed at each electrode when the cell is functioning?

	Cathode	Anode
A	Cu^{2+}	Sn
B	Sn	Cu^{2+}
C	Sn^{2+}	Cu
D	Cu	Sn^{2+}

(2)

1.9 Which ONE of the following half-reactions takes place at the POSITIVE ELECTRODE of an electrochemical cell used to electroplate an iron rod with silver?

A $Ag^+ + e^- \rightarrow Ag$

B $Fe^{2+} + 2e^- \rightarrow Fe$

C $Ag \rightarrow Ag^+ + e^-$

D $Fe \rightarrow Fe^{2+} + 2e^-$ (2)

1.10 Which ONE of the following elements is a primary nutrient?

A Potassium

B Sulphur

C Oxygen

D Carbon (2)

[20]

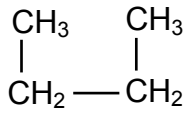
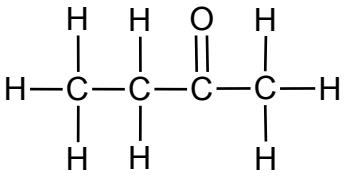
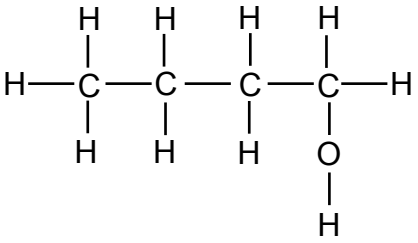
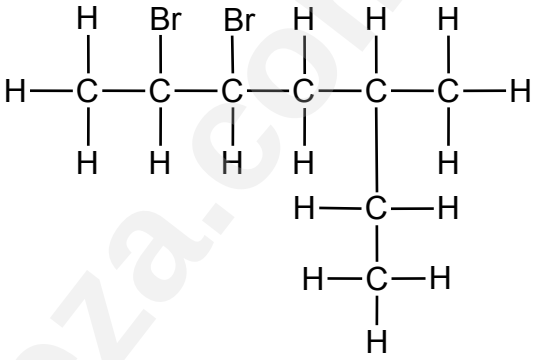
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QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A		**B**	
C	$CH_3CCCH_2CH_3$	**D**	Butyl propanoate
E		**F**	

2.1 Is compound **C** SATURATED or UNSATURATED? Give a reason for the answer. (2)

2.2 Write down the LETTER that represents each of the following:

2.2.1 An ester (1)

2.2.2 A FUNCTIONAL ISOMER of butanal (1)

2.2.3 A compound with the general formula C_nH_{2n-2} (1)

2.2.4 A compound used as reactant in the preparation of compound **D** (1)

2.3 Write down the STRUCTURAL FORMULA of:

2.3.1 The functional group of compound **C** (1)

2.3.2 Compound **D** (2)

2.3.3 A CHAIN ISOMER of compound **A** (2)

2.4 Write down the:

2.4.1 IUPAC name of compound **F** (3)

2.4.2 Balanced equation, using MOLECULAR FORMULAE, for the complete combustion of compound **A** (3)

[17]

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QUESTION 3 (Start on a new page.)

Three compounds are used to investigate one of the factors that influences boiling point. The results obtained are shown in the table below.

COMPOUND		MOLECULAR MASS ($g \cdot mol^{-1}$)	BOILING POINT (°C)
A	Butane	58	– 0,5
B	Propan-1-ol	60	98
C	Ethanoic acid	60	118

3.1 In one investigation the boiling points of compound **B** and compound **C** are compared.

3.1.1 Is this a fair investigation? Write down YES or NO. Refer to the data in the table and give a reason for the answer. (2)

3.1.2 Write down the independent variable for this investigation. (1)

3.2 Which ONE of the compounds (**A**, **B** or **C**) has the highest vapour pressure? Give a reason for the answer. (2)

3.3 Refer to the intermolecular forces present in each compound and FULLY explain the trend in boiling points, as shown in the above table. (5)

3.4 Which compound, BUTAN-1-OL or PROPAN-1-OL, has the higher boiling point? Give a reason for the answer. (2)
[12]

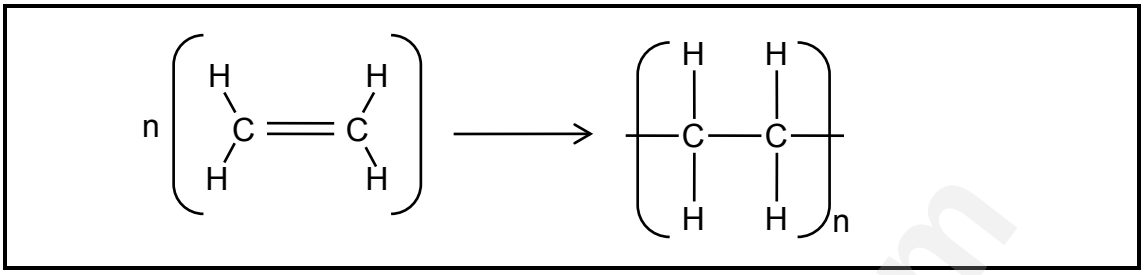
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QUESTION 4 (Start on a new page.)

4.1 The balanced equation for a polymerisation reaction is shown below.



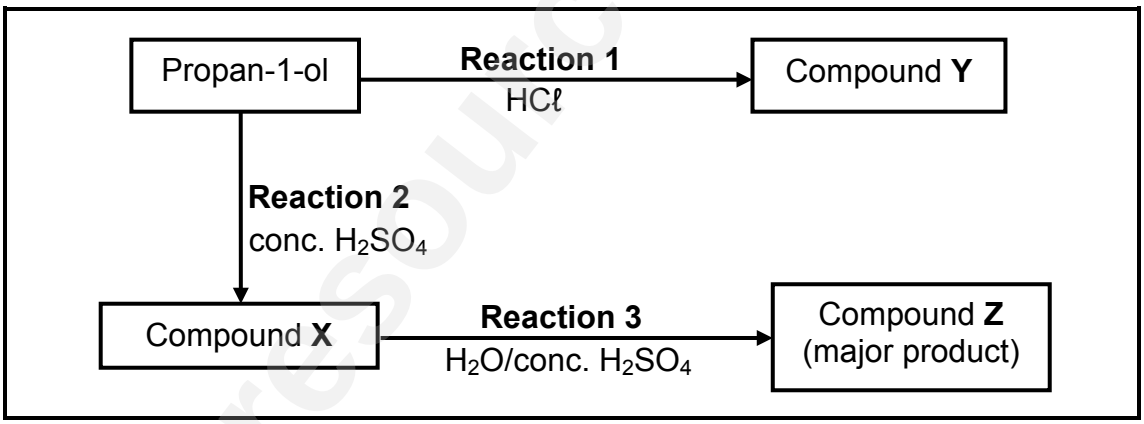
Write down the:

4.1.1 Type of polymerisation reaction represented by the equation (1)

4.1.2 IUPAC name of the monomer (1)

4.1.3 IUPAC name of the polymer (1)

4.2 Propan-1-ol undergoes two different reactions, as shown in the diagram below.



Write down the:

4.2.1 Type of reaction represented by **reaction 2** (1)

4.2.2 Function of concentrated H_2SO_4 in **reaction 2** (1)

4.2.3 IUPAC name of compound **X** (2)

4.2.4 STRUCTURAL FORMULA of compound **Y** (2)

4.2.5 Type of reaction represented by **reaction 3** (1)

4.2.6 IUPAC name of compound **Z** (2)

[12]

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QUESTION 5 (Start on a new page.)

Learners use the reaction of a sodium thiosulphate solution with dilute hydrochloric acid to investigate several factors that affect the rate of a chemical reaction. The balanced equation for the reaction is:

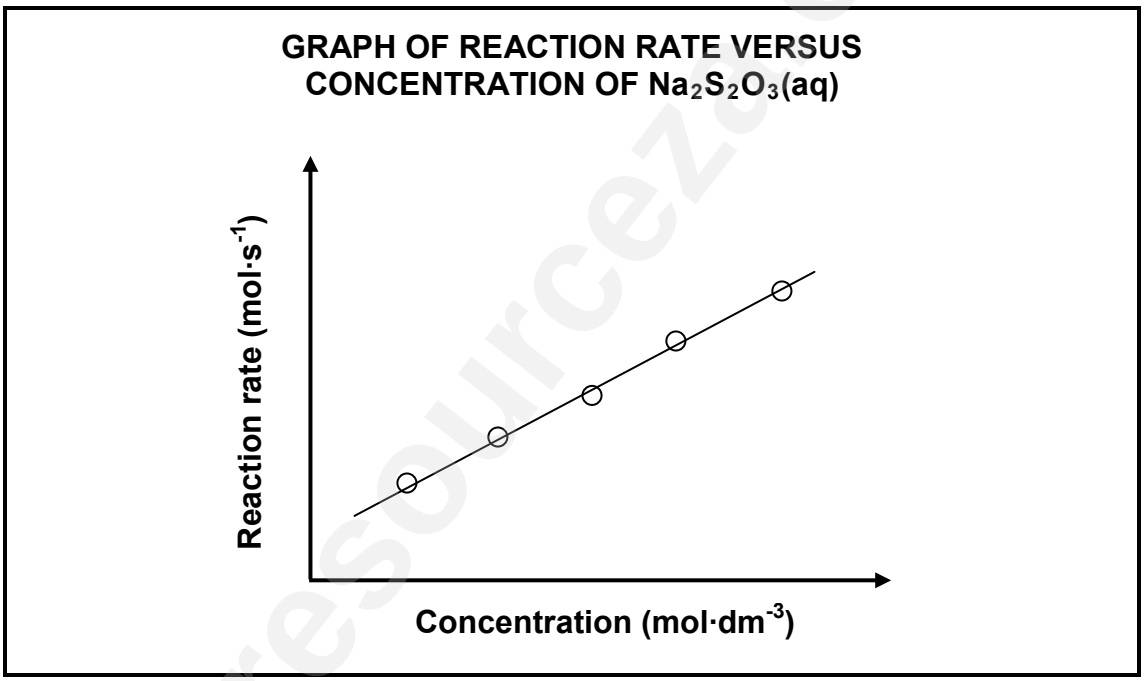
$$Na_2S_2O_3(aq) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + SO_2(g) + S(s) + H_2O(\ell)$$

5.1 Define *reaction rate*. (2)

Three investigations (**I**, **II** and **III**) are carried out.

5.2 **INVESTIGATION I**

The results obtained in INVESTIGATION **I** are shown in the graph below.



For this investigation, write down the:

5.2.1 Dependent variable (1)

5.2.2 Conclusion that can be drawn from the results (2)

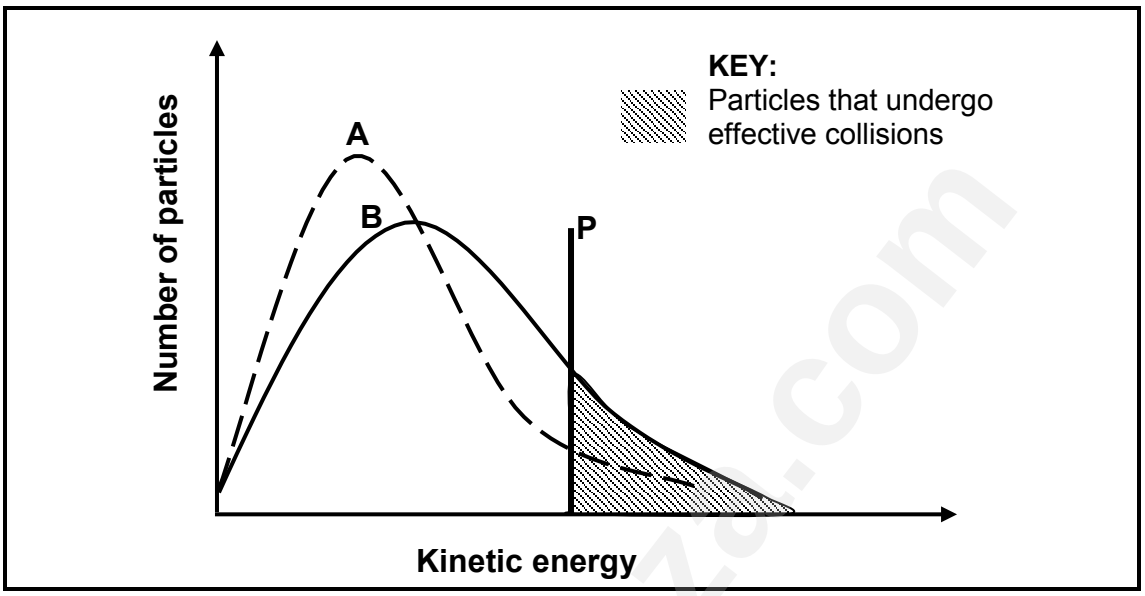
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5.3 **INVESTIGATION II**

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The Maxwell-Boltzmann distribution curves, **A** and **B**, below represent the number of particles against kinetic energy for the reaction at two different temperatures.



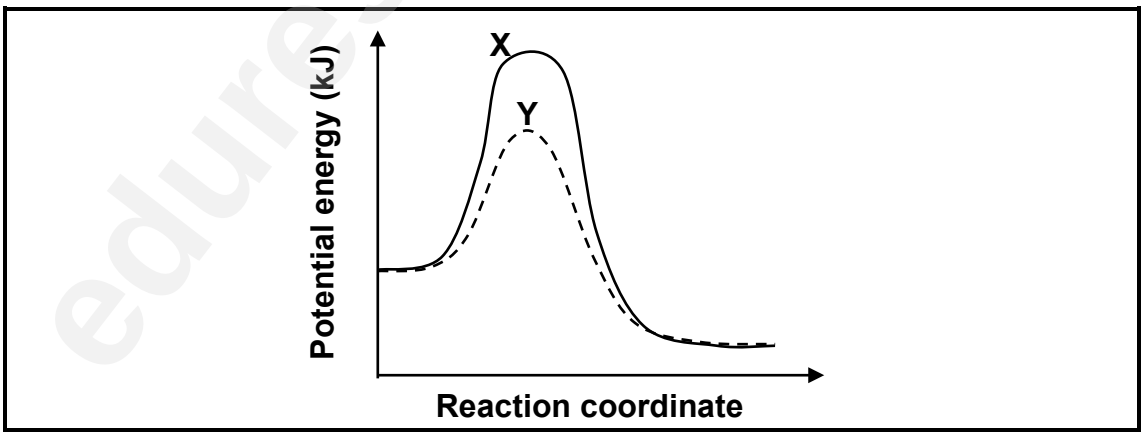
5.3.1 What does line **P** represent? (1)

5.3.2 Which curve (**A** or **B**) was obtained at the higher temperature? (1)

5.3.3 Explain, in terms of the collision theory, how an increase in temperature influences the rate of a reaction. (4)

5.4 **INVESTIGATION III**

The potential energy diagrams, **X** and **Y**, below represent the reaction under two different conditions.



Give a reason why curve **Y** differs from curve **X**. (1)

5.5 In one of the investigations, 100 cm^3 of 0,2 $mol \cdot dm^{-3}$ $HC\ell(aq)$ reacts with excess $Na_2S_2O_3(aq)$ and the solution is then filtered. After filtration of the solution, 0,18 g of sulphur is obtained. Calculate the PERCENTAGE YIELD of sulphur. (6)

[18]

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QUESTION 6 (Start on a new page.)

The balanced equation below represents the reaction used in the Haber process to produce ammonia.

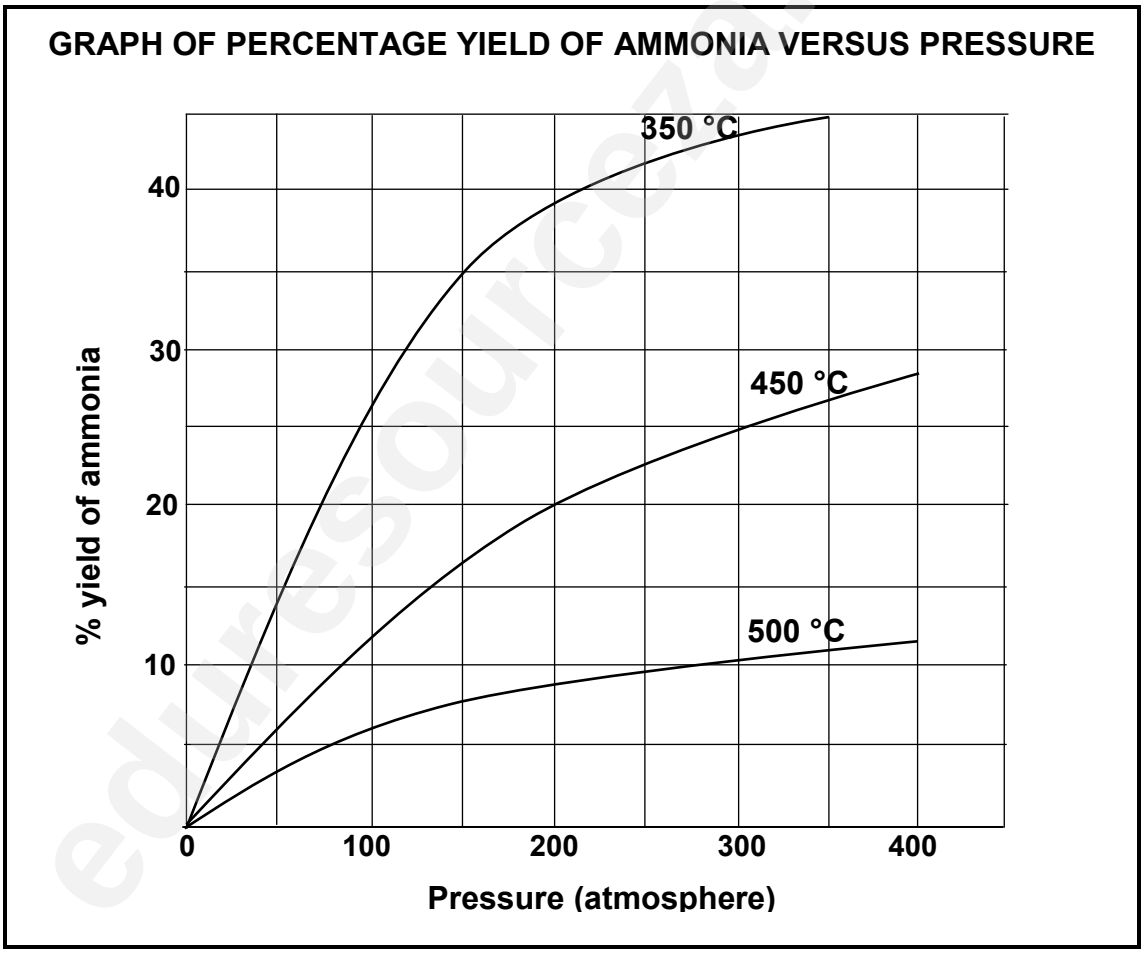
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

In industry the product is removed as quickly as it forms.

6.1 Write down the meaning of the double arrow used in the equation above. (1)

6.2 Give ONE reason why ammonia is removed from the reaction vessel as quickly as it forms. (1)

The graph below shows the percentage yield of ammonia at different temperatures and pressures.



6.3 Write down the percentage yield of ammonia at a temperature of 450 °C and a pressure of 200 atmospheres. (1)

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6.4 Refer to Le Chatelier's principle to explain EACH of the following deductions made from the graph:

6.4.1 For a given pressure, the yield of ammonia at 500 °C is much lower than that at 350 °C (3)

6.4.2 For a given temperature, the yield of ammonia at 350 atmospheres is much higher than that at 150 atmospheres (2)

6.5 A technician prepares $NH_3(g)$ by reacting 6 moles of $H_2(g)$ and 6 moles of $N_2(g)$.

6.5.1 Calculate the maximum number of moles of $NH_3(g)$ that can be obtained in this reaction. (2)

6.5.2 The above reaction now takes place in a 500 cm^3 container at a temperature of 350 °C and a pressure of 150 atmospheres. The system is allowed to reach equilibrium.

Use the graph above and calculate the equilibrium constant, K_c, for this reaction under these conditions. (7)

[17]

QUESTION 7 (Start on a new page.)

7.1 Define a *base* in terms of the Arrhenius theory. (2)

7.2 Explain how a *weak base* differs from a *strong base*. (2)

7.3 Write down the balanced equation for the hydrolysis of $NaHCO_3$. (3)

7.4 A learner wishes to identify element **X** in the hydrogen carbonate, $XHCO_3$. To do this she dissolves 0,4 g of $XHCO_3$ in 100 cm^3 of water. She then titrates all of this solution with a 0,2 mol dm^{-3} hydrochloric acid ($HC\ell$) solution. Methyl orange is used as the indicator during the titration.

7.4.1 Calculate the pH of the hydrochloric acid solution. (3)

7.4.2 Give a reason why methyl orange is a suitable indicator in this titration. (1)

At the endpoint she finds that 20 cm^3 of the acid neutralised ALL the hydrogen carbonate solution. The balanced equation for the reaction is:

$$XHCO_3(aq) + HC\ell(aq) \rightarrow XC\ell(aq) + CO_2(g) + H_2O(\ell)$$

7.4.3 Identify element **X** by means of a calculation. (6)

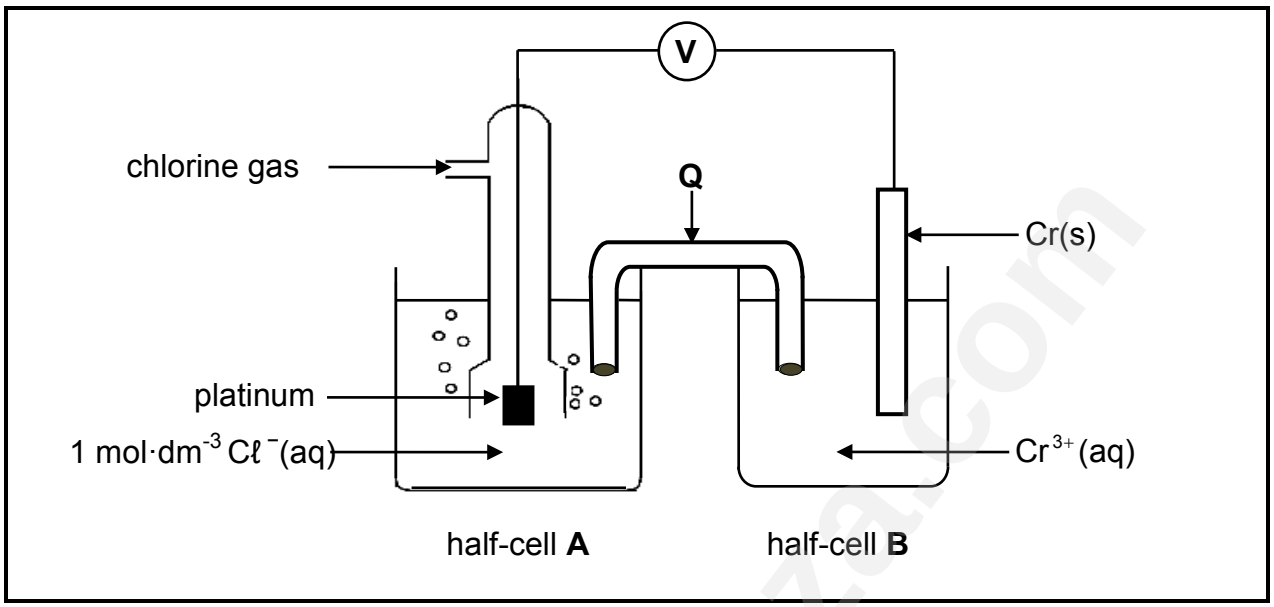
[17]

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QUESTION 8 (Start on a new page.)

The electrochemical cell below functions under standard conditions.



8.1 Give a reason why platinum is used as the electrode in half-cell **A**. (1)

8.2 Write down the:

8.2.1 Energy conversion that takes place in this cell (1)

8.2.2 Half-reaction that takes place at the cathode (2)

8.2.3 Cell notation for this cell (3)

8.3 Calculate the initial emf of this cell. (4)

8.4 Silver chloride is an insoluble salt.

What will be the effect on the cell potential when a small amount of silver nitrate solution, $AgNO_3(aq)$, is added to half-cell **A**? Choose from INCREASES, DECREASES or REMAINS THE SAME. (2)

[13]

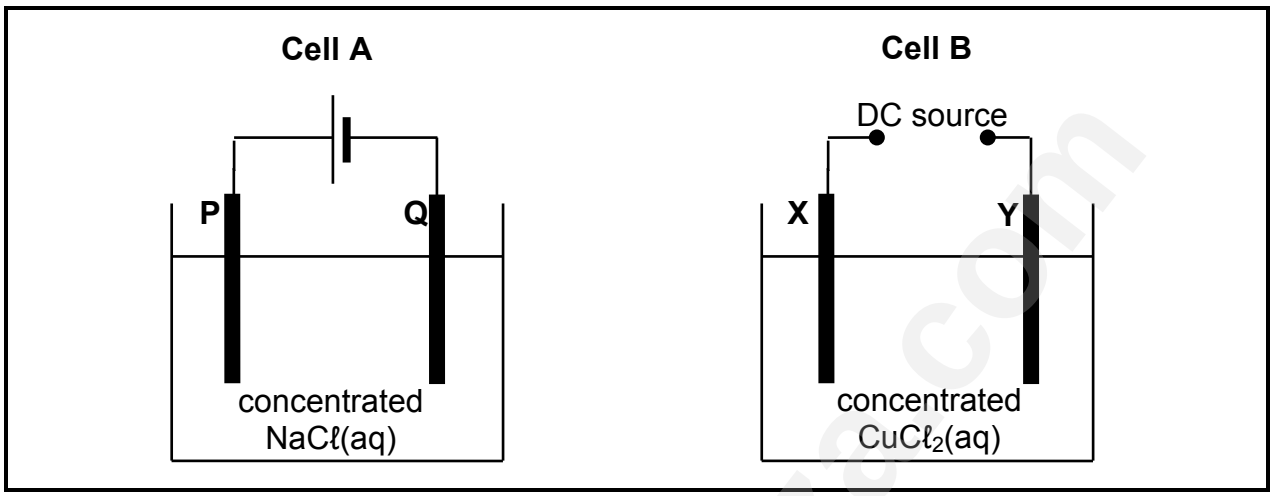
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QUESTION 9 (Start on a new page.)

The diagrams below represent two electrochemical cells.

P, **Q**, **X** and **Y** are carbon electrodes.



When cell **B** is functioning, the mass of electrode **X** increases.

9.1 What type of electrochemical cell, GALVANIC or ELECTROLYTIC, is illustrated above? (1)

9.2 Write down the half-reaction that takes place at electrode **Q**. (2)

9.3 The products formed in the two cells are compared.

9.3.1 Name ONE substance that is produced in BOTH cells. (1)

9.3.2 Write down the LETTERS of the TWO electrodes where this product is formed. Choose from **P**, **Q**, **X** and **Y**. (2)

9.4 Is electrode **X** the CATHODE or the ANODE? Give a reason for the answer. (2)

9.5 Write down the net (overall) cell reaction that takes place in cell **B**. (3)
[11]

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QUESTION 10 (Start on a new page.)

10.1 The four steps in the manufacture of an inorganic fertiliser are listed below. These steps are NOT written in the order in which they occur.

Step I: Sulphuric acid reacts with ammonia to produce ammonium sulphate.
Step II: Sulphur dioxide reacts with oxygen to produce sulphur trioxide.
Step III: Oleum is diluted with water to produce sulphuric acid.
Step IV: Sulphur trioxide is bubbled in concentrated sulphuric acid to produce oleum.

Write down the:

10.1.1 Correct order in which the steps occur in the preparation of the inorganic fertiliser by using the numbers **I** to **IV** (1)

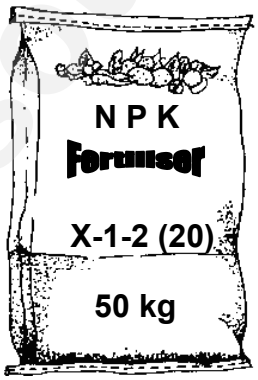
10.1.2 Balanced chemical equation for **step I** (3)

10.1.3 NAME of the catalyst used in **step II** (1)

10.1.4 Balanced chemical equation for **step IV** (3)

10.1.5 Reason why sulphur trioxide is NOT dissolved in water in **step IV** (1)

10.2 The diagram below shows a bag of NPK fertiliser. One of the numbers of the NPK ratio on the bag is labelled as **X**.



If the mass of potassium in the bag is 3,33 kg, calculate the value of **X**. (4)
[13]

TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^{5}$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	pH = $-\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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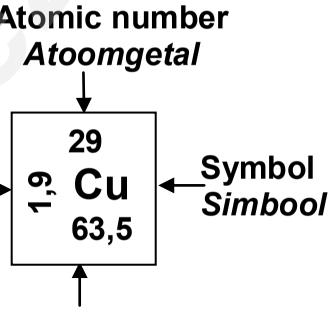
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 **1** **H** 1																	**2** **He** 4
1,0 **3** **Li** 7	1,5 **4** **Be** 9											2,0 **5** **B** 11	2,5 **6** **C** 12	3,0 **7** **N** 14	3,5 **8** **O** 16	4,0 **9** **F** 19	**10** **Ne** 20
0,9 **11** **Na** 23	1,2 **12** **Mg** 24											1,5 **13** **Aℓ** 27	1,8 **14** **Si** 28	2,1 **15** **P** 31	2,5 **16** **S** 32	3,0 **17** **Cℓ** 35,5	**18** **Ar** 40
0,8 **19** **K** 39	1,0 **20** **Ca** 40	1,3 **21** **Sc** 45	1,5 **22** **Ti** 48	1,6 **23** **V** 51	1,6 **24** **Cr** 52	1,5 **25** **Mn** 55	1,8 **26** **Fe** 56	1,8 **27** **Co** 59	1,8 **28** **Ni** 59	1,9 **29** **Cu** 63,5	1,6 **30** **Zn** 65	1,6 **31** **Ga** 70	1,8 **32** **Ge** 73	2,0 **33** **As** 75	2,4 **34** **Se** 79	2,8 **35** **Br** 80	**36** **Kr** 84
0,8 **37** **Rb** 86	1,0 **38** **Sr** 88	1,2 **39** **Y** 89	1,4 **40** **Zr** 91	**41** **Nb** 92	1,8 **42** **Mo** 96	1,9 **43** **Tc**	2,2 **44** **Ru** 101	2,2 **45** **Rh** 103	2,2 **46** **Pd** 106	1,9 **47** **Ag** 108	1,7 **48** **Cd** 112	1,7 **49** **In** 115	1,8 **50** **Sn** 119	1,9 **51** **Sb** 122	2,1 **52** **Te** 128	2,5 **53** **I** 127	**54** **Xe** 131
0,7 **55** **Cs** 133	0,9 **56** **Ba** 137	**57** **La** 139	1,6 **72** **Hf** 179	**73** **Ta** 181	**74** **W** 184	**75** **Re** 186	**76** **Os** 190	**77** **Ir** 192	**78** **Pt** 195	**79** **Au** 197	**80** **Hg** 201	1,8 **81** **Tℓ** 204	1,8 **82** **Pb** 207	1,9 **83** **Bi** 209	2,0 **84** **Po**	2,5 **85** **At**	**86** **Rn**
0,7 **87** **Fr**	0,9 **88** **Ra** 226	**89** **Ac**															

58 **Ce** 140	**59** **Pr** 141	**60** **Nd** 144	**61** **Pm**	**62** **Sm** 150	**63** **Eu** 152	**64** **Gd** 157	**65** **Tb** 159	**66** **Dy** 163	**67** **Ho** 165	**68** **Er** 167	**69** **Tm** 169	**70** **Yb** 173	**71** **Lu** 175
90 **Th** 232	**91** **Pa**	**92** **U** 238	**93** **Np**	**94** **Pu**	**95** **Am**	**96** **Cm**	**97** **Bk**	**98** **Cf**	**99** **Es**	**100** **Fm**	**101** **Md**	**102** **No**	**103** **Lr**

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TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARDREDUKSIEPOTENSIALE

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Half-reactions/*Halfreaksies*			$E^{\ominus}$ (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

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TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARDREDUKSIEPOTENSIALE

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Half-reactions/*Halfreaksies*			$E^{\ominus}$ (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	– 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

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Increasing reducing ability/*Toenemende reduserende vermoë* ↑

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Department of Education
FREE STATE PROVINCE

EXAMINATION

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

JUNE 2019

MARKS: 150

TIME: 3 HOURS

This paper consists of 13 pages and three information sheets.

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INSTRUCTIONS AND INFORMATION

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1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of NINE questions. Answer ALL questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave one line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable pocket calculator.

7. You may use appropriate mathematical instruments.

8. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your FINAL numerical answers to a minimum of TWO decimal places where applicable.

11. Give brief motivations, discussions, et cetera where required.

12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down only the letter A, B, C or D next to the question number (1.1–1.10) in your ANSWER BOOK.

1.1 The frictional force acting on a sliding object ...

A is inversely proportional to the normal force.

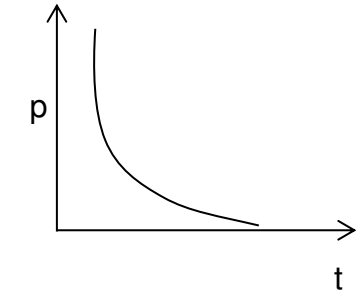
B depends on the magnitude of the area of contact.

C depends on the velocity of motion.

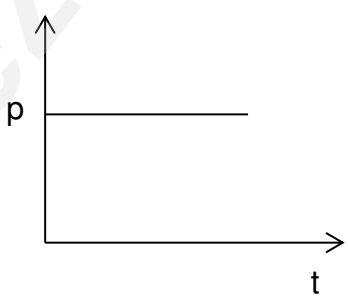
D depends on the type of surface. (2)

1.2 Which one of the following momentum/time graphs best represents the motion of an object that starts from rest and move in a straight line under the influence of a constant, net force?

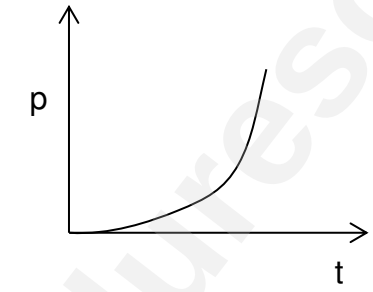
A



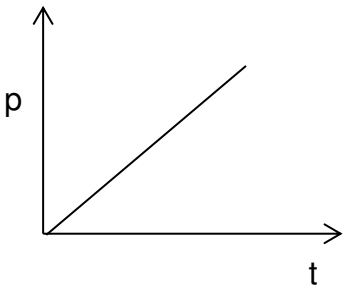
B



C



D



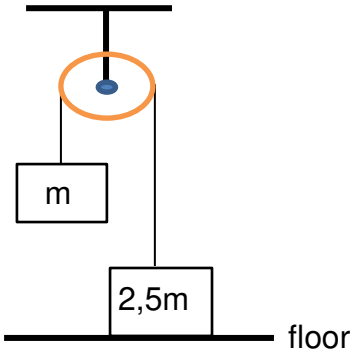
(2)

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1.3 Two objects with masses *m* and 2,5*m* are connected by a string that runs over a pulley as shown in the diagram below. The 2,5*m* mass rests on the floor. Ignore the mass of the pulley, the string and all the effects of friction.



Which one of the following represents the tension in the string?

A 3,5mg

B 2,5mg

C 1,5mg

D mg (2)

1.4 An object is projected vertically upward. Ignore air resistance. As the object rises, its velocity …

A decreases and its acceleration remains constant.

B increases and its acceleration remains constant.

C decreases and its acceleration increases.

D increases and its acceleration decreases. (2)

1.5 A non-conservative force is a force …

A which is not in contact with an object when it moves between two points and depends on the path taken.

B which is in contact with an object when it moves between two points but does not depend on the path taken.

C for which the work done in moving an object between two points depends on the path taken.

D for which the work done in moving an object between two points does not dependent of the path taken. (2)

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1.6 The kinetic energy of a car, moving at a constant velocity *v*, is equal to *K*. The velocity of the car then changes to 2*v*. What is the new kinetic energy of the car?

A $\frac{1}{4}$K

B $\frac{1}{2}$K

C 2K

D 4K (2)

1.7 Which one of the following is used to measure the rate of blood flow in a person?

A Doppler effect

B Photoelectric effect

C Atomic emission spectrum

D Atomic absorption spectrum (2)

1.8 The sketch below shows two small, metal spheres, **A** and **B**, on insulated stands. They carry charges of magnitude *q* and 2*q* respectively. The distance between the centres of the two spheres is *r*.



Sphere **A** exerts a force with a magnitude of *F* on sphere **B**. What is the magnitude of the force that sphere **B** exerts on sphere **A**?

A $\frac{1}{2}$F

B F

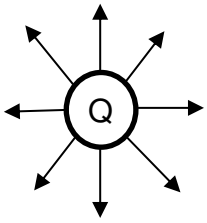
C 2F

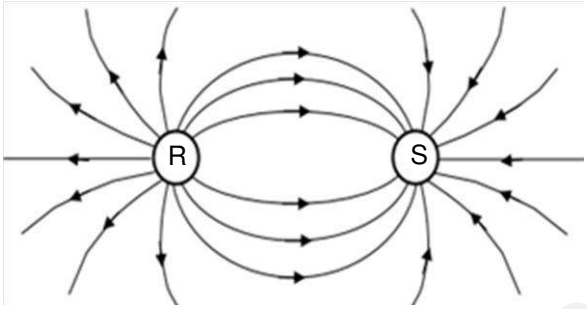
D 4F (2)

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1.9 Consider the electric field patterns around charged particles **Q**, **R** and **S**.

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What is the charge on each of particles **Q**, **R** and **S**?

	Charge on Q	**Charge on R**	**Charge on S**
A	Negative	Negative	Positive
B	Positive	Positive	Negative
C	Negative	Positive	Negative
D	Positive	Positive	Positive

(2)

1.10 Two bulbs, **X** and **Y**, are connected in SERIES to a battery. Bulb **X** glows BRIGHTER than bulb **Y**. Ignore the internal resistance of the battery as well as the resistance of the connecting wires.

X and **Y** are then disconnected and RE-CONNECTED IN PARALLEL with each other to the same battery. Which one of the following combinations is correct?

	Comparison of the brightness of X in the series versus the parallel connection	**Comparison of the brightness of X and Y in the parallel connection**
A	Brighter in parallel	**X** is brighter than **Y**.
B	Brighter in series	**X** is brighter than **Y**.
C	Brighter in parallel	**X** is dimmer than **Y**.
D	Brighter in series	**X** is dimmer than **Y**.

(2)
[20]

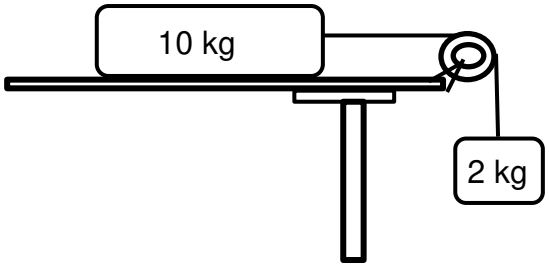
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QUESTION 2

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The diagram below shows a 10 kg block resting on a rough, horizontal table. The block is connected by means of a light, inextensible string to a 2 kg block, which is hanging over the side of the table. The string runs over a light, frictionless pulley. The blocks are STATIONARY.



2.1 State *Newton's first law of motion* in words. (2)

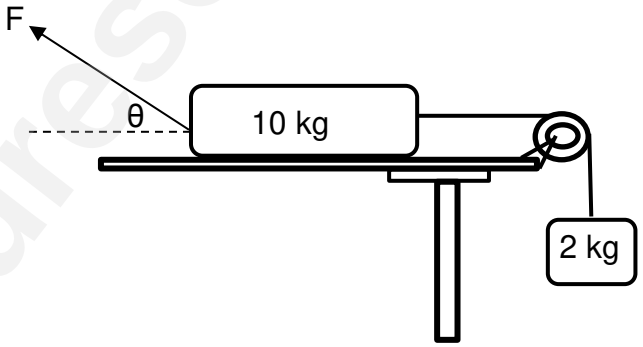
2.2 Write down the magnitude of the NET force acting on the 10 kg block. (1)

2.3 When a horizontal force *F* is applied to the 10 kg block, it accelerates to the left at 1,2 $m \cdot s^{-2}$.

2.3.1 Draw a free-body diagram of ALL THE FORCES acting on the 10 kg block when *F* is applied to it. (5)

2.3.2 Calculate the magnitude of *F* if the coefficient of kinetic friction for the 10 kg block and the surface of the table is 0,21. (5)

2.4 The two blocks are put back in their original, stationary positions and force *F* is once again applied to the 10 kg block. The magnitude of *F* is the SAME as before, but *F* is applied at an angle θ to the horizontal as shown below.



Will the force of friction on the 10 kg block be GREATER THAN, THE SAME AS or LESS THAN before? Give a reason for your answer. (2)

[15]

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QUESTION 3

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3.1 An object with a weight of 140 N on the surface of the earth is moved to a position which is 6,7 x 10^6 m above the surface of the earth.

3.1.1 State *Newton's law of universal gravitation* in words. (2)

3.1.2 Calculate the magnitude of the object's weight, with respect to the earth, at this new position WITHOUT USING the equation $w = mg$. (6)

3.1.3 Calculate the magnitude of the object's gravitational acceleration at this new position. (3)

3.2 A spaceship, on its way to the moon from the earth, reaches a point **Y** where the magnitude of the earth's gravitational force on the spaceship is equal to the magnitude of the moon's gravitational force on the spaceship. Assume that the mass of the earth is 81 times heavier than the mass of the moon. **X** and **Z** represent the centres of the earth and moon respectively.

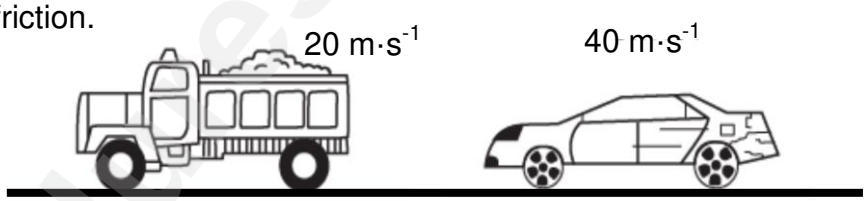


Write down AN EQUATION to give the relationship between distance **ZY** and **XY**. (2)

[13]

QUESTION 4

A car, mass 1 000 kg, is moving at 40 m·s^{-1} west when it collides with the back of a truck, mass 5 000 kg, moving in the same direction at 20 m·s^{-1}. The truck and the car become intertwined during the collision, which lasts for 0,5 s. Ignore the effect of friction.



4.1 State the *principle of conservation of linear momentum* in words. (2)

4.2 Calculate the velocity of the truck-car system immediately after the collision. (4)

4.3 Research has shown that forces greater than 85 000 N during collisions may cause fatal injuries. Determine, by means of a calculation, whether this collision could result in a fatal injury. (5)

4.4 Is this collision elastic or inelastic? Support your answer by means of calculations and a brief explanation. (4)

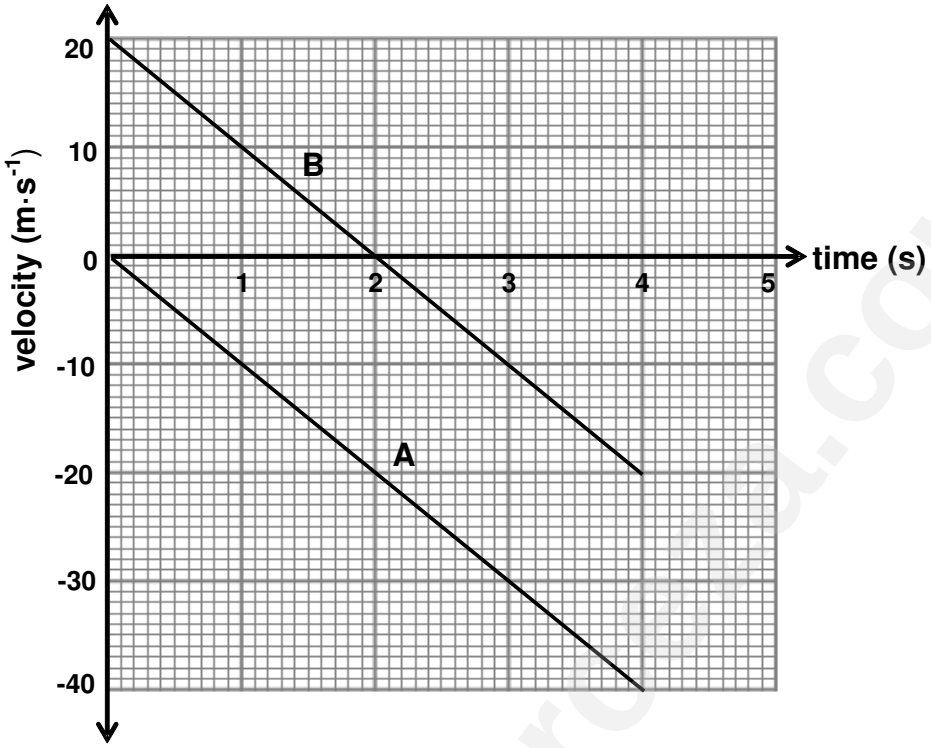
[15]

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QUESTION 5

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The velocity/time graph shown below represents the motion of two objects, **A** and **B**. Object **A** is DROPPED from REST from a certain height above the earth. At the same instant, object **B** is PROJECTED vertically upwards from the SAME height above the earth. Ignore the effects of air resistance.



5.1 Define the term *projectile*. (2)

5.2 What is represented by the GRADIENT of a velocity/time graph? (1)

5.3 Give a reason why the gradients of the two graphs are the same. (1)

5.4 Object **A** hits the ground after 4 seconds. Use the ACCELERATION represented by the GRAPHS and calculate the following:

5.4.1 Height from which object **A** was dropped. (4)

5.4.2 Velocity with which object **B** hits the ground. (4)

5.5 Use the SAME DIRECTION CONVENTION as for the velocity/time graph and sketch a displacement/time graph for the motion of object **B** from the moment it is projected upwards until it hits the ground. Clearly indicate the following:

- Time taken to reach maximum height.
- Height above the earth from where it was projected. (3)

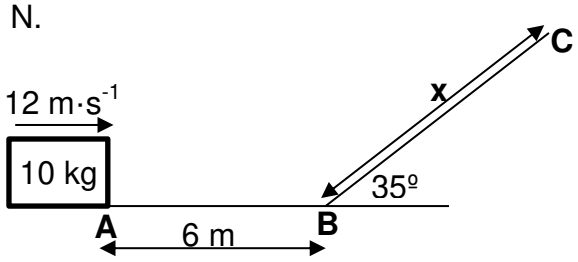
[15]

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QUESTION 6

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6.1 A block with a mass of 10 kg is sliding along a uniform, rough surface. The surface is horizontal from **A** to **B**, but inclined, at an angle of 35º to the horizontal, from **B** to **C**. The block is travelling at a speed of 12 m·s^{-1} as it passes point **A**. The frictional force acting on the block from **A** to **B** is 54,9 N.



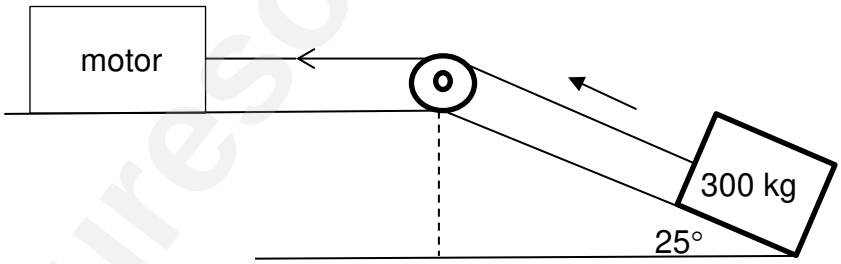
6.1.1 Calculate the kinetic energy of the block as it passes point **A**. (3)

6.1.2 State *the work-energy theorem* in words. (2)

6.1.3 Calculate the speed of the block as it reaches point **B**. (4)

6.1.4 The block then slides up the incline from point **B** and comes to rest at point **C**. The frictional force acting on the block from **B** to **C** is 45,0 N. Use energy principles to calculate the distance, **x**, from **B** to **C**. (5)

6.2 A motor pulls a crate, mass 300 kg, up an incline with a constant force by means of a light, inextensible rope as shown below. The rope runs over a light, frictionless pulley. The crate moves up the incline at a constant speed of 0,5 m·s^{-1}. The coefficient of kinetic friction for the crate and inclined plane is 0,19.



6.2.1 Define the term *power* in words. (2)

6.2.2 Calculate the magnitude of the frictional force on the crate. (3)

6.2.3 Calculate the average power delivered by the motor while pulling the crate up the incline. (6)

[25]

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QUESTION 7

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7.1 The siren of a stationary ambulance emits sound with a wavelength of 0,2875 m. When the ambulance moves at a constant speed, a stationary observer detects a frequency that is 6% LOWER than that emitted by the siren. Take the speed of sound in air as 345 $m \cdot s^{-1}$.

7.1.1 Define the *Doppler effect* in words. (2)

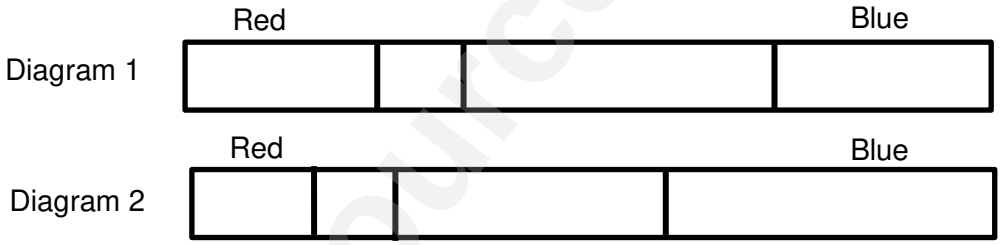
7.1.2 Is the ambulance moving towards or away from the observer? Give a reason for your answer. (2)

7.1.3 Calculate the frequency of the sound emitted by the siren. (3)

7.1.4 Calculate the speed at which the ambulance is travelling. (5)

7.2 A study of spectral lines obtained from various stars can provide valuable information about the movement of the stars.

The two diagrams below represent different spectral lines of an element. Diagram 1 represents the spectrum of the element in a laboratory on Earth. Diagram 2 represents the spectrum of the same element from a distant star.



Is the star moving towards or away from the earth? Explain the answer by referring to the shifts in the spectral lines in the two diagrams above. (2)
[14]

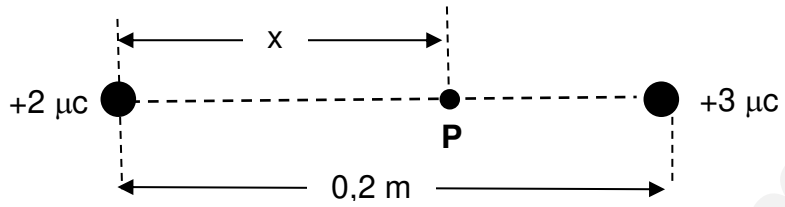
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QUESTION 8

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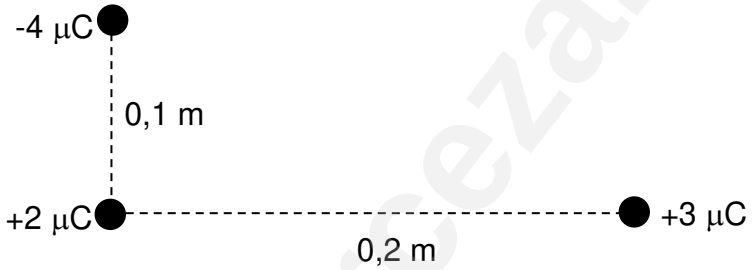
Two point charges of +2 µC and +3 µC are placed a distance of 0,2 m apart. **P**, a point on the imaginary line between the charges, is a distance *x* from the +2 µC charge. The NET ELECTRIC FIELD AT **P** is zero.



8.1 Describe the term *electric field* in words. (2)

8.2 Calculate the distance *x*. (7)

8.3 A -4µC charge is now placed 0,1 m from the +2 µC charge as shown in the sketch below. The three charges form an imaginary right-angled triangle.



Calculate the magnitude of the electrostatic force experienced by the +2 µC charge due to the presence of the other two charges. (5)
[14]

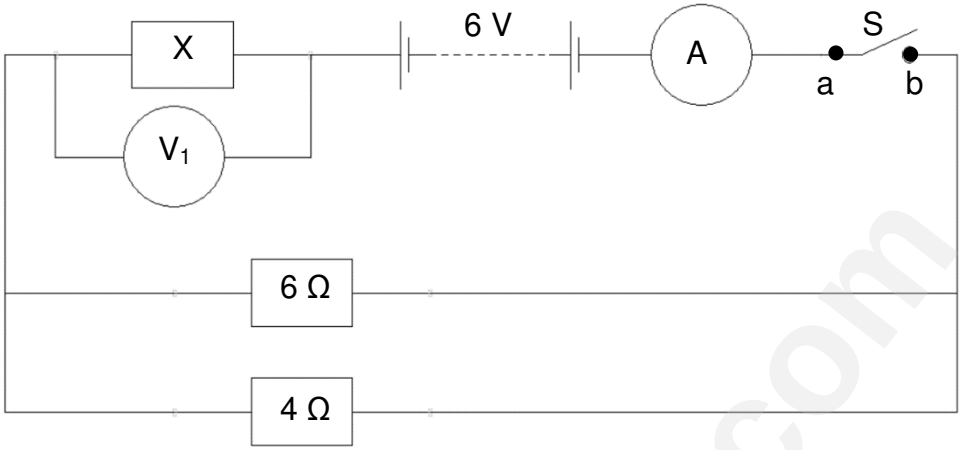
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QUESTION 9

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In the circuit diagram below the internal resistance of the 6 V battery and the resistance of the connecting wires in the circuit are negligible.



9.1 State *Ohm's law* in words. (2)

9.2 Switch **S** open. A voltmeter is connected across points **a** and **b** of the switch. What will the reading on the voltmeter be? (1)

9.3 When switch **S** is closed, the current in the 4 Ω resistor is 0,9 A. Calculate the:

9.3.1 Current in the 6 Ω resistor (4)

9.3.2 Total current in the circuit (2)

9.3.3 Resistance of **X** (3)

9.3.4 Energy dissipated by resistor **X** in 1,5 minutes. (4)

9.4 The 4 Ω resistor is hotter than the 6 Ω resistor after a while. Explain this observation. (3)
[19]

GRAND TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

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GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS / *TABEL 1: FISIESE KONSTANTES*

NAME / *NAAM*	SYMBOL / *SIMBOOL*	VALUE / *WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Radius of the earth *Radius van die aarde*	R_E R_A	6,38 x 10^6 m
Mass of the earth *Massa van die aarde*	M_E M_A	5,98 x 10^{24} kg
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J·s
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg

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TABLE 2: FORMULAE/*TABEL 2: FORMULES*

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MOTION / *BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^{\,2} = v_i^{\,2} + 2a\Delta x$ or/*of* $v_f^{\,2} = v_i^{\,2} + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE / *KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$

WORK, ENERGY AND POWER / *ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

WAVES, SOUND AND LIGHT / *GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_k$ where / *waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$	

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ELECTROSTATICS / *ELEKTROSTATIKA*

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$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS / *ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf (ε) = I(R + r) emk (ε) = I(R + r)
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I \Delta t$
W = Vq W = VIΔt W= $I^2R\Delta t$ W= $\frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ P = VI P = I^2R P = $\frac{V^2}{R}$

ALTERNATING CURRENT / *WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{average} = I^2_{rms}R$ / $P_{gemiddeld} = I^2_{wgk}R$ $P_{average} = \frac{V^2_{rms}}{R}$ / $P_{gemiddeld} = \frac{V^2_{wgk}}{R}$

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education

Department of Education
FREE STATE PROVINCE

EXAMINATION

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

JUNE 2019

MARKS: 150

TIME: 3 HOURS

This paper consists of 15 pages and two information sheets.

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INSTRUCTIONS AND INFORMATION

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1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of NINE questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable pocket calculator.

7. You may use appropriate mathematical instruments.

8. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your FINAL numerical answers to a minimum of TWO decimal places where applicable.

11. Give brief motivations, discussions, et cetera where required.

12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTION

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Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down only the letter A, B, C or D next to the question number (1.1–1.10) in your ANSWER BOOK.

1.1 All members of a homologous series differ only with ...

A CH.

B CH_2.

C CH_3.

D CH_4. (2)

1.2 Which one of the following increases as the relative molecular mass of alkanes decrease?

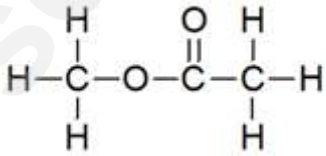
A Boiling point

B Melting point

C Vapour pressure

D Strength of intermolecular forces (2)

1.3 Two organic substances react to form water and a product with the following structural formula.



What are the names of THIS PRODUCT and ONE OF THE REACTANTS to prepare this product?

A Methanol and ethanoic acid

B Methyl ethanoate and ethanol

C Methyl ethanoate and ethanoic acid

D Ethyl methanoate and ethanoic acid (2)

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1.4 Consider the reaction represented below:

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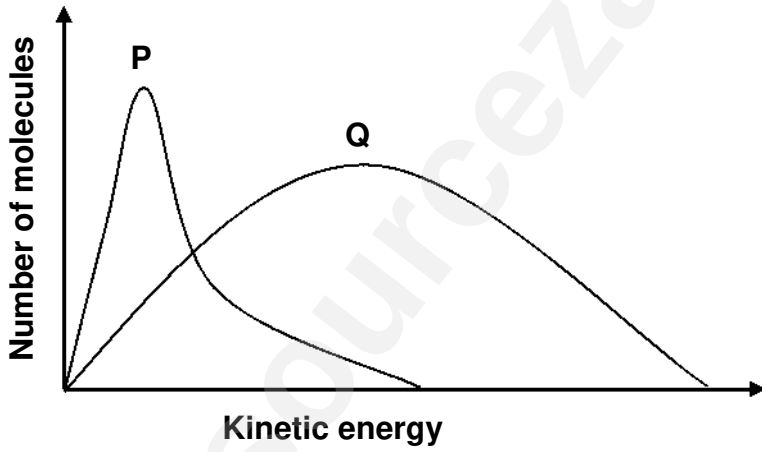
$CH_3CH_2CH_2CH_2CH_2CH_3 \rightarrow CH_3CHCH_2 + H_2 + \mathbf{Z}$

Which one of the following correctly gives the type of reaction that take place and the IUPAC name of product **Z**?

	TYPE OF REACTION	Z
A	Elimination	Propene
B	Elimination	Propane
C	Addition	Propene
D	Addition	Propane

(2)

1.5 Two Boltzmann distribution curves, **P** and **Q**, for oxygen gas under different conditions are shown below:



Which one of the following is correct for both curves **P** and **Q**?

A **Q** is at a higher temperature.

B **P** and **Q** are at the same temperature.

C **P** represents more molecules than **Q**.

D **P** and **Q** represent the same number of molecules. (2)

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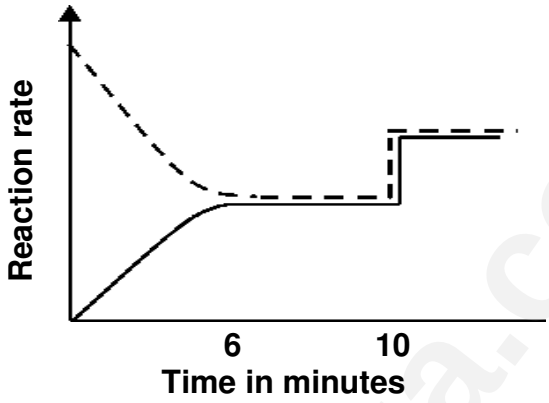
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1.6 Pure hydrogen iodide decomposes in a sealed container according to the following balanced equation.

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$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad \Delta H > 0$$

The reaction reaches equilibrium after 6 minutes. A sudden change in conditions at t = 10 minutes causes the rate of both forward and reverse reactions to increase as shown in the graph below.



Which one of the following adjustments was made after 10 minutes?

A A catalyst was introduced.

B The temperature was increased.

C The volume of the container was increased.

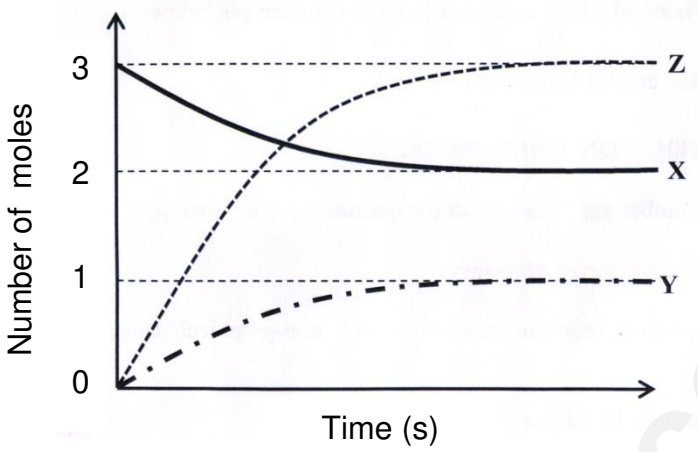
D The amount of HI was increased. (2)

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1.7 Gas **X** is placed in a flask, which is then sealed. Gas **X** decomposes to produce gas **Y** and gas **Z**. The reaction reaches dynamic chemical equilibrium after a certain period of time as shown in the graph below.



Which one of the following balanced chemical equations represents the decomposition of gas **X** as shown in the above graph?

A $X(g) \rightleftharpoons Y(g) + 2Z(g)$

B $2X(g) \rightleftharpoons 2Y(g) + Z(g)$

C $2X(g) \rightleftharpoons Y(g) + Z(g)$

D $X(g) \rightleftharpoons Y(g) + 3Z(g)$ (2)

1.8 Which one of the following compounds is diprotic?

A SO_2

B HS^-

C H_2S

D SO_4^{2-} (2)

1.9 Which one of the following statements about a WEAK acid is TRUE?

A It is a proton acceptor.

B It can have a high concentration.

C It neutralizes a strong acid.

D It reacts with sodium carbonate to release oxygen. (2)

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1.10 A bottle containing an unknown acid solution is labelled 1,0 mol·dm^{-3} H_3X.

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The following unbalanced ionisation reaction applies.

$$H_3X + H_20 \rightleftharpoons HX^{2-} + H_3O^+$$

From this one can deduce that the solution contains ...

A 6 moles of HX^{2-} ions in 2 dm^3 of the solution.

B 4 moles of hydronium ions in 2 dm^3 of the solution.

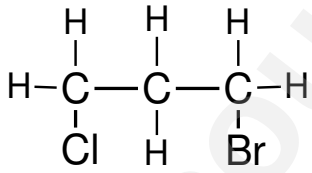
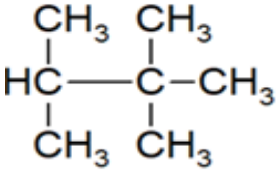
C 2 moles of HX^{2-} ions in 1 dm^3 of the solution.

D 3 moles of hydronium ions in 1 dm^3 of the solution. (2)

[20]

QUESTION 2

The letters **A** to **F** in the table below represent six organic compounds with DIFFERENT FUNCTIONAL GROUPS.

A		**B**	
C	CH_3COOH	**D**	C_2H_4O
E	3-methylbutan-2-one	**F**	4,4,5-trimethylhex-2-yne

2.1 Define the term *alkane*. (2)

2.2 Write down the:

2.2.1 Letter representing an alkane. (1)

2.2.2 Letter representing a ketone. (1)

2.2.3 IUPAC name of compound **A** (2)

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2.2.4 IUPAC name of compound **B** (3)

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2.2.5 Homologous series to which compound **F** belongs. (1)

2.2.6 Structural formula of compound **F** (3)

2.3 Consider compound **C**. Draw the structural formula of its:

2.3.1 Functional group (1)

2.3.2 Functional isomer (2)
[16]

QUESTION 3

The table below shows the vapour pressures of four compounds.

	Compound	**Vapour pressure at 20°C (kPa)**
A	Methanol	13
B	Ethanol	6
C	Propan-2-ol	4,4
D	Propan-1-ol	2

3.1 Define the term *vapour pressure*. (2)

3.2 Identify ONE of the compounds (**A**, **B**, **C** or **D**) which has the:

3.2.1 Lowest boiling point and give a reason for the answer by referring to the vapour pressures in the table. (2)

3.2.2 Weakest intermolecular forces (1)

3.3 Compounds **C** and **D** are structural isomers. What type of structural isomers are compound **C** and **D**? (1)

3.4 Write down the general formula of the homologous series to which compound **C** belongs to. (1)

3.5 Explain the difference in vapour pressure between compound **B** and compound **D** by referring to the TYPE of intermolecular forces (3)
[10]

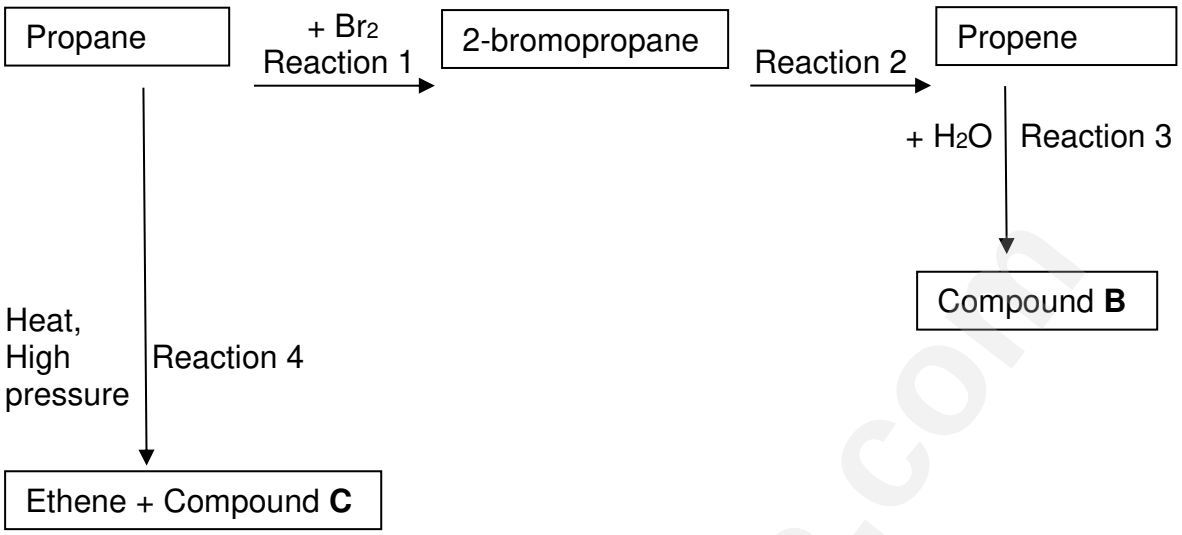
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QUESTION 4

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The flow diagram below shows the conversion of propane to other compounds.



4.1 For **reaction 1**, write down:

4.1.1 ONE reaction condition (1)

4.1.2 The type of reaction that takes place. (1)

4.1.3 The structural formula of the positional isomer of the product (2)

4.2 Consider **reaction 2**. Write down the:

4.2.1 Type of reaction that takes place. (1)

4.2.2 Formula of the inorganic product (1)

4.3 Compound **B** is the major product formed during **reaction 3**.

4.3.1 Write down the structural formula of compound **B**. (2)

4.3.2 Is compound **B** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for your answer. (2)

4.4 For **reaction 4**, write down:

4.4.1 The type of reaction (1)

4.4.2 A balanced equation using structural formulae. (3)

4.4.3 The IUPAC name of compound **C**. (1)

4.4.4 Whether compound **C** is classified as saturated or unsaturated. (1)

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4.5 During a reaction 7,4 g of propan-1-ol reacts with excess ethanoic acid (CH_3COOH) to form compound **Z**.

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4.5.1 Write down the homologous series to which compound **Z** belongs. (1)

4.5.2 Write down the NAME or FORMULA of the catalyst needed for this reaction. (1)

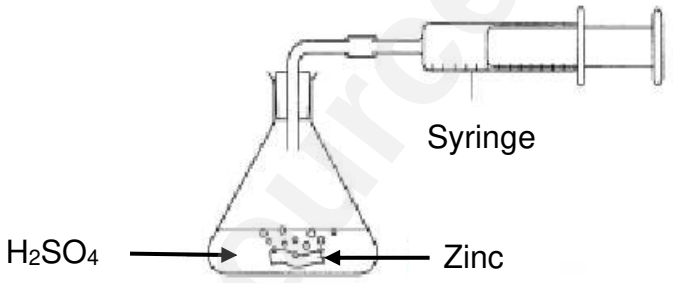
4.5.3 Calculate the mass of compound **Z** if the percentage yield is 10%. (6)
[24]

QUESTION 5

A group of learners use the apparatus below during an investigation to determine how surface area affects the reaction rate between solid pieces of zinc metal and 100 cm^3 of dilute sulphuric acid with a concentration of 1 $mol \cdot dm^{-3}$.

During the reaction, the gas that is formed is collected in a glass syringe and the volume of gas produced is measured. The balanced equation for the reaction is:

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$



Two experiments are conducted. The reaction conditions are as follows:

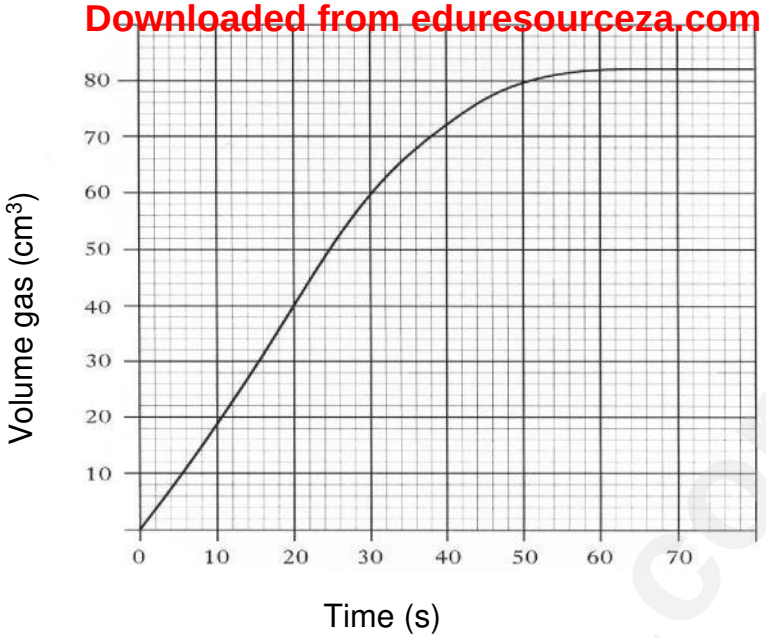
- EXPERIMENT I: 19,5 g of zinc is used in the form of 5 small pieces.
- EXPERIMENT II: 19,5 g of zinc is used in the form of one large piece.

The results of experiment I are used to plot the following graph.

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5.1 Apart from the mass and the volume of the reactants, write down ONE other variable that must be kept constant during the investigation. (1)

5.2 Write down the dependent variable for this investigation. (1)

5.3 Use the graph and calculate the average reaction rate (in $cm^3 \cdot s^{-1}$) for the first 30 seconds. (3)

5.4 Will the reaction rate at 50s be GREATER THAN, LESS THAN or EQUAL TO the one calculated in question 5.3? (1)

5.5 Give a reason for your answer to question 5.4. (1)

5.6 Predict how the gradient of the graph of EXPERIMENT II will compare to that of EXPERIMENT I. Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

5.7 Use the collision theory and explain how the increase in surface area of the zinc metal will affect the reaction rate. (3)

5.8 Calculate the mass of zinc metal remaining unreacted after the reaction has stopped. (5)

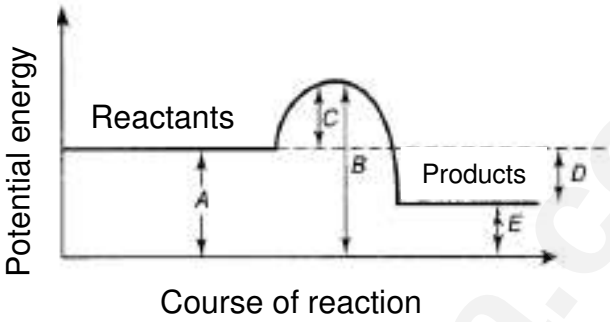
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5.9 Ziegler-Natta catalysts are used to make everything from plastic wrap to yogurt cups in the polymer industry.

5.9.1 Define a positive catalyst. (2)

5.9.2 Consider the following graph of potential energy versus the course of the reaction. Write down the letter that will be influenced by the use of a positive catalyst and describe how the value of this letter will be affected.



(2)
[20]

QUESTION 6

A number of moles of N_2 (g) and H_2 (g) are placed in an empty 2 dm^3 container at 800 °C and the container is sealed. A reaction takes place and equilibrium is reached. The balanced equation for the reaction is.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

At equilibrium 0,4 $mol \cdot dm^{-3}$ of each of H_2 and NH_3 is present. You also get the following information for the reaction:

Temperature (°C)	Kc
1 200	0,8
1 000	2,5
800	4,0

6.1 Write down the K_C equation for the reaction. (1)

6.2 Calculate the concentration of the N_2 at equilibrium. (3)

6.3 Calculate the initial number of moles of N_2 and H_2 placed in the container. (5)

6.4 Is the forward reaction endothermic or exothermic? (1)

6.5 Give a reason for the answer to question 6.4. (3)

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6.6 What will be the effect on the following if more H_2 (g) is added at 800°C? Answer only INCREASES, DECREASES or REMAINS THE SAME.

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6.6.1 Kc value (1)

6.6.2 Concentration of N_2(g) (1)

6.7 The temperature of the reaction mixture is now reduced to less than 400°C. How will this change affect each of the following? Choose from INCREASES, DECREASES or REMAINS THE SAME.)

6.7.1 The reaction rate of the forward reaction. Use the collision theory to explain your answer. (4)

6.7.2 The concentration of the H_2 (1)

6.8 The temperature of the reaction mixture is reduced to less than 400°C. How will this change affect the equilibrium position? Use Le Chatelier's principle to explain your answer. (3)
[23]

QUESTION 7

7.1 Ethanol can be produced by the reaction of ethene with steam in the presence of phosphoric acid as catalyst. The balanced equation for the reaction is:

$$C_2H_4\ (g) + H_2O\ (g) \rightleftharpoons C_2H_5OH\ (g) \quad \Delta H < 0$$

7.1.1 How will an increase in pressure affect the percentage of ethanol present at equilibrium? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

7.1.2 Give a reason for the answer to QUESTION 7.1.1. (2)

7.1.3 Name 2 more changes apart from pressure that can be made to increase the percentage of alcohol forming. (2)

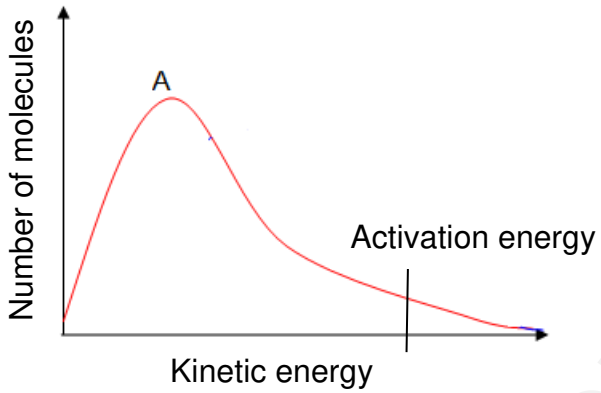
7.1.4 What will be the influence of the introduction of a catalyst on the percentage of alcohol forming? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

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7.2 The Boltzman curve **A** is showing the energy of the reactants for a specific reaction.

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7.2.1 Explain the change that will occur when a catalyst is introduced to the reaction by referring to curve **A** and the activation energy line. (2)

7.2.2 Explain the change that will occur when more moles of reactant are introduced to the reaction by referring to curve **A** and the activation energy line. (2)

[10]

QUESTION 8

8.1 Amy prepares 250 cm^3 of a standard solution of hydrogen carbonate (H_2CO_3) with a concentration of 0,1 $mol \cdot dm^{-3}$.

8.1.1 Define the term *standard solution*. (2)

8.1.2 Calculate the mass of hydrogen carbonate needed to make this solution. (4)

8.2 During a titration, 25 cm^3 of a 0,1 $mol \cdot dm^{-3}$ LiOH solution neutralises a 0,2 $mol \cdot dm^{-3}$ H_2CO_3 solution. The balanced equation for the reaction is.

$$H_2CO_3\ (aq) + 2LiOH\ (aq) \rightarrow Li_2CO_3\ (aq) + 2H_2O\ (\ell)$$

8.2.1 Define a base in terms of the Arrhenius theory. (2)

8.2.2 Write down the name of the most suitable indicator for this titration. (1)

8.2.3 What is the purpose of the indicator in question 8.2.2? (1)

8.2.4 Calculate the volume of acid that reacted with the base when the endpoint was reached. (5)

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8.3 H_2CO_3 dissociate in water and form HCO_3^-.

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8.3.1 Write down the FORMULAE of the two compounds that are conjugate acids during the dissociation equilibrium. (2)

8.3.2 Write down the dissociation reaction when HCO_3^- dissociates FURTHER in water. (3)
[20]

QUESTION 9

H_2SO_4 is a strong, diprotic acid and ionises as shown below.

$$H_2SO_4\ (aq) + H_2O\ (\ell) \rightleftharpoons X\ (aq) + 2H_3O^+\ (aq)$$

9.1 Define the term *diprotic acid*. (2)

9.2 Consider the reaction:

9.2.1 Write down the NAME and FORMULA of the conjugate acid of H_2O (ℓ). (2)

9.2.2 Write down the formula of **X**. (2)

9.2.2 Complete the following sentence:
H_2O is an ampholyte because H_2O can form H_3O^+ or … (1)
[7]

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

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GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	pH = $-\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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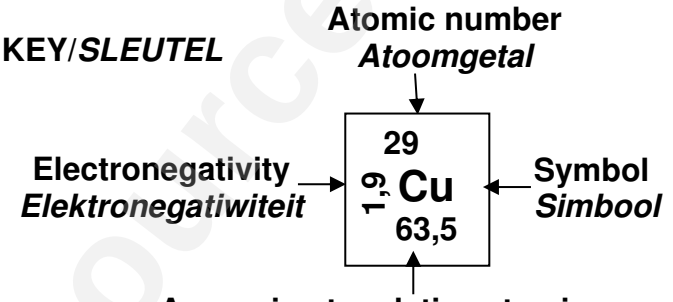
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2.0 B 11	2.5 C 12	3.0 N 14	3.5 O 16	4.0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1.5 Aℓ 27	1.8 Si 28	2.1 P 31	2.5 S 32	3.0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1.5 Ti 48	1.6 V 51	1.6 Cr 52	1.5 Mn 55	1.8 Fe 56	1.8 Co 59	1.8 Ni 59	1.9 Cu 63,5	1.6 Zn 65	1.6 Ga 70	1.8 Ge 73	2.0 As 75	2.4 Se 79	2.8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1.4 Zr 91	41 Nb 92	1.8 Mo 96	1.9 Tc	2.2 Ru 101	2.2 Rh 103	2.2 Pd 106	1.9 Ag 108	1.7 Cd 112	1.7 In 115	1.8 Sn 119	1.9 Sb 122	2.1 Te 128	2.5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	1.6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1.8 Tℓ 204	1.8 Pb 207	1.9 Bi 209	2.0 Po	2.5 At	86 Rn
0,7 Fr 87	0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KEY/*SLEUTEL*



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education

Department of Education
FREE STATE PROVINCE

EXAMINATION

GRADE 12

PHYSICAL SCIENCES P1

JUNE 2018

MARKS: 150

TIME: 3 HOURS

This paper consists of 11 pages and THREE data sheets.

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INSTRUCTIONS AND INFORMATION

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1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave one line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable pocket calculator.

7. You may use appropriate mathematical instruments.

8. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your FINAL numerical answers to a minimum of TWO decimal places where applicable.

11. Give brief motivations, discussions, et cetera where required.

12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down only the letter A, B, C or D next to the question number (1.1–1.10) in your ANSWER BOOK.

1.1 A car is moving north at CONSTANT velocity. At this instant, which of these physical quantities associated with the car must also be directed north?

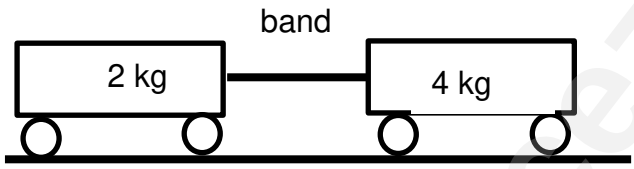
A Velocity and momentum.

B Velocity and acceleration.

C Velocity, momentum and acceleration.

D Velocity, momentum, acceleration and net force. (2)

1.2 Two trolleys with masses of 2 kg and 4 kg are joined by a stretched rubber band and held apart as shown below:



After the trolleys are released from rest, they collide and stick together. Assume that friction can be ignored. After the collision, the trollies will …

A remain at rest.

B accelerate to the left.

C move to the left at a constant velocity.

D move to the right at a constant velocity. (2)

1.3 During an experiment, two iron balls of mass *m* and *2m* are dropped from the same height at the same instant in the absence of air resistance. When they are 1 m above the ground, they have the same …

A inertia.

B momentum.

C acceleration.

D potential energy. (2)

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1.4 A winch pulls a trailer with a load of vegetables, causing it to accelerate at **X** $m \cdot s^{-2}$. The trailer has a mass of 100 kg, and the vegetables have a mass of 500 kg. The load of vegetables falls sideways off of the trailer. Assuming that the force of the winch on the trailer remains constant, the acceleration of the trailer, in $m \cdot s^{-2}$, would now be … if friction is disregarded.

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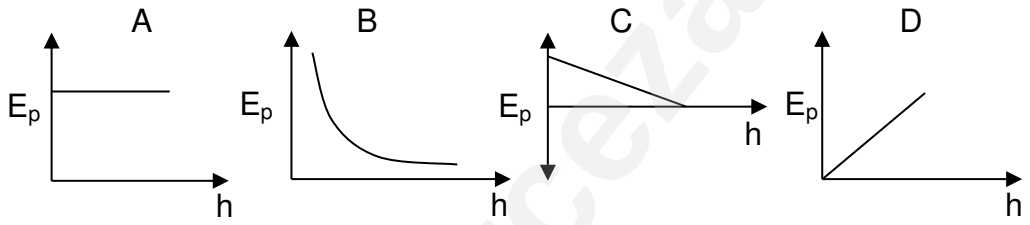
A 2X

B 4X

C 5X

D 6X (2)

1.5 A tennis ball is dropped from the top of a building. Which one of the following graphs best represents the relationship between the ball's gravitational potential energy (E_p) and its height (h) above the ground in the absence of air resistance?



(2)

1.6 A crane lifts a container of mass *m* at a constant velocity *v* through a height of *h* metres. The magnitude of the net work done on the container is …

A 0.

B mgh.

C ½ mv^2.

D mgh + ½ mv^2. (2)

1.7 An ambulance moves away from a stationary observer. The pitch of the siren heard by the observer decreases because the …

A amplitude of the sound wave decreases.

B amplitude of the sound wave increases.

C wavelength of the sound wave decreases.

D wavelength of the sound wave increases. (2)

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1.8 Two small, identical charged objects are placed a certain distance apart. Their charges are equal, and the electrostatic force of the one object on the other object is *F*. If the charge on each object is doubled, and the distance between them is also doubled, the force of the one object on the other object will then be …

A ¼ F.

B ½ F.

C F.

D 4F. (2)

1.9 The kW·h is a/an …unit

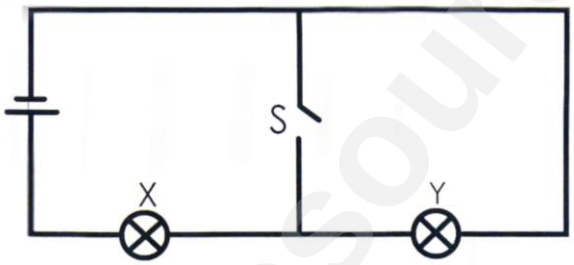
A energy

B power

C time

D force (2)

1.10 The bulbs in the diagram are identical.



When switch **S** is closed …

A **X** and **Y** no longer burn.

B only **X** burns.

C **X** and **Y** burn with equal brightness.

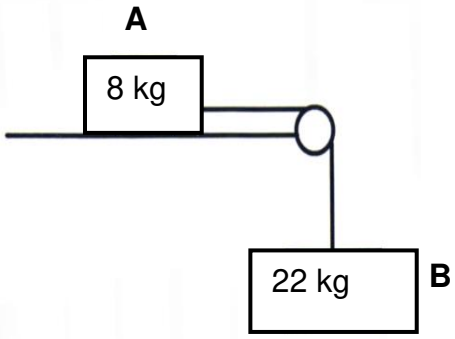
D both bulbs burn, but **X** is brighter. (2)
[20]

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QUESTION 2

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2.1 Block **A**, mass 8 kg, is moving on a horizontal surface. This block is connected to block **B**, mass 22 kg, by a light, inextensible cord that passes over a frictionless pulley. The cord is horizontal between **A** and the pulley. A frictional force of 39,2 N acts on the 8 kg block.



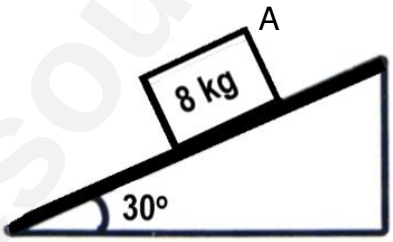
2.1.1 Write down *Newton's second law of motion* in words. (3)

2.1.2 Draw a free-body diagram and show all the forces acting on block **A**. (4)

2.1.3 Calculate the magnitude of the acceleration of block **A**. (5)

2.1.4 Calculate the force that the cord exerts on block **B**. (3)

The 8 kg block is now placed on a different surface, which is also inclined at 30° to the horizontal. The coefficient of static friction between the block and the surface is 0,53.



2.1.5 Define the term *frictional force*. (2)

2.1.6 Determine, by means of a calculation, what happens to the block when it is released. (5)

2.2 The Hubble telescope has a mass of 11 600 kg, and orbits at a distance of 596 km above the surface of the earth. Determine the approximate weight of the Hubble telescope when it is:

2.2.1 On the surface of the earth (3)

2.2.2 In orbit (5)

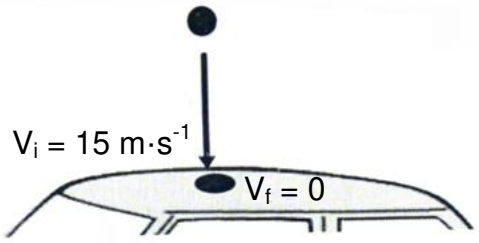
[30]

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QUESTION 3

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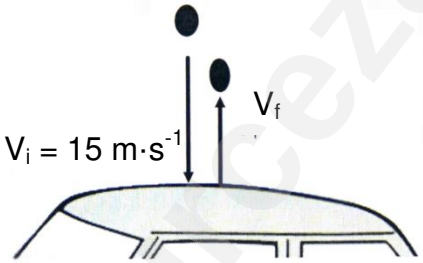
During a rainstorm, a raindrop with a mass of 0,03 g strikes the roof of a car with a downward velocity of 15 $m \cdot s^{-1}$. The raindrop comes to rest on the roof because of a force of 0,9 N that the roof exerts on the raindrop.



3.1 Define *impulse*. (2)

3.2 Calculate the time taken for the raindrop to come to rest. (5)

A hailstone, also with a mass of 0,03 g, now strikes the roof of the car with the same initial velocity as the raindrop. It bounces off the roof. The contact time between the roof and hailstone is the same as the time calculated in question 3.2.



3.3 Will the force exerted by the hailstone on the roof be GREATER THAN, SMALLER THAN or EQUAL TO the force exerted by the raindrop? Explain your answer without using calculations. (4)

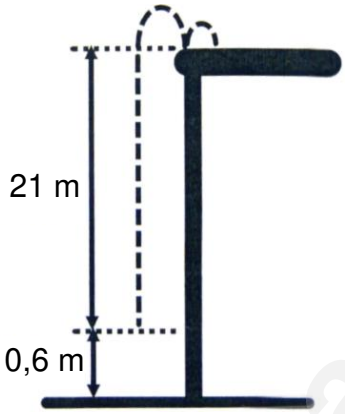
[11]

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QUESTION 4

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A ball is thrown vertically upwards from a height of 0,6 m above the ground. It passes a bridge, which is 21 m higher than the point from which the ball was thrown. The ball hits the surface of the bridge 3,1 s after it was thrown. The ball bounces once and then comes to rest. Ignore the effects of air resistance. Assume that the motion of the ball takes place in the vertical plane; there is no sideways motion.



4.1 Define the term *projectile*. (2)

4.2 What is the acceleration of the ball when it reaches its maximum height? (2)

4.3 Calculate the speed at which the ball was thrown. (4)

4.4 Calculate the maximum height reached by the ball above the ground. (4)

4.5 Is the collision between the ball and the surface of the bridge ELASTIC or INELASTIC? Give a reason for your answer. (2)

4.6 Sketch a displacement-time graph for the complete motion of the ball, from the instant it was thrown upwards until it comes to rest. Use the surface of the bridge as the zero position. Indicate the following on the graph and ensure critical values are shown on your graph:

- The position of the ball when it is thrown.
- The maximum height reached by the ball.
- The time at which the ball hits the bridge for the first time. (5)

[19]

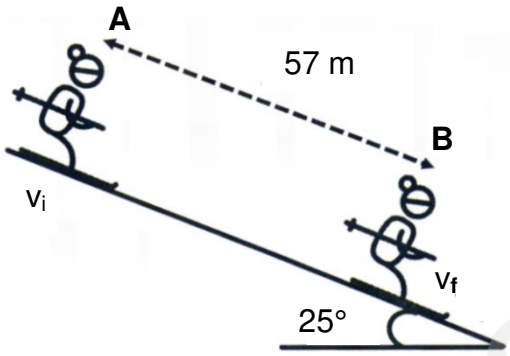
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QUESTION 5

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5.1 During the recent Winter Olympics in South Korea, a skier of mass 58 kg moved down a slope. The slope makes an angle of 25° with the horizontal. She experienced a kinetic frictional force of 70 N. At a particular point on the slope, **A**, her speed (v_i) was measured as 3,6 $m \cdot s^{-1}$.



5.1.1 Write down the *work-energy theorem* in words. (2)

5.1.2 Draw a free-body diagram and show all the forces acting on the skier as she moves down the slope. (3)

5.1.3 Name the *conservative force* acting on the skier. (1)

5.1.4 Does the normal force do work on the skier as she moves down the slope? Write only YES or NO, and briefly explain your answer. (2)

5.1.5 Why is the mechanical energy of the skier NOT conserved? (1)

5.1.6 Use the work-energy theorem to calculate the speed (v_f) of the skier when she reaches **B**, a point 57 m from where her speed was originally measured. (6)

5.1.7 Calculate the magnitude of the acceleration of the skier as she moves down the slope WITHOUT USING EQUATIONS OF MOTION. (4)

5.2 A farmer uses an electric motor to pump water from a depth of 50 m. Calculate the minimum power required to pump 600 kg of water per minute, if the water moves through the pipe at a constant speed. (5)

[24]

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QUESTION 6

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A high-speed train is travelling at 44,7 m·s^{-1} when its hooter emits a sound with a frequency of 415 Hz. The speed of sound in air is 343 m·s^{-1}.

6.1 Write down the *Doppler Effect* in words. (2)

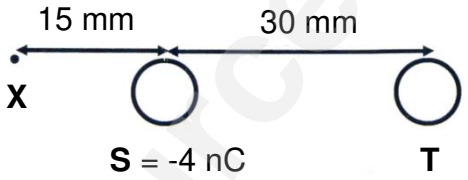
6.2 Calculate the wavelength of the sound heard by a passenger waiting stationary at the side of the train track as the train approaches. (6)

6.3 An observation of the spectrum of a distant star shows that it is approaching the earth. Briefly explain, in terms of the frequencies of the spectral lines, how it is possible to conclude that the star moves towards the earth. (2)

[10]

QUESTION 7

Two small, identical metal spheres, **S** and **T**, are placed 30 mm apart. **S** has a NEGATIVE charge with a magnitude of 4 nC. **X** is a point 15 mm from sphere **S**. The NET ELECTRIC FIELD at **X** due to **S** AND **T** is 2,0 x 10^5 N·C^{-1}, to the RIGHT.



7.1 Define the term *electric field at a point.* (2)

7.2 Calculate the magnitude and direction of the electric field at point **X** due to the presence of **S**. (5)

7.3 Calculate the magnitude of the charge on sphere **T**. (6)

7.4 Is the charge on sphere **T** positive or negative? (1)

7.5 Draw the electric field pattern for **S** (without any influence from **T**.) (3)

7.6 Calculate the magnitude of the electrostatic force that an electron will experience when placed at point **X**. (4)

[21]

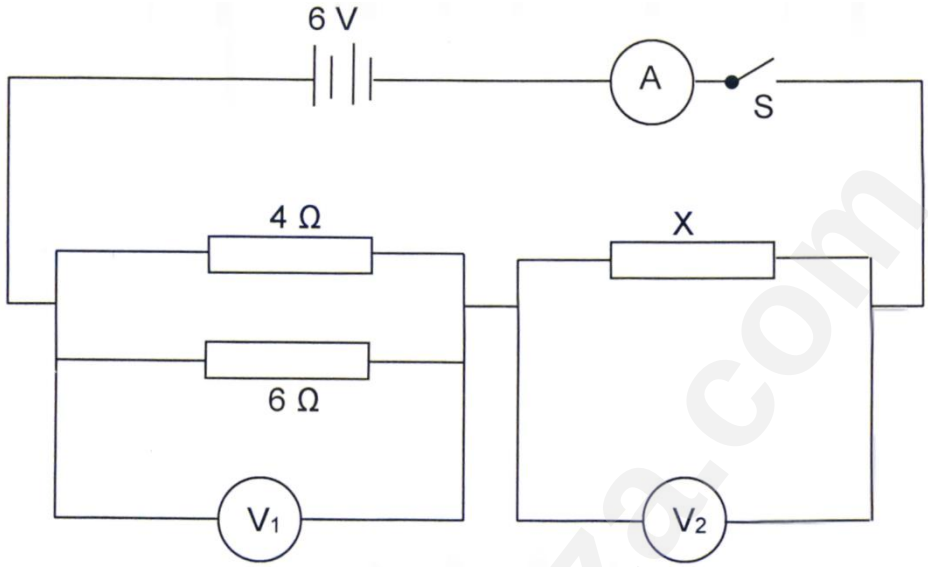
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QUESTION 8

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In the circuit below, the internal resistance of the battery, as well as the resistance of the connecting wires, is negligible. When switch **S** is closed, the current in the 6 Ω resistor is 0,6 A.



8.1 Write down *Ohm's law* in words. (2)

8.2 Calculate the current in the 4 Ω resistor. (4)

8.3 Calculate the total current in the circuit. (2)

8.4 Calculate the resistance of **X**. (3)

8.5 Which resistor, 4 Ω or 6 Ω, will dissipate the most power? Fully explain your answer without any further calculation. (4)

[15]

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

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GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS / *TABEL 1: FISIESE KONSTANTES*

NAME / *NAAM*	SYMBOL / *SIMBOOL*	VALUE / *WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Radius of the earth *Radius van die aarde*	R_E R_A	6,38 x 10^6 m
Mass of the earth *Massa van die aarde*	M_E M_A	5,98 x 10^{24} kg
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J·s
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg

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TABLE 2: FORMULAE / *TABEL 2: FORMULES*

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MOTION / *BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE / *KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$

WORK, ENERGY AND POWER / *ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_p = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ of/*or* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gem} = Fv_{gem}$	

WAVES, SOUND AND LIGHT / *GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_S}f_S$ / $f_L = \frac{v \pm v_L}{v \pm v_B}f_B$	$E = hf$ or/of $E = h\frac{c}{\lambda}$
$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_o = hf_o$ and/*en* $E_k = \frac{1}{2}mv^2$	

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ELECTROSTATICS / *ELEKTROSTATIKA*

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$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS / ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf (E) = I(R + r) emk (E) = I(R + r)
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I\Delta t$
W = Vq W = VIΔt $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ P = VI $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT / *WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{average} = I_{rms}^2R$ / $P_{gemiddeld} = I_{wgk}^2R$ $P_{average} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$

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GRADE 12

JUNE 2016

PHYSICAL SCIENCES P1

MARKS: 150

TIME: 3 hours

* P H S C E 1 *

This question paper consists of 14 pages, including a 2-page formula sheet.

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INSTRUCTIONS AND INFORMATION

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1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. Write neatly and legibly.
7. You may use a non-programmable calculator.
8. You may use appropriate mathematical instruments.
9. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
10. Show ALL formulae and substitutions in ALL calculations.
11. Round off your FINAL numerical answers to a minimum of TWO decimal places.
12. Give brief motivations, discussions, et cetera where required.

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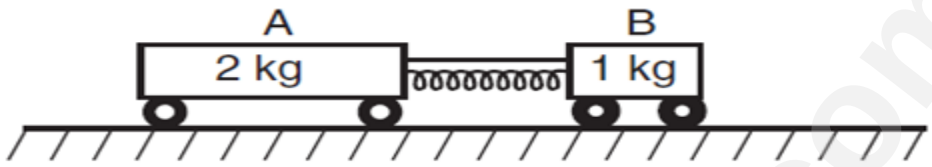
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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D), corresponding to the correct answer of your choice, next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The diagram below shows a compressed spring between two trolleys initially at rest on a horizontal, frictionless surface. Trolley A has a mass of 2 kg and trolley B has a mass of 1 kg. A string holds the trollies together.



The string is cut and the trollies move apart. Compared to the magnitude of the force the spring exerts on trolley A, the magnitude of the force the spring exerts on trolley B is …

A half as great.
B the same.
C twice as great.
D four times as great. (2)

1.2 A net force acts on each of the isolated objects, **R** and **S**, as shown below.



The mass of **S** is three times that of **R**. When effects of friction are ignored, the rate of change of momentum of **S** is X. What is the rate of change of momentum of **R** under the same conditions?

A $\frac{1}{9}$ X
B $\frac{1}{3}$ X
C X
D 3 X (2)

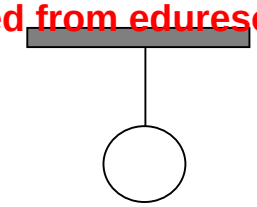
1.3 An object moving with a constant velocity **v** has a kinetic energy **E**. Which one of the following will be true for the kinetic energy if the object has a constant velocity of **2v**?

A ½ E
B E
C 2E
D 4E (2)

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1.4 A sphere is attached to a string, which is suspended from a fixed horizontal bar as shown in the sketch.

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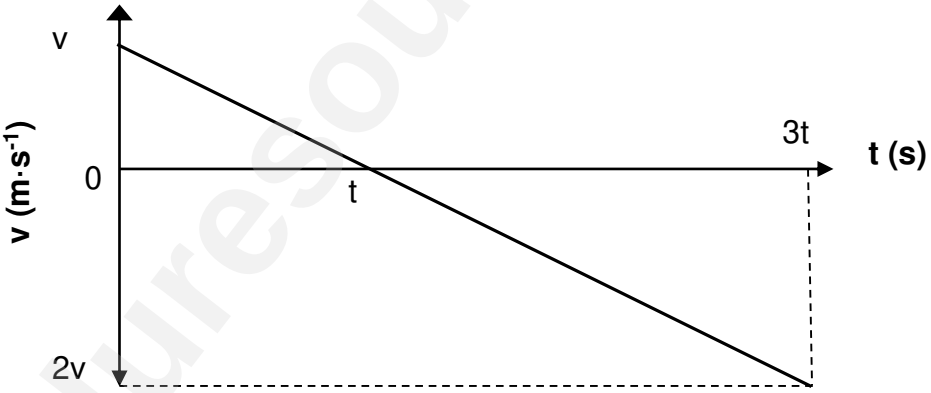
The reaction force to the gravitational force exerted by the earth on the sphere is the force of the …

A bar on the sphere.
B string on the sphere.
C sphere on the earth.
D bar on the string. (2)

1.5 A ball is dropped from height **h** above the ground and reaches the ground with kinetic energy **E**. From which height must the ball be dropped to reach the ground with kinetic energy **2E**? (Ignore all effects of friction.)

A 2**h**
B 3**h**
C 4**h**
D 8**h** (2)

1.6 The velocity versus time graph below represents the movement of an object under the influence of gravitational force ONLY.



The displacement of the object in time **3t** is …

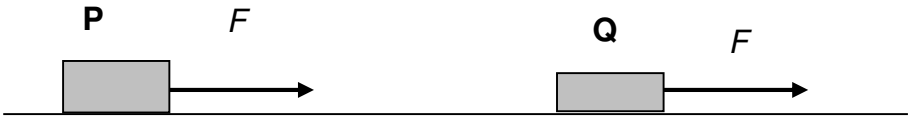
A $\frac{5}{2}$ **vt**.
B 7**vt**.
C $\frac{7}{2}$ **vt**.
D $-\frac{3}{2}$ **vt**. (2)

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1.7 A net force *F* accelerates two isolated objects, **P** and **Q**, from rest on a straight line for time **t** as shown below. Object **P** experiences an acceleration of **a** and object **Q** an acceleration of **2a**.

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If the amount of work done by net force *F* on object **P** equals **W**, the amount of work done on **Q** will be …

A W.
B ½ W.
C 2 W.
D 4 W. (2)

1.8 Which ONE of the following can be **explained by** the *Doppler Effect*?

A A source of sound moves closer to a listener, the sound observed by the listener becomes louder.
B If light shining on a metal has a frequency that is high enough, electrons will be emitted from the metal.
C A spectrum will be shifted towards shorter wavelengths than expected if the light comes from distant celestial objects moving towards the observer.
D A spectrum of frequencies of electromagnetic radiation is emitted when an atom makes a transition from high energy to a lower energy state. (2)

1.9 The red shift can be used to estimate the speed of a galaxy relative to earth. Which ONE of the following statements is CORRECT? Distant galaxies are moving …

A faster than closer galaxies and the universe is expanding.
B faster than closer galaxies and the universe is contracting.
C slower than closer galaxies and the universe is contracting.
D moving at the same speed as closer galaxies and the universe remains unchanged. (2)

1.10 A ball is dropped onto a concrete floor and bounces off the floor to the same height from which it was dropped. Which ONE of the following laws best explains why the ball experiences an upward force? Newton's …

A first law of motion.
B second law of motion.
C third law of motion.
D law of universal gravitation. (2)

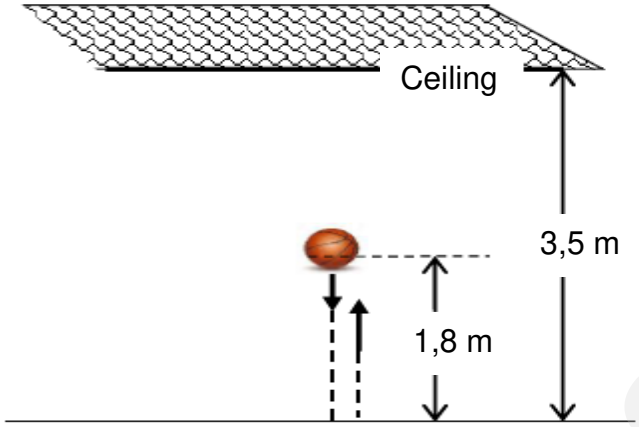
[20]

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QUESTION 2

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A girl stands on a platform in a classroom. She throws a ball vertically downwards to the floor hoping that the ball, after it bounced on the floor, will hit the ceiling of the classroom. She throws the ball with a velocity of 8 $m \cdot s^{-1}$ from the height of 1,8 m above the floor. Ignore the effects of friction.



2.1 Write down the magnitude and direction of the acceleration of the ball immediately after the ball left her hand. (2)

2.2 Is the motion of the ball while moving downwards towards the floor a free fall? Answer YES or NO. Explain your answer. (2)

2.3 Calculate the magnitude of the velocity with which the ball hits the floor. (4)

2.4 How long does it take the ball to hit the floor? (3)

The ball bounces INELASTICALLY on the floor where the velocity of the ball DECREASES by 20%. The ball is in contact with the floor for 0,01 s.

2.5 Determine by means of calculations, whether the ball will reach the ceiling after its first bounce on the floor. (5)

2.6 Sketch a velocity-time graph for the motion of the ball, from the time the ball is thrown until it reaches the maximum height after the bounce.

Clearly show the following on the graph:

- The initial velocity of the ball
- The velocity and time when the ball hits the floor
- The velocity and time when the ball leaves the floor (4)

[20]

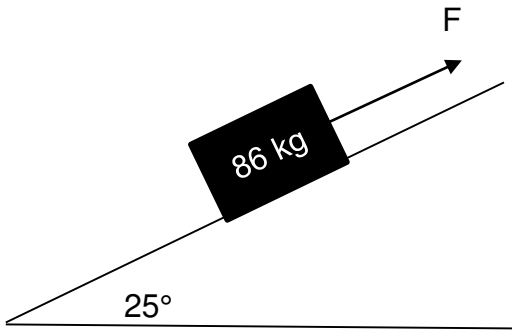
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QUESTION 3

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A crate of mass 86 kg is accelerating down a surface inclined at an angle of 25° to the horizontal.



A man applies a force F upwards parallel to the plane in an attempt to prevent the crate from sliding down the inclined plane. In spite of the man's efforts the crate is accelerating down the incline.

3.1 The applied force is a non-conservative force. What is meant by a non-conservative force? (2)

3.2 The coefficient of kinetic friction (μ_k) between the crate and the surface of the plane is 0,22. Prove that the magnitude of the kinetic frictional force is 168,04 N. (2)

3.3 State work-energy theorem in words. (2)

3.4 Draw a labelled free-body diagram of all the forces acting on the crate. (4)

3.5 The crate accelerates parallel down the inclined plane for a distance of 0,9 m at 1,54 m·s^{-2}. Use the work-energy theorem and calculate the work done by the man on the crate. (5)

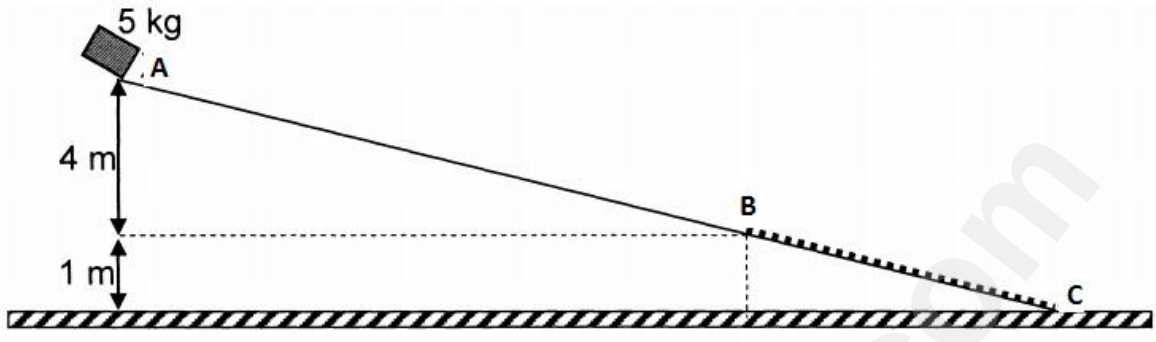
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QUESTION 4

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A 5 kg rigid crate moves from rest down path ABC as shown in the diagram below (diagram not drawn to scale). Section AB of the path is frictionless whilst section BC is a rough surface. Assume that the crate moves in a straight line down the path.



4.1 State, in words, the principle of the conservation of mechanical energy. (2)

4.2 Use the principle of the conservation of mechanical energy to calculate the velocity of the crate when it reaches point B. (4)

On reaching point B, the crate continues to move down the section BC of the path. It experiences an average frictional force of 10 N and reaches point C at a velocity of 4 m·s^{-1}.

4.3 Apart from friction, write down the names of TWO other forces that act on the crate as it moves down section BC. (2)

4.4 In which direction does the net force act on the crate as it moves down section BC? Write down only B to C or C to B. (1)

Another crate of mass 10 kg now moves from point A down path ABC.

4.5 How will the velocity of this 10 kg crate at point B compare to that of the 5 kg crate at B? Write down only GREATER, SMALLER or EQUAL TO. (1)

[10]

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QUESTION 5

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5.1 A submarine can use the Doppler effect to detect the speed of the ship. A submarine at rest and just below the surface of the water, detects the frequency of a moving ship as 437 Hz, which is 0,985 times the actual frequency of the sound emitted by the ship. The speed of sound in water is 1 470 $m \cdot s^{-1}$.

5.1.1 State Doppler effect in words. (2)

5.1.2 Is the ship moving away from or towards the submarine? Give a reason for your answer. (2)

5.1.3 Calculate the speed of the ship. (5)

5.2 Light emitted from distant stars demonstrates the phenomenon known as red shift.

Explain how the phenomenon known as red shift can be used to explain an expanding universe. (2)

5.3 Absorption spectra from the Sun and another galaxy is shown below:

Study the atomic absorption spectra and answer the question that follows:

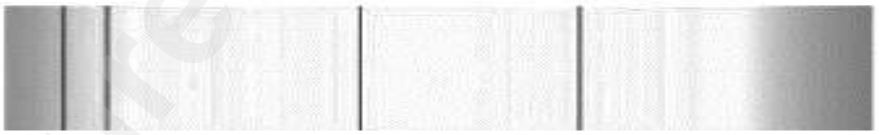
Spectrum from the Sun

Blue Red



Spectrum from the other galaxy

Blue Red



Does the spectrum of the other galaxy constitute a RED SHIFT or BLUE SHIFT? (1)

[12]

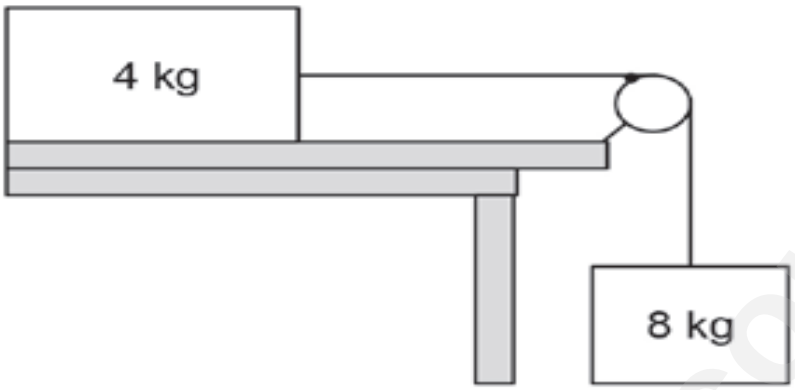
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QUESTION 6

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A 4 kg block on a horizontal, rough surface is connected to an 8 kg block by a light, inelastic string that passes over a frictionless pulley as shown below. The coefficient of kinetic friction between the block of 4 kg and the surface is 0,6.



6.1 Draw a free-body diagram showing the forces acting horizontally on the 4 kg block. (2)

6.2 Calculate the acceleration of the system. (7)

6.3 Calculate the magnitude of the tension in the string. (3)

6.4 Calculate the magnitude of the frictional force that acts on the 4 kg block. (4)

[16]

QUESTION 7

Collisions between vehicles take place on the roads in our country daily. In one of these collisions, a car of mass 1 650 kg, travelling at a velocity of 25 $m \cdot s^{-1}$ to the left, collides head-on with a minibus of mass 3 050 kg, travelling at 15 $m \cdot s^{-1}$ to the right. The two vehicles move together as unit in a straight line after collision.



7.1 Calculate the velocity of the two vehicles after the collision. (5)

7.2 Prove by means of calculations that the collision was inelastic. (9)

7.3 New cars have crumple zones to help minimise injuries during accidents. Airbags and padded interiors can also help to reduce the chances of fatal injury or serious injury. Use a principle in Physics to explain how **crumple zones** can reduce the chances of fatal or serious injury. (3)

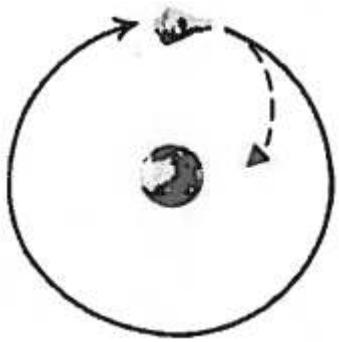
[17]

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QUESTION 8

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The diagram below shows a spaceship, with a mass of 3 500 kg, travelling in the vacuum of space in an orbit around the earth, with a mass of $5,98 \times 10^{24}$ kg at a constant speed. There is a distance of $8,53 \times 10^{6}$ m between the earth and the spaceship centres.



8.1 Define the Newton's law of Universal Gravitation. (2)

8.2 Calculate the gravitational force that the earth exerts on the spaceship. (4)

8.3 How does the force exerted by the spaceship on the earth compare to the force calculated in QUESTION 8.2 above?

Write ONLY **greater than**, **smaller than** or **equal to**. (1)

8.4 Name and state the Newton's Law of motion used to make a choice in QUESTION 8.3 above. (3)

8.5 Due to the change in the distance between the earth and the spaceship centres, the force increased by a factor of 4. Calculate the new distance between the earth and the spaceship centres. (4)

[14]

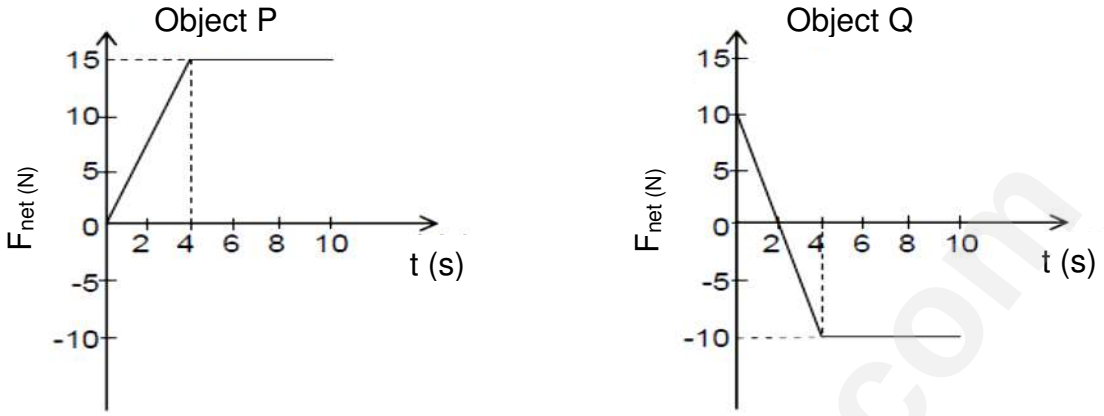
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QUESTION 9

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Two identical objects P and Q with a mass of 10 kg each, are moving side by side with an initial velocity of 5,5 m·s^{-1} east on a horizontal surface. The following graphs show the net force experienced by each object respectively during the same time interval.



9.1 Calculate the total impulse experienced by object Q in 10 s. (5)

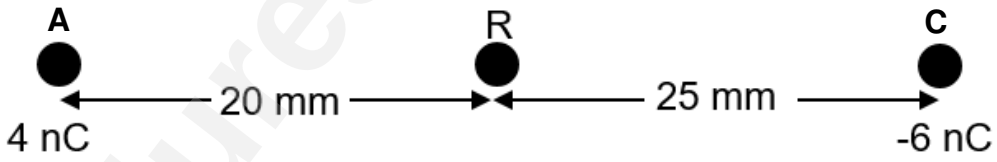
9.2 Compare without using any calculations the total impulse for object P with that of object Q. Write down only GREATER THAN, LESS THAN or EQUAL TO. (2)

9.3 Calculate the final velocity of object Q. (4)

[11]

QUESTION 10

Two point charges of magnitudes +4 nC and -6 nC are placed at points A and C respectively. These charges are respectively 20 mm and 25 mm away from point R as shown in the diagram below:



10.1 Draw the electric field pattern formed between the two point charges (A and C). (3)

10.2 Calculate the net electric field at R due to the two point charges. (7)

10.3 If the distance between the two charges (A and C) is reduced by 15 mm, calculate the electrostatic force that charge A exerts on charge C. (5)

[15]

TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)
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GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasie konstante*	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}\ m{\cdot}s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$
Mass of Earth *Massa van Aarde*	M	$5,98 \times 10^{24}\ kg$
Radius of Earth *Radius van Aarde*	R_E	$6,38 \times 10^{3}\ km$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^{\,2} = v_i^{\,2} + 2a\Delta x$ or/*of* $v_f^{\,2} = v_i^{\,2} + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$\mu_k = \frac{f_k}{N}$	$\mu_s = \frac{f_{s(maks)}}{N}$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

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WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_p = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/of $W_{nc} = \Delta E_k + \Delta E_p$	$P_{av} = Fv_{av}$ $P_{gemid} = Fv_{gemid}$
$P = \frac{W}{\Delta t}$	

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WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ $E = h\frac{c}{\lambda}$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ or/of $n = \frac{Q}{q_e}$	

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NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2016

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKS: 150

TIME: 3 hours

* P H S C E 2 *

This question paper consists of 16 pages, including formula sheet, data sheets and an answer sheet.

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INSTRUCTIONS AND INFORMATION

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1. Write your full NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of EIGHT questions. Answer QUESTION 5.8 on the attached GRAPH SHEET. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. Write neatly and legibly.
7. You may use a non-programmable calculator.
8. You may use appropriate mathematical instruments.
9. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
10. Show ALL formulae and substitutions in ALL calculations.
11. Round off your FINAL numerical answers to a minimum of TWO decimal places.
12. Give brief motivations, discussions, et cetera where required.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D), corresponding to the correct answer of your choice, next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 A reaction in which products can be converted back to reactants is described as:

A Heterogeneous
B Homogeneous
C Reversible
D Spontaneous (2)

1.2 Which ONE of the following reaction conditions applies to esterification?

A Heat reaction mixture mildly over a water bath
B Apply mild heat directly to the reaction mixture
C Apply strong heat directly to the reaction mixture
D Add concentrated hydrochloric acid as a catalyst (2)

1.3 What NAME is given to the process of breaking down long chain hydrocarbons into more useful shorter chains?

A Hydrogenation
B Cracking
C Dehydrohalogenation
D Polymerisation (2)

1.4 Which ONE of the following changes will increase the rate of production of $H_2(g)$ in the reaction given below?

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

A Increase in pressure by decreasing the volume
B Add water to the reaction mixture
C Increase the volume of the $H_2SO_4(aq)$
D Increase the concentration of the $H_2SO_4(aq)$ (2)

1.5 Consider the reversible reaction: $3\ Y_2(g) \rightleftharpoons 2\ Y_3(g)$ $\Delta H = -80$ kJ

If the activation energy for the reverse reaction is 180 kJ, then the activation energy for the forward reaction is …

A -80 kJ.
B 80 kJ.
C 100 kJ.
D 180 kJ. (2)

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1.6 An acid, HX has a concentration of 5×10^{-2} mol·dm^{-3} and K_a value equal to 10^3 at 25 ºC.

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The solution of HX is most correctly described as a …

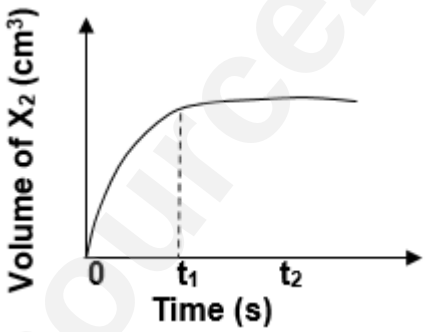
A dilute solution of a strong acid.
B dilute solution of a weak acid.
C concentrated solution of a weak acid.
D concentrated solution of a strong acid. (2)

1.7 To what volume must 20 cm^3 of a 10 mol·dm^{-3} solution of potassium hydroxide (KOH) be diluted to obtain a 2 mol·dm^{-3} solution?

A 100 cm^3
B 90 cm^3
C 200 cm^3
D 110 cm^3 (2)

1.8 The sketch graph below represents changes in the volume of $X_2(g)$ as the following reaction proceeds in an open container.

$$2\ XY(aq) + M \rightarrow MY_2(aq) + X_2(g)$$



The horizontal section after time t_1 means that the …

A reaction has stopped.
B reaction reaches equilibrium.
C rate of reaction increases.
D rate of reaction decreases. (2)

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1.9 Consider the following reaction that is at equilibrium in a closed container

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$$CoC\ell_4(aq) + 6H_2O(\ell) \rightleftharpoons Co(H_2O)_6^{2+}(aq) + 4C\ell^-(aq) \quad \Delta H < 0$$

What will be observed when a few drops of concentrated hydrochloric acid are added to the equilibrium mixture?

A The solution turns pink.
B The solution turns blue.
C The solution's colour remains the same.
D The solution's colour turns pink then turns blue. (2)

1.10 Distilled water ionises according to the following equation:

$$2\ H_2O(\ell) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$

The K_w values for distilled water are given below:

$K_w = 1 \times 10^{-14}$ at 25 °C

$K_w = 2{,}92 \times 10^{-14}$ at 40 °C

Which statement is TRUE about distilled water as temperature increases from 25 °C to 40 °C?

A The water becomes acidic
B The water becomes alkaline
C $[OH^-]$ becomes higher than $[H_3O^+]$
D $[OH^-]$ remains equal to $[H_3O^+]$ (2)

[20]

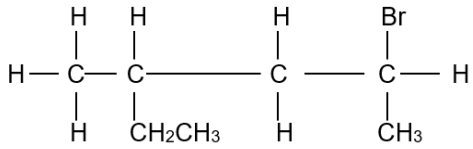
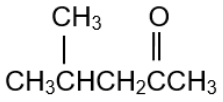
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QUESTION 2

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The letters A to F represent six organic compounds.

A	Ethyl propanoate	**B**	Ethene
C		**D**	
E	Methanal	**F**	$C_4H_{10}O$

2.1 Write down the …

2.1.1 general formula for the homologous series to which compound **B** belongs. (1)

2.1.2 name of the homologous series to which compound **D** belongs. (1)

2.1.3 letter of the compound that represents an aldehyde. (1)

2.2 Compound **B** undergoes polymerisation to form a polymer that is used to make plastic products.

2.2.1 Give a reason why compound **B** is classified as unsaturated. (2)

2.2.2 Classify the polymerisation as ADDITION or CONDENSATION. (1)

2.2.3 Write down the CONDENSED STRUCTURAL FORMULA of the polymer. (2)

2.3 Write down the …

2.3.1 IUPAC name of compound **C**. (3)

2.3.2 IUPAC name of compound **D**. (2)

2.4 Compound **F** is a secondary alcohol.

Write down the …

2.4.1 STRUCTURAL FORMULA of compound **F**. (2)

2.4.2 IUPAC NAME of a CHAIN ISOMER of compound **F**. (2)

2.5 Compound **A** is prepared from the reaction between an alcohol and carboxylic acid in the presence of an inorganic acid.

Write down the …

2.5.1 IUPAC NAME of the carboxylic acid used. (2)

2.5.2 STRUCTURAL FORMULA of compound **A**. (2)

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2.6 Compound **B** reacts with bromine (Br_2).

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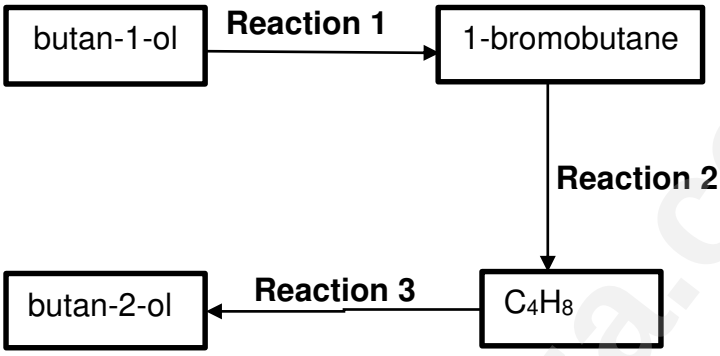
2.6.1 Write down the MOLECULAR FORMULA of the product. (1)

2.6.2 Use a calculation to determine the percentage composition of the product. (5)

[27]

QUESTION 3

In the flow diagram below butan-1-ol is converted to its structural isomer, butan-2-ol.



3.1 What type of structural isomers are butan-1-ol and butan-2-ol? (1)

3.2 For **Reaction 1**, write down the …

3.2.1 type of reaction of which this is an example. (1)

3.2.2 NAME or FORMULA of the INORGANIC reactant needed. (1)

3.3 For **Reaction 2**, write down …

3.3.1 the NAME or FORMULA of the INORGANIC reactant needed. (1)

3.3.2 ONE reaction condition. (1)

3.4 Write down the type of addition reaction of which **Reaction 3** is an example. (1)

3.5 Butan-1-ol can be converted directly to the ORGANIC PRODUCT C_4H_8 without forming 1-bromobutane.

Write down the NAME or FORMULA of the substance that can be used for this direct conversion. (1)

3.6 Using MOLECULAR FORMUAE write down a balanced equation for the complete combustion of the compound C_4H_8. (3)

[10]

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QUESTION 4

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The relationship between strength of intermolecular forces and boiling point is investigated using five organic compounds that belong to different homologous series.

	COMPOUND	BOILING POINT (°C)
A	Butane	-1
B	Butan-2-one	79,5
C	Butan-1-ol	117,4
D	Butanoic acid	163,5
E	Pentanoic acid	187

4.1 Which compound in the table is a gas at room temperature? (1)

4.2 Define the term *homologous series*. (2)

4.3 A type of van der Waals force exists between molecules of compound **A** and also between molecules of compounds **B**, **C**, **D** and **E**. Write down the NAME of the Van der Waals force. (1)

4.4 Refer to the TYPE and STRENGTH of intermolecular forces to explain the difference in the boiling points between:

4.4.1 Compounds **A** and **B** (3)

4.4.2 Compounds **C** and **D** (3)

4.5 Consider compounds **D** and **E**.

4.5.1 Which compound has a HIGHER vapour pressure? (1)

4.5.2 Refer to MOLECULAR STRUCTURE, TYPE and STRENGTH of intermolecular forces to explain the answer to QUESTION 4.5.1. (3)

[14]

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QUESTION 5

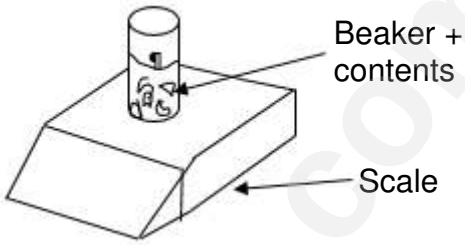
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A certain mass of calcium carbonate chunks is added to EXCESS hydrochloric acid solution in an open beaker placed on a scale as shown below. The equation for the reaction is as follows:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

The initial temperature of the reaction flask is 30 °C. The data in the table was obtained for the reaction.

Time (minutes)	Mass of beaker and contents (g)
0	192,4
1	188,8
2	188,0
3	187,4
4	187,1
5	186,7
6	186,7



5.1 Is the reaction mixture HETEROGENEOUS or HOMOGENEOUS? (1)

5.2 Give a reason why the mass of the contents of the beaker decreases as the reaction proceeds. (1)

5.3 How long (in minutes) did the reaction take to reach completion? (1)

5.4 Calculate the average rate of reaction during the interval 0 to 1 minute in grams per minute. (3)

5.5 The rate of reaction decreases as the reaction proceeds.

Give TWO reasons why the reaction rate decreases. (2)

5.6 Apart from CO_2, write the NAME or FORMULA of another substance that is not present in the container after 6 minutes. (1)

5.7 Calculate the mass of calcium carbonate consumed after completion of the reaction. (5)

5.8 Plot a graph of mass of contents of beaker versus time for the time interval from the 0th to the 6th minute. (A graph paper is provided at the back). (4)
NOTE: The graph is not a straight line.
(ATTACH THIS GRAPH SHEET TO THE ANSWERBOOK.)

5.9 Use the collision theory to explain how the rate of the above reaction will change when the initial temperature is changed to 50 °C. (4)
[22]

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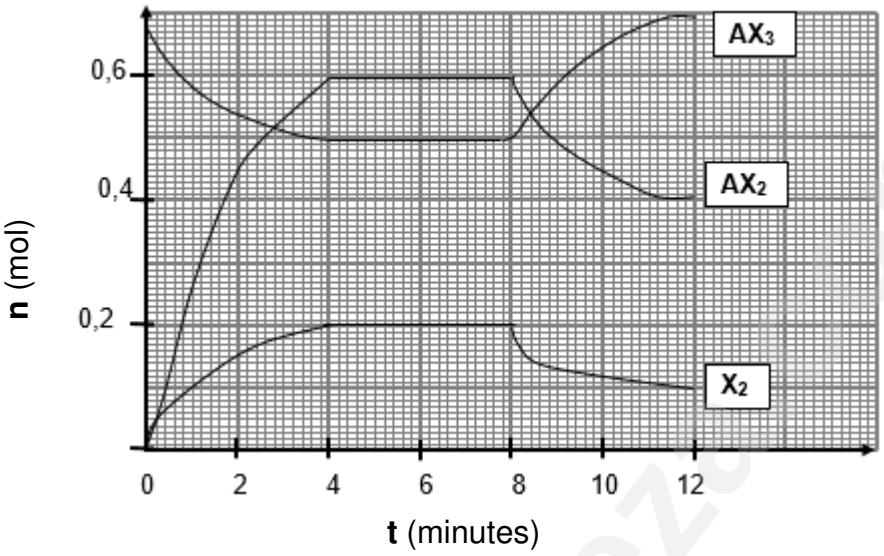
QUESTION 6

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The following reaction reaches chemical equilibrium in a closed container at 1 000 °C.

$$2AX_3(g) \rightleftharpoons 2AX_2(g) + X_2(g)$$

The course of reaction is illustrated in the graph below:



6.1 Explain the meaning of the term *chemical equilibrium*. (2)

6.2 Use the graph to determine the …

6.2.1 time the reaction took to reach chemical equilibrium for the first time. (1)

6.2.2 number of moles of AX_3 at the first equilibrium. (1)

6.3 Calculate the volume of the container if $K_c = 2,5 \times 10^{-2}$ at 1000 °C. (6)

6.4 Is the yield, HIGH or LOW at 1000 °C? Give a reason. (2)

6.5 The change in the number of moles at t = 8 minutes is caused by a DECREASE in temperature.

Is the forward reaction ENDOTHERMIC or EXOTHERMIC?

Explain your answer by using Le Chatelier's principle. (4)

6.6 What effect will the addition of a suitable catalyst have on the value of K_c? Write down only DECREASES, INCREASES or REMAINS THE SAME. (1)

[17]

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QUESTION 7

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7.1 Oxalic acid, $(COOH)_2$, ionises in two steps as shown below.

$(COOH)_2(s) + H_2O(\ell) \rightleftharpoons H(COO)_2^-(aq) + H_3O^+(aq)$ $\quad K_a = 5,4 \times 10^{-2}$ at 25 °C

$H(COO)_2^-(aq) + H_2O(\ell) \rightleftharpoons (COO)_2^{2-}(aq) + H_3O^+(aq)$ $\quad K_a = 5,4 \times 10^{-5}$ at 25°C

7.1.1 Write down in words what the symbol, K_a, stands for. (1)

7.1.2 Why is the temperature at which the K_a is calculated always given? (1)

7.1.3 H_2O is acting as a base in both reactions. Write down the FORMULA of a substance that acts as an ampholyte in the reactions. (1)

7.1.4 Write down the **net equation** for the ionisation of oxalic acid. (3)

7.2 A sodium hydroxide (NaOH) solution of volume 40 cm^3 and concentration 1 $mol \cdot dm^{-3}$ is prepared.

7.2.1 Calculate the mass of sodium hydroxide needed to prepare the solution. (4)

The 40 cm^3 of sodium hydroxide solution of concentration 1 $mol \cdot dm^{-3}$ is added to 50 cm^3 of a 0,06 $mol \cdot dm^{-3}$ sulphuric acid (H_2SO_4) solution in a flask. The reaction taking place in the flask is given below:

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$$

Calculate the …

7.2.2 initial number of moles of sulphuric acid in the flask. (3)

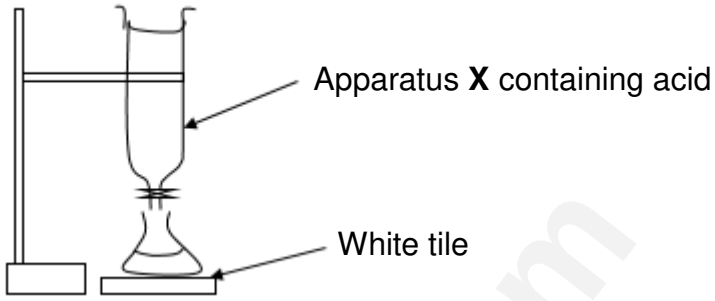
7.2.3 pH of the solution in the flask after the completion of the reaction. (8)

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7.3 A titration between solutions of a strong base and standard ethanoic acid (CH_3COOH) solution is performed. The acid is added from apparatus **X** into a flask under which a white tile is placed until a point where the indicator changes colour is reached.

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7.3.1 Write down a term for the underlined phrase. (1)

7.3.2 Name apparatus **X** from which the acid is added. (1)

7.3.3 What is the purpose of the white tile? (1)

7.3.4 A learner performing the titration accidentally adds three drops of the acid after the indicator has changed colour. When she measures the pH of the solution after adding the three drops she finds out that the solution has a pH > 7.

With the aid of a balanced equation, explain why the solution has a pH > 7. (4)

[28]

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QUESTION 8

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Three reactions that lead to the formation of nitric acid (HNO_3) are shown below:

Reaction 1: $4NH_3(g) + 5O_2(g) \xrightarrow{Pt} 4NO(g) + 6H_2O(g)$

Reaction 2: $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ $\Delta H = -149,1$ kJ

Reaction 3: $4NO_2(g) + O_2(g) + H_2O \rightarrow 4HNO_3$

8.1 In **Reaction 1**, platinum (Pt) acts as a catalyst.

What NAME is given to the energy that a catalyst changes in a chemical reaction? (1)

8.2 **Reaction 2** reaches equilibrium in a closed container.

8.2.1 Is the reaction EXOTHERMIC or ENDOTHERMIC? Give a reason. (2)

8.2.2 Write down TWO changes that must be made to increase the YIELD of NO_2. (2)

8.2.3 What is the value of ΔH per mole of NO_2 formed? (1)

8.3 Nitric acid reacts with ammonia (NH_3) to produce ammonium nitrate (NH_4NO_3).

8.3.1 Write down the NAME of the type of reaction between an acid and a base. (1)

8.3.2 Which particle (PROTON or ELECTRON) is transferred during the reaction mentioned in QUESTION 8.3.1? (1)

8.3.3 To determine the percentage purity of an IMPURE ammonium nitrate sample, the sample is dissolved in water and allowed to react with a solution of sodium hydroxide according to the balanced equation:

$$NH_4NO_3(aq) + NaOH(aq) \rightarrow NaNO_3(aq) + NH_3(g) + H_2O(\ell)$$

0,204 g of the IMPURE sample of ammonium nitrate (NH_4NO_3) neutralises exactly $2,4 \times 10^{-3}$ mol of sodium hydroxide (NaOH).

Calculate the percentage purity of the ammonium nitrate sample. (4)

[12]

TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAAM/*NAME*	SIMBOOL/*SYMBOL*	WAARDE/*VALUE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume teen STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron Lading op elektron	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant Avogadro se konstante	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$ or/of $n = \frac{N}{N_A}$ or/of $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at /by 298K
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$		

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TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 1 H 1																	2 He 4
1,0 3 Li 7	1,5 4 Be 9											2.0 5 B 11	2.5 6 C 12	3.0 7 N 14	3.5 8 O 16	4.0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24											1.5 13 Aℓ 27	1.8 14 Si 28	2.1 15 P 31	2.5 16 S 32	3.0 17 Cℓ 35,5	18 Ar 40
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1,5 22 Ti 48	1.6 23 V 51	1.6 24 Cr 52	1.5 25 Mn 55	1.8 26 Fe 56	1.8 27 Co 59	1.8 28 Ni 59	1.9 29 Cu 63,5	1.6 30 Zn 65	1.6 31 Ga 70	1.8 32 Ge 73	2.0 33 As 75	2.4 34 Se 79	2.8 35 Br 80	36 Kr 84
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1,4 40 Zr 91	41 Nb 92	1.8 42 Mo 96	1.9 43 Tc	2.2 44 Ru 101	2.2 45 Rh 103	2.2 46 Pd 106	1.9 47 Ag 108	1.7 48 Cd 112	1.7 49 In 115	1.8 50 Sn 119	1.9 51 Sb 122	2.1 52 Te 128	2.5 53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 72 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1.8 81 Tℓ 204	1.8 82 Pb 207	1.9 83 Bi 209	2.0 84 Po	2.5 85 At	86 Rn
0,7 87 Fr	0,9 88 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KEY/ *SLEUTEL*

Atoomgetal Atomic number

Elektronegatiwiteit Electronegativity

29
1,9 Cu
63,5

Simbool Symbol

Benaderde relatiewe atoommassa Approximate relative atomic mass

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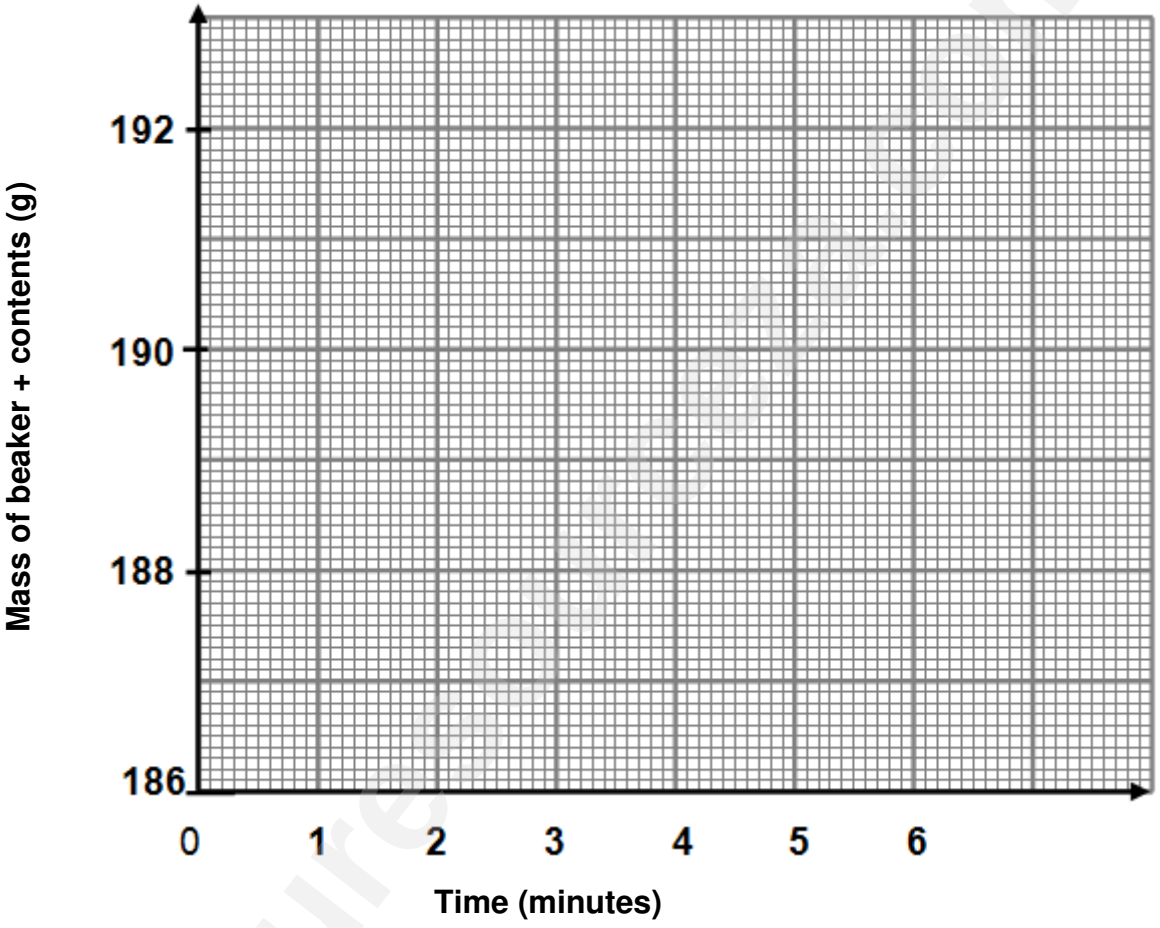
GRAPH SHEET FOR QUESTION 5.8

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NAME OF LEARNER: ..... **DATE:** .....

NAME OF SCHOOL: ..... **GRADE 12:** .....

GRAPH OF MASS OF BEAKER + CONTENTS vs. TIME



Detach this page and hand it in with your answerbook at the end of the examination.

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GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

MARKING GUIDELINE

HALF - YEARLY EXAMINATIONS

JUNE 2020

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SECTION A

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

1.1	A	✓✓	(2)
1.2	A	✓✓	(2)
1.3	B	✓✓	(2)
1.4	C	✓✓	(2)
1.5	D	✓✓	(2)
1.6	C	✓✓	(2)
1.7	B	✓✓	(2)
1.8	D	✓✓	(2)
1.9	D	✓✓	(2)
1.10	C	✓✓	(2)

[20]

SECTION B

QUESTION 2

2.1.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force at an acceleration directly proportional to the force and inversely proportional to the mass of the object. ✓✓

OR

The resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force. ✓✓ (2)

2.1.2 Kinetic (friction) ✓ (1)

2.1.3 $f_3 = \mu N$ ✓
$= \mu mg$
$= (0,1)(3)(9,8)$ ✓
$= 2,94$ N (2)

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2.1.4 **OPTION 1**
Right: Positive

Trailer: $F_{net} = ma$ ✓
$T + f_3 = ma$
$\underline{T - 2,94}$ ✓ $= 3a$

Car: $F_{net} = ma$ ✓
$F + f_5 + T = ma$
$\underline{40 - 4,9 - T}$ ✓ $= 5a$
$a = 4,02\ m \cdot s^{-2}$ ✓

OPTION 2
Right: Negative

Trailer: $F_{net} = ma$ ✓
$T + f_3 = ma$
$-T + 2,94$✓ $= -3a$

Car: $F_{net} = ma$ ✓
$F + f_5 + T = ma$
$\underline{-40 + 4,9 + T}$✓ $= -5a$
$a = 4,02\ m \cdot s^{-2}$✓

OPTION 3
Right Positve

SYSTEM METHOD
$F_{net} = ma$ ✓
$F + f_5 + f_3 = ma$
$40 - 4,9 - 2,94 = 8a$ ✓
$a = 4,02\ m \cdot s^{-2}$ ✓

Max:3/5

(5)

2.1.5 **POSITIVE MARKING FROM 2.1.4**
OPTION 1 (Car)
Right Positve

$F_{net} = ma$
$F + f_5 + F_T = ma$
$\underline{40 + (-4,9) + F_T = 5(4,02)}$ ✓
$F_T = -15$ N
$F_T = 15$ N✓; left ✓

OPTION 1 (Car)
Right Positve

$F_{net} = ma$
$F + f_5 + F_T = ma$
$\underline{-40 + 4,9 + F_T = 5(-4,02)}$ ✓
$F_T = 15$ N
$F_T = 15$ N✓; left ✓

OPTION 3 (Trailer)
Right Positve

$F_{net} = ma$
$f_3 + F_T = ma$
$\underline{-2,94 + F_T = 3(4,02)}$ ✓
$F_T = 15$ N
F_T on car = 15 N✓; left ✓

OPTION 4 (Trailer)
Right Negative

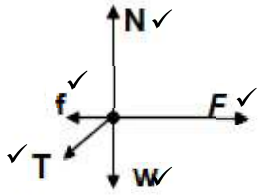
$F_{net} = ma$
$f_3 + F_T = ma$
$\underline{2,94 - F_T = 3(-4,02)}$ ✓
$F_T = 15$ N
F_T on car = 15 N✓; left ✓

(3)

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2.1.6



	Acceptable Symbols
N	F_{Normal}, F_N
T	Tension, F_T, $F_{tension}$
f	F_f,f_k, $F_{friction}$
w	F_g, $F_{gravity}$
F	F_{app}

(5)

2.1.7 Less than✓✓ (2)

2.1.8 Greater than✓✓ (2)

2.2 $g \equiv G\frac{M}{r^2}$ ✓

$g = 6{,}67 \times 10^{-11}\frac{6{,}39 \times 10^{23}}{(3{,}39 \times 10^{6})^2}$ ✓✓

$g = 3{,}71\ m \cdot s^{-2}$ ✓ (4)

[25]

QUESTION 3

3.1 The total linear momentum of a closed system remains constant (is conserved). ✓✓ (2)

3.2

OPTION 1
Right Positive

$\Sigma p_f = \Sigma p_i$ ✓

$m_1v_1 + m_2v_2 = (m_1+m_2)v$

$60v_f + 2(4)$ ✓ $= 62(1{,}5)$ ✓

$v_f = 1{,}42\ m \cdot s^{-1}$

$v_f = 1{,}42\ m \cdot s^{-1}$✓; forward / to the right ✓

OPTION 1
Right Negative

$\Sigma p_f = \Sigma p_i$ ✓

$m_1v_1 + m_2v_2 = (m_1+m_2)v$

$60v_f + 2(-4)$ ✓ $= 62(-1{,}5)$ ✓

$v_f = -1{,}42\ m \cdot s^{-1}$

$v_f = 1{,}42\ m \cdot s^{-1}$✓; forward / to the right ✓

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OPTION 3

Right Positive

$\Delta p_1 = -\Delta p_2$ ✓

$m_1\Delta v_1 = -m_2\Delta v_2$

$60(v_f - 1,5)$ ✓ $= -2(4 - 1,5)$ ✓

$v_f = 1,42\ m\cdot s^{-1}$

$v_f = 1,42\ m\cdot s^{-1}$✓; forward / to the right ✓

OPTION 3

Right Negative

$\Delta p_1 = -\Delta p_2$ ✓

$m_1\Delta v_1 = -m_2\Delta v_2$

$60[v_f - (-1,5)]$ ✓ $= -2[-4 - (-1,5)]$ ✓

$v_f = -1,42\ m\cdot s^{-1}$

$v_f = 1,42\ m\cdot s^{-1}$✓; forward / to the right ✓

(5)

3.3.1 Greater than ✓ (1)

3.3.2 Greater than ✓ (1)

[9]

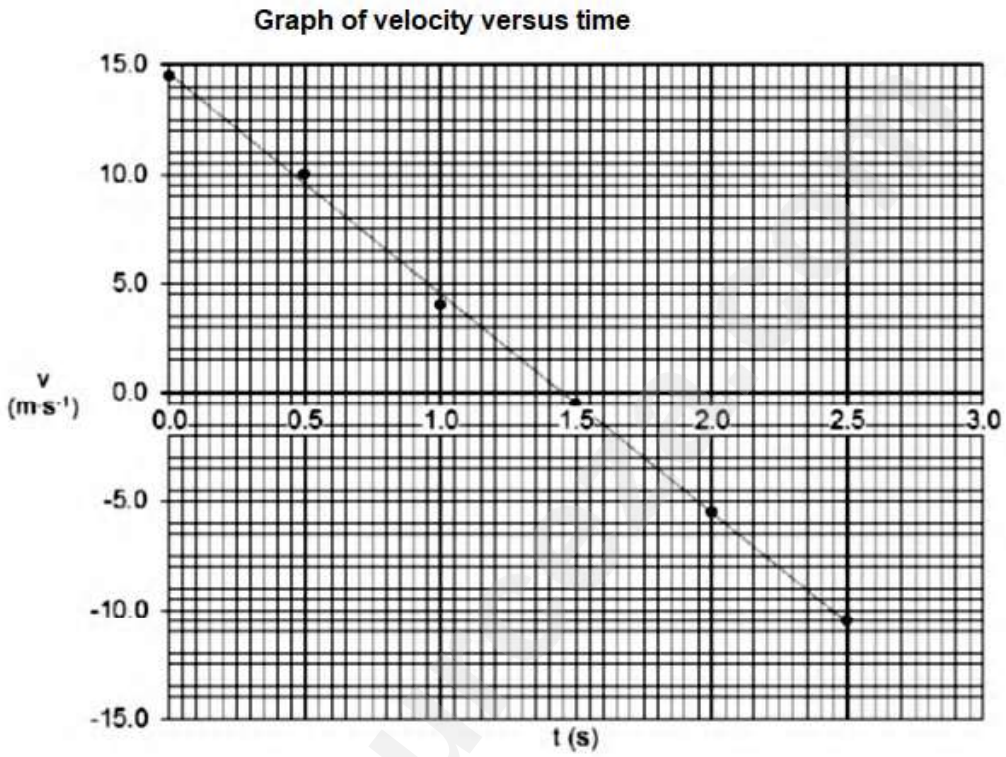
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QUESTION 4

4.1.1



Marking criteria

- Any first point plotted correctly✓
- Any second point plotted correctly✓
- Any third and fourth points plotted correctly ✓
- Any fifth and six points plotted correctly✓
- Best-fit line drawn✓ (5)

4.1.2 **Positive marking from 4.1.1**

For triangle+rectangle	**For trapezium**
$\Delta y = \frac{1}{2}bh + \ell \times w$ ✓ (or similar)	$\Delta y = \frac{1}{2}(\Sigma_{//})\Delta t$ ✓ (or similar)
$= \underline{\frac{1}{2}(1)(-10)}$ ✓ + $\underline{(1)(-0,5)}$ ✓	$= \underline{\frac{1}{2}[-0,5 + (-10,5)]}$ ✓ x $\underline{(1)}$ ✓
= -5,5 m	= -5,5 m
Δy = 5,5 m✓; downwards ✓	Δy = 5,5 m✓; downwards ✓

(5)

4.1.3 When the only force acting on it is the force of gravity. ✓ (1)

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4.2.1

OPTION 1
UPWARDS: POSITIVE

$V_f^2 = v_i^2 + 2a\Delta y$ ✓

0^2 ✓$= 40^2 + 2(-9,8)\Delta y$✓

$\Delta y = 81,6327$ m

Height = 81,63 +✓ 15

= 96,63 m ✓

OPTION 2
UPWARDS: NEGATIVE

$V_f^2 = v_i^2 + 2a\Delta y$ ✓

0^2 ✓$= -40^2 + 2(9,8)\Delta y$✓

$\Delta y = -81,6327$ m

Height = 81,63 +✓ 15

= 96,63 m ✓

(5)

4.2.2

OPTION 1
UPWARDS: POSITIVE

$v_f = v_i + a\Delta t$ ✓

$0 = 40 + (-9,8)\Delta t$ ✓

$\Delta t = 4,08$ s ✓

OPTION 2
UPWARDS: NEGATIVE

$v_f = v_i + a\Delta t$ ✓

$0 = -40 + (9,8)\Delta t$ ✓

$\Delta t = 4,08$ s ✓

(3)

POSITIVE MARKING FROM 4.2.1

OPTION 3
UPWARDS: POSITIVE

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$81,63 = 40\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓

$\Delta t = 4,08$ s ✓

OPTION 4
UPWARDS: NEGATIVE

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$-81,63 = -40\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓

$\Delta t = 4,08$ s ✓

OPTION 5
UPWARDS: POSITIVE

$\Delta y = (\frac{v_i+v_f}{2})\Delta t$✓

$81,63 = (\frac{40+0}{2})\Delta t$✓

$\Delta t = 4,08$ s ✓

OPTION 6
UPWARDS: NEGATIVE

$\Delta y = (\frac{v_i+v_f}{2})\Delta t$✓

$-81,63 = (\frac{-40+0}{2})\Delta t$✓

$\Delta t = 4,08$ s ✓

4.2.3

OPTION 1
UPWARDS: POSITIVE

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

-15✓ = +40Δt✓ + ½(-9,8)Δt²✓

OPTION 2
UPWARDS: NEGATIVE

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

15✓ = - 40Δt✓ + ½(9,8)Δt²✓

(3)

[22]

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QUESTION 5

5.1.1 A non-conservative force is a force for which the work done in moving an object between two points depends on the path taken. ✓✓ (2)

5.1.2

$W_{net} = \Delta K$ ✓

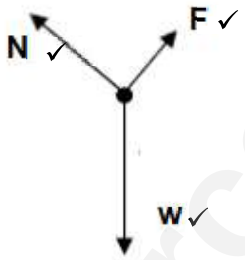
$W_{app} + W_w = K_f - K_i$

425 ✓$+ (0,20)(9,8)(29)(\cos 180°)$✓ $= ½(0,20)(v_p^2 - 0)$ ✓

$vp = 60,68\ m \cdot s^{-1}$ ✓

(5)

5.2.1



	Acceptable Symbols
N	F_N, F_{Normal}
w	F_g, $F_{gravity}$
F	F_{app}

(3)

5.2.2 The net/total work done on an object is equal to the change in the object's kinetic energy. ✓✓

OR

The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy. ✓✓

(2)

5.2.3 No ✓

Weight is not the only force doing work on the crate. ✓

(2)

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5.2.4 N is perpendicular to displacement. ✓ (1)

5.2.5 **OPTION 1**

$W_{net} = \Delta K$ ✓

$W_F + W_N + W_w = K_f - K_i$

$F(3,5)\cos 0° + 0$ ✓ + [$25 \times 9,8 \times 3,5 \sin 30°$ ✓ x $\cos 180°$] ✓ = $\frac{1}{2} \times 25 \times [10,8^2 - (12^2]$ ✓

$F = 24,79$ N ✓

(6)

[21]

QUESTION 6

6.1 Speed ✓ (1)

6.2 3 ✓ ($m \cdot s^{-1}$) (1)

6.3.1 It is the change in frequency (or pitch) of the sound detected by a listener because the sound source and the listener have different velocities *of* propagation ✓✓ (2)

6.3.2 345 ✓ ($m \cdot s^{-1}$) (1)

6.3.3 **POSITIVE MARKING FROM 6.3.2**

$$f_L = \frac{v + v_L}{v - v_S} f_s$$ ✓

$$f_L = \left(\frac{345 + 0}{345 - 57,5}\right)(1000)$$ ✓

$f_L = 1200$ Hz ✓ (5)

6.3.4 295 ✓ (K) Accept: The same temperature (1)

6.4.1 (Diagram) 3 ✓ (1)

6.4.2 1 ✓

The source is stationary. ✓ (2)

[14]

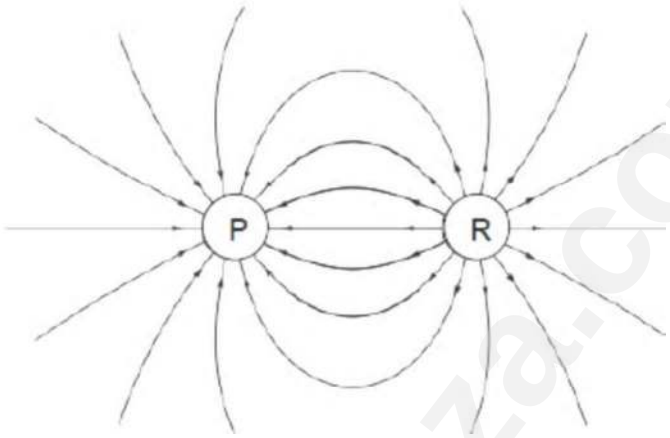
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QUESTION 7

7.1 The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. ✓✓ (2)

7.2

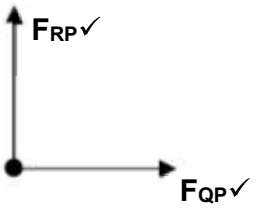


Marking criteria
Pattern ✓
Direction ✓
Field lines must touch charges at 90°. ✓

(3)

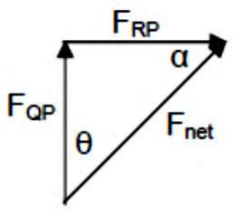
7.3 The magnitude of the electrostatic forces exerted by two point charges on each other is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance between them. ✓✓ (2)

7.4



(2)

7.5 $F = k\frac{q_1 q_2}{r^2}$✓



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$F_{QP} = 9 \times 10^9 \frac{45\times10^{-6}\times20\times10^{-6}}{(0,09)^2}$ ✓ = 1 x 10^3 N

$F_{RP} = 9 \times 10^9 \frac{30\times10^{-6}\times20\times10^{-6}}{(0,07)^2}$ ✓ = 1,102 x 10^3 N

$F_{net}^2 = F_{RP}^2 + F_{QP}^2$ ✓

$= (1,102 \times 10^3)^2 + (1 \times 10^3)^2$ ✓

$F_{net} = 1,49 \times 10^3$ N ✓

$\theta = \tan^{-1}(1,102 \times 10^3/1 \times 10^3)$ ✓
$= 47,78°$ ✓

If α is used:
$\alpha = \tan^{-1}(1 \times 10^3/1,102 \times 10^3)$ ✓
$= 42,22°$ ✓

Accept correct trigonometry if F_{net} and F_{QP} or F_{net} and F_{RP} are used.	(8)

[17]

QUESTION 8

8.1 The battery can supply a maximum of 12 J of (electrical) energy to every 1 C of charge. ✓✓ (2)

8.2 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓ (2)

8.3

OPTION 1	**OPTION 2**	
$P = I^2R$ ✓ $5 = I^2(5)$ ✓ I = 1 A✓	$P = \frac{V^2}{R}$ $5 = \frac{V^2}{5}$ V = 5 V	
	$P = VI$ ✓ $5 = 5\ I$✓ I = 1 A ✓	$V = IR$✓ $5 = I.\ 5$✓ I = 1A✓

(3)

8.4 _____

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OPTION 1	**OPTION 2**

$V = I \times R_{bulb}$ ✓
$V = 1 \times 5$ ✓
$V = 5$ V
$V_{//} = 12 - 5 = 7$ V
$V_{//} = I \times R_{(3+11)}$
 	
7 ✓$= I \times 14$ ✓
 	
I = 0,5 A
$I_{AB} = 1 - 0,5 = 0,5$ A
$R_{AB} = \frac{V_{//}}{I}$
$R_{AB} = \frac{7✓}{0,5✓}$
 	
$R_{AB} = 14\ \Omega$
 	
$R_Y = 14 - 4 = 10\ \Omega$ ✓
	$E = I(R + r)$ ✓
	$12 = 1(R + 0)$ ✓
	$R = 12\ \Omega$
	$R_T = R_{Bulb} + R_{//}$
	12✓ = 5✓ + $R_{//}$
	$R_{//} = 7\ \Omega$
	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
	
	$\frac{1}{R//} = \frac{1}{R_{3+11}} + \frac{1}{R_{AB}}$
	
	$\frac{1}{7}✓ = \frac{1}{14}✓ + \frac{1}{R_{AB}}$
	$R_{AB} = 14\ \Omega$
	
	$R_Y = 14 - 4 = 10\ \Omega$ ✓

(7)

8.5 Cost = energy used x tariff per kWh
= Pt x tariff per kWh

$Cost = (\frac{5}{1000})(\frac{1400}{6})✓(180)✓$

Cost =R0,21 ✓

(3)

8.6.1 No ✓

- Total resistance increases. ✓
- Current through bulb/main current decreases. ✓
- According to $P = I^2R$ power decreases. ✓

(4)

8.6.2 Greater than ✓ (1)

[22]

[150]

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education

Department of Education
FREE STATE PROVINCE

EXAMINATION

GRADE 12

PHYSICAL SCIENCES P2

JUNE 2018

MARKS: 150

TIME: 3 HOURS

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INSTRUCTIONS AND INFORMATION

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1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave one line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable pocket calculator.

7. You may use appropriate mathematical instruments.

8. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your FINAL numerical answers to a minimum of TWO decimal places where applicable.

11. Give brief motivations, discussions, et cetera where required.

12. Write neatly and legibly.

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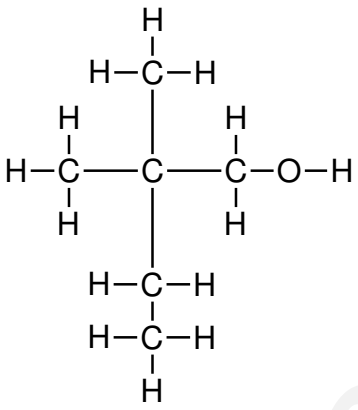
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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down only the letter A, B, C or D next to the question number (1.1–1.10) in your ANSWER BOOK.

For QUESTION 1.1 and 1.2 consider the structural formula below.



1.1 The IUPAC name for the compound is ...

A 2,2-dimethylbutan-1-ol.

B 3,3-dimethylbutan-4-ol.

C 2-ethyl-2-methylpropan-1-ol.

D 2-ethyl-2-methylpropan-3-ol. (2)

1.2 What is the name of its functional group?

A Alcohol

B Hydroxide

C Hydronium

D Hydroxyl (2)

1.3 Reaction rate can be defined as the ...

A time taken for the reaction to occur.

B change in mass of products per unit time.

C speed at which reactants convert to products.

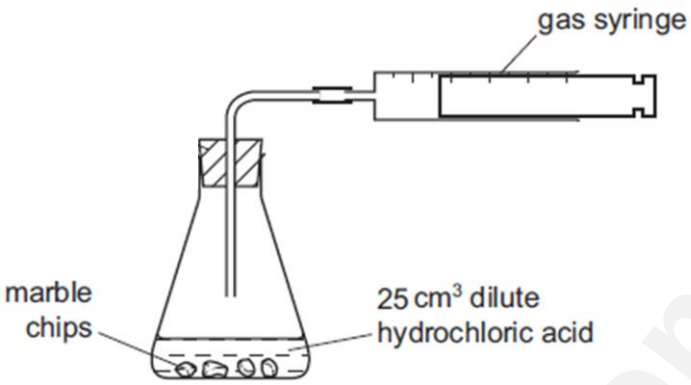
D rate at which reactants are changed into products. (2)

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1.4 A student was investigating the reaction between marble chips and dilute hydrochloric acid.

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Which changes would increase the rate of reaction?

	Temperature of acid	Surface area of marble chips
A	Decrease	Decrease
B	Decrease	Increase
C	Increase	Decrease
D	Increase	Increase

(2)

1.5 Chemical reactions are in a state of dynamic equilibrium only when ...

A products can be converted back to reactants.

B the concentrations of reactants and products are equal.

C the rate of the forward reaction equals that of the reverse reaction.

D the activation energies of the forward and the backward reactions are equal. (2)

1.6 Which line in the table best describes the effect of adding a positive catalyst to the reaction below?

$$4NH_3(g) + 2O_2(g) \rightleftharpoons 4NO(g) + 6H_2(g) \qquad \Delta H < 0$$

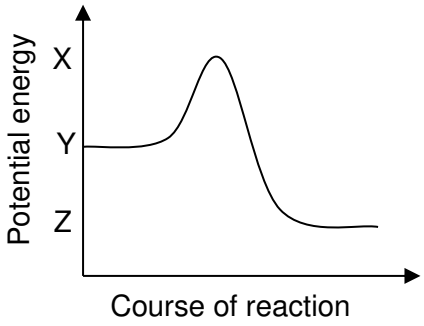
	Position of equilibrium	Rate of reverse reaction
A	Unchanged	Unchanged
B	Shifts to the left	Increases
C	Unchanged	Decreases
D	Unchanged	Increases

(2)

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1.7 A reaction has the following potential energy diagram.

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The activation energy for the reverse reaction is ...

A X – Z.

B X – Y.

C Y – Z.

D Z – Y. (2)

1.8 Which acid reacts with ammonia to produce ammonium sulphate?

A $HC\ell$

B HNO_3

C H_3PO_4

D H_2SO_4 (2)

1.9 Which one of the following represents the complete neutralisation of H_3PO_4 by NaOH?

A $H_3PO_4 + NaOH \rightarrow NaH + HPO_4 + H_2O$

B $H_3PO_4 + NaOH \rightarrow NaH_2PO_4 + H_2O$

C $H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$

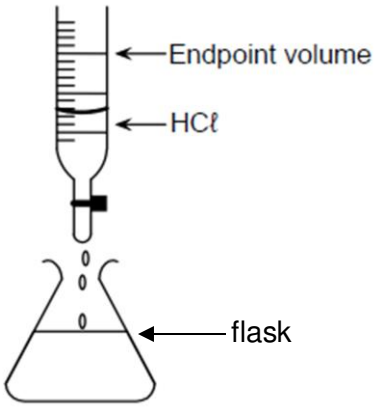
D $H_3PO_4 + 2NaOH \rightarrow Na_2HPO_4 + 2H_2O$ (2)

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1.10 In a titration involving HCℓ and NaOH, as shown in the sketch below, a learner accidentally exceeded the endpoint.



Which one of the following is correct for the solution that is now in the flask?

A $[H^+] < [OH^-]$ and acidic

B $[H^+] > [OH^-]$ and basic

C $[H^+] < [OH^-]$ and basic

D $[H^+] > [OH^-]$ and acidic (2)

[20]

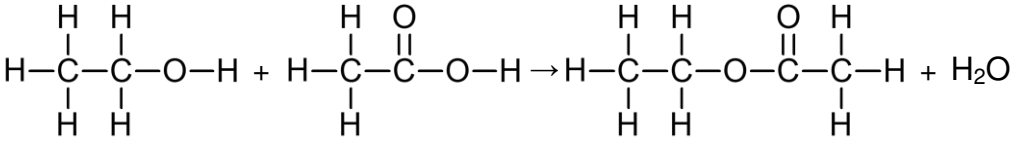
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QUESTION 2

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2.1 A student used 2,3 g of ethanol and EXCESS ethanoic acid to produce 2,6 g of ethyl ethanoate. The balanced equation for the reaction is:



2.1.1 What do you understand by the term *excess* as used in the statement above? (1)

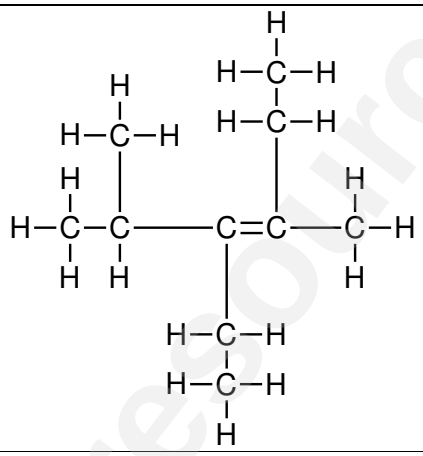
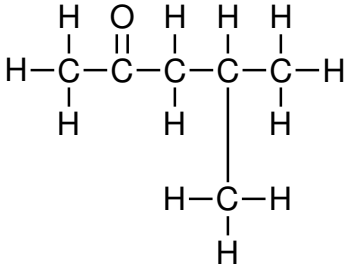
For ethyl ethanoate:

2.1.2 Write down the homologous series to which it belongs. (1)

2.1.3 Draw the STRUCTURAL FORMULA of its positional isomer. Write down the IUPAC name of this isomer. (4)

2.1.4 Calculate the percentage yield. (5)

2.2 Consider compounds **A** and **B** below

A		B	

2.2.1 Define the term *functional group* (2)

Write down the following for compound **A**:

2.2.2 General formula of the homologous series to which it belongs. (1)

2.2.3 IUPAC name (3)

Write down the following for compound **B**:

2.2.4 Name of its functional group (1)

2.2.5 IUPAC name (2)

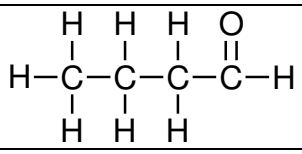
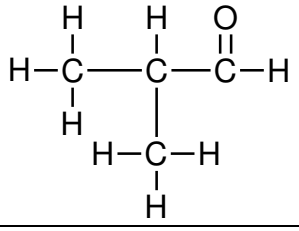
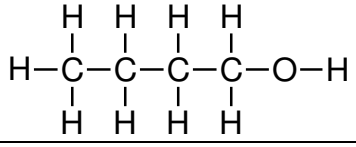
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QUESTION 3

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Two structural isomers, **A** and **B**, are used to investigate factors which affect boiling point. The results obtained are shown in the table below.

	Compound	Boiling point (°C)
A		75
B		63
C		

3.1 Define the term *structural isomers*. (2)

3.2 Name the type of structural isomerism between compounds **A** and **B**. (1)

3.3 Compound **A** has a higher boiling point than compound **B**. Fully explain this difference. (3)

3.4 Draw the STRUCTURAL FORMULA of the straight chain (unbranched) functional isomer of compound **A**. Write down the IUPAC name of this isomer (4)

3.5 Predict the boiling point of compound **C**. Choose from 57°C, 69°C and 118°C. (1)

3.6 Refer to the TYPES of intermolecular forces to explain the difference in boiling points between compound **A** and compound **C**. (3)

3.7 Write down the IUPAC name of compound:

3.7.1 **B** (2)

3.7.2 **C** (2)

[18]

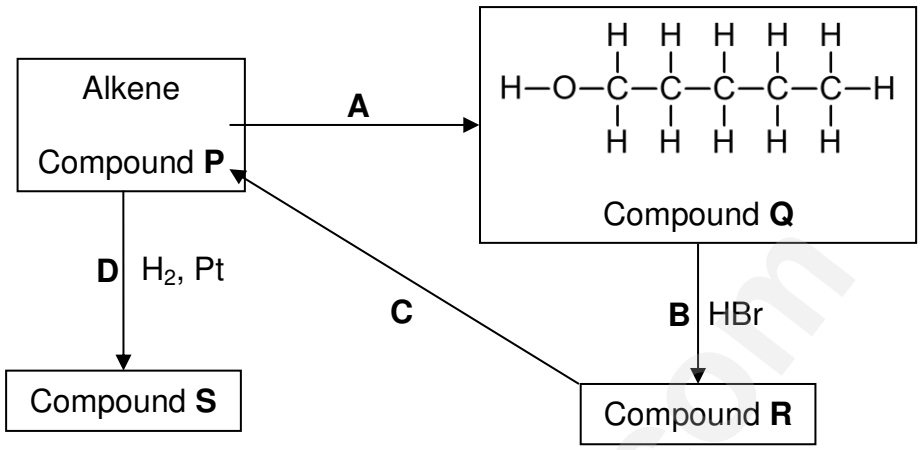
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QUESTION 4

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Consider the reactions represented in the flow diagram below.



4.1 Consider compound **P**.

4.1.1 Is compound **P** saturated or unsaturated. Give a reason for the answer. (2)

4.1.2 Write down its STRUCTURAL FORMULA. (2)

4.2 Consider reaction **A**.

4.2.1 Is compound **Q** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

4.2.2 Write down the name or formula of an inorganic reactant. (1)

4.2.3 Write down the FORMULA of the catalyst used in reaction **A**. (1)

4.3 Hydrogen bromide is used as one of the reactants in reaction **B**.

4.3.1 What type of reaction takes place here? (1)

4.3.2 Write down the IUPAC name of compound **R**. (2)

4.4 Write down the type of:

4.4.1 Addition reaction represented by **A**. (1)

4.4.2 Elimination reaction represented by **C**. (1)

4.4.3 Addition reaction represented by **D**. (1)

4.5 Write down the TWO reaction conditions needed for reaction **C**. (2)

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4.6 Consider reaction **D**.

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4.6.1 Using STRUCTURAL FORMULAE, write down a balanced equation. (3)

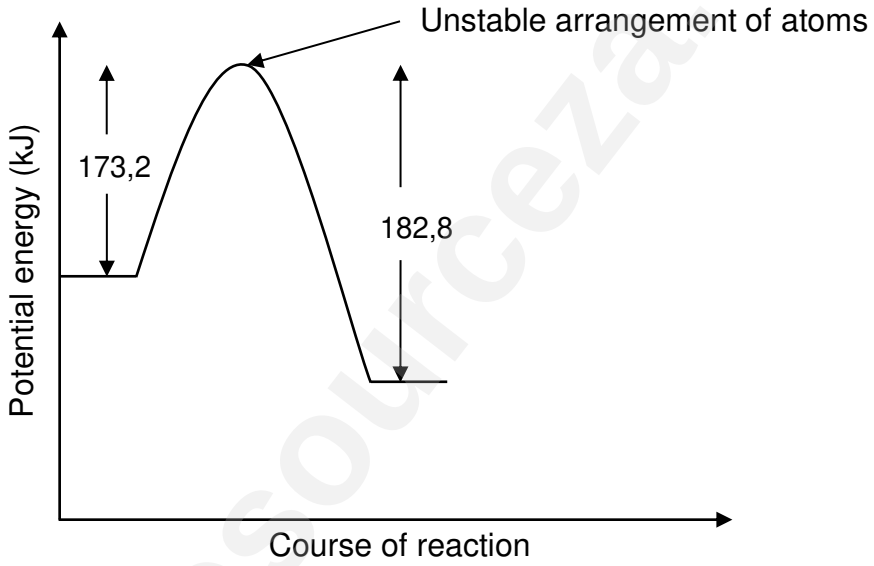
4.6.2 Write down the IUPAC name of compound **S**. (1)
[20]

QUESTION 5

Reactions involving iodine are commonly used to investigate rates of reaction. One reaction involves hydrogen and iodine to form hydrogen iodide.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

5.1 The potential energy diagram for the reaction between hydrogen and iodine is shown below.



5.1.1 Write down the term used for "unstable arrangement of atoms". (1)

5.1.2 Calculate the enthalpy change, ΔH, in kJ, for the forward reaction. (1)

5.1.3 Is the above reaction ENDOTHERMIC or EXOTHERMIC? Give a reason for the answer. (2)

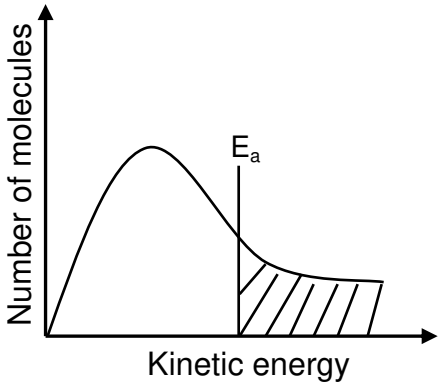
5.1.4 Platinum can be used as a catalyst for this reaction. What effect would platinum have on the activation energy of the reaction? Write down only INCREASE, DECREASE or REMAIN THE SAME. (1)

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5.2 The graph below shows the distribution of the kinetic energy of reactant molecules in the gas mixture at 300°C.

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5.2.1 Redraw the graph in your answer book and label it **X**. Add a second curve to the graph to show the distribution of the kinetic energy at 400°C and label it **Y**. (3)

5.2.2 Compare the reaction rate at 400°C with that at 300°C. Write down only LOWER THAN, HIGHER THAN or EQUAL TO. (1)

5.2.3 Use the collision theory to explain the answer to QUESTION 5.2.2. (3)
[12]

QUESTION 6

Hydrogen peroxide, H_2O_2, decomposes into water and oxygen in the presence of a catalyst, manganese (IV) oxide. The balanced equation for the reaction is given below.

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$$

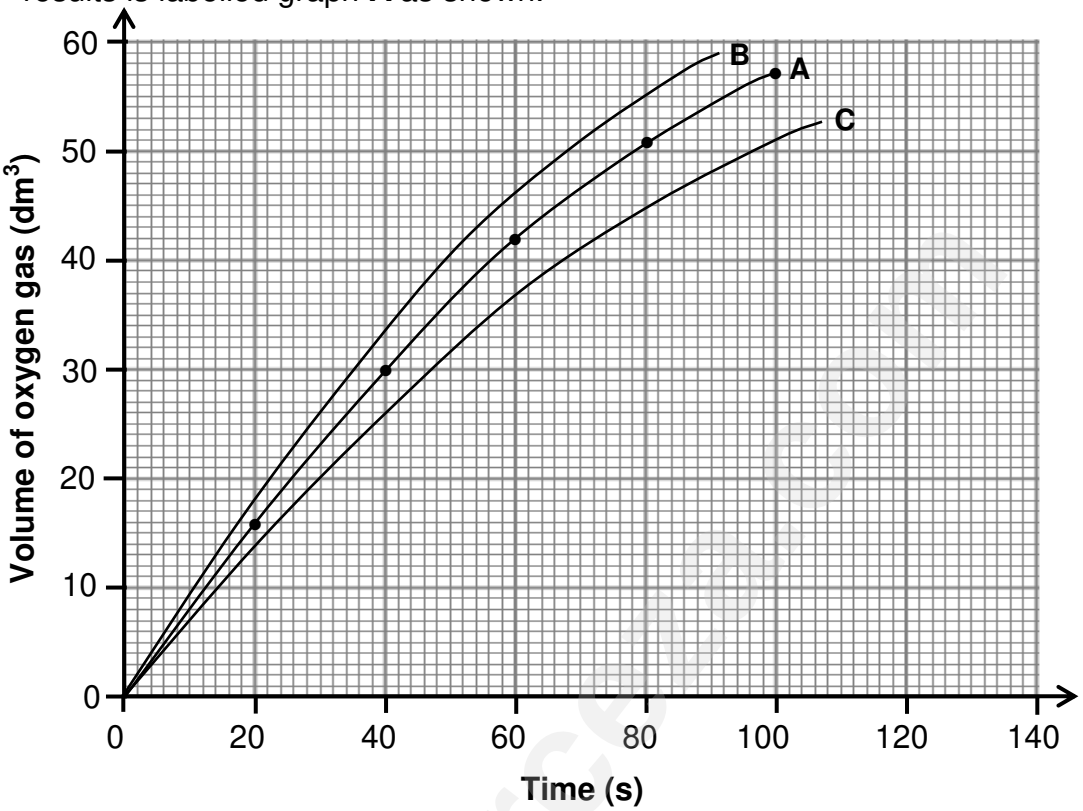
6.1 Define the term *catalyst* (2)

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6.2. In experiment **1**, 20 cm^3 of 0,1 $mol \cdot dm^{-3}$ hydrogen peroxide is added to 1 g of manganese (IV) oxide at 25 °C. The volume of oxygen given off is measured at regular time intervals until the reaction stops. A graph of the results is labelled graph **A** as shown.



The experiment is repeated a few times under different reaction conditions.

Experiment	Volume of H_2O_2 (cm^3)	Concentration of H_2O_2 ($mol \cdot dm^{-3}$)	Temperature of H_2O_2 (°C)	Mass of MnO_2 (g)
1	20	0,1	25	1
2	20	0,08	25	1
3	20	0,1	35	1
4	10	0,1	25	1

Use graph **A** to answer QUESTIONS 6.2.1 to 6.2.4.

6.2.1 Has the reaction reached completion at 100 s? (1)

6.2.2 When is the rate of reaction the highest? Choose from 0-20 s, 40-60 s, and 80-100 s. Give a reason for the answer. (2)

6.2.3 Calculate the volume of oxygen produced. Assume that all the hydrogen peroxide decomposed. Use 24 $dm^3 \cdot mol^{-1}$ as the molar volume of oxygen. (5)

6.2.4 Calculate the average rate of the reaction (in $dm^3 \cdot s^{-1}$) between t = 10 s and t = 20 s. (3)

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6.3 Which graph represents the results of experiment ...

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6.3.1 **2**? (1)

6.3.2 **3**? Explain the answer (3)

6.4 Compare the rate of reaction in experiment **2** with that in experiment **1**. Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

6.5 Use the collision theory to explain the answer to QUESTION 6.4. (2)

6.6 What would be the effect on the volume of oxygen if the catalyst is removed? Write down only INCREASES, DECREASES or NO EFFECT. (1)

6.7 Redraw graph **A** in your answer book. On the same set of axes, draw a graph for the results of experiment **4**. (2)

[23]

QUESTION 7

Iodine monochloride, ICℓ, reacts with chlorine, Cℓ_2, according to the following balanced equation:

$$\underset{\text{Dark brown}}{IC\ell(\ell)} + C\ell_2(g) \rightleftharpoons \underset{\text{Yellow}}{IC\ell_3(s)}$$

The system reaches equilibrium at 50°C.

7.1 State *Le Chatelier's principle* in words. (2)

7.2 An unknown amount of Cℓ_2(g) is initially bubbled through a solution of IC$\ell(\ell)$ that has a mass of 32 g in a sealed 2 dm^3 container. When equilibrium is reached at 50°C, it is found that 10 g of IC$\ell(\ell)$ is present. The equilibrium constant, K_C, for the reaction at this temperature is 73. Calculate the:

7.2.1 Number of moles of Cℓ_2 that reacted (3)

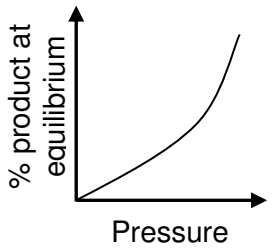
7.2.2 Percentage of Cℓ_2 that reacted (6)

7.3 When the equilibrium mixture is heated, it becomes a darker brown colour. Is the forward reaction endothermic or exothermic? Use Le Chatelier's principle to explain the answer. (3)

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7.4 The graph below shows how the percentage of the product at equilibrium varies with pressure.

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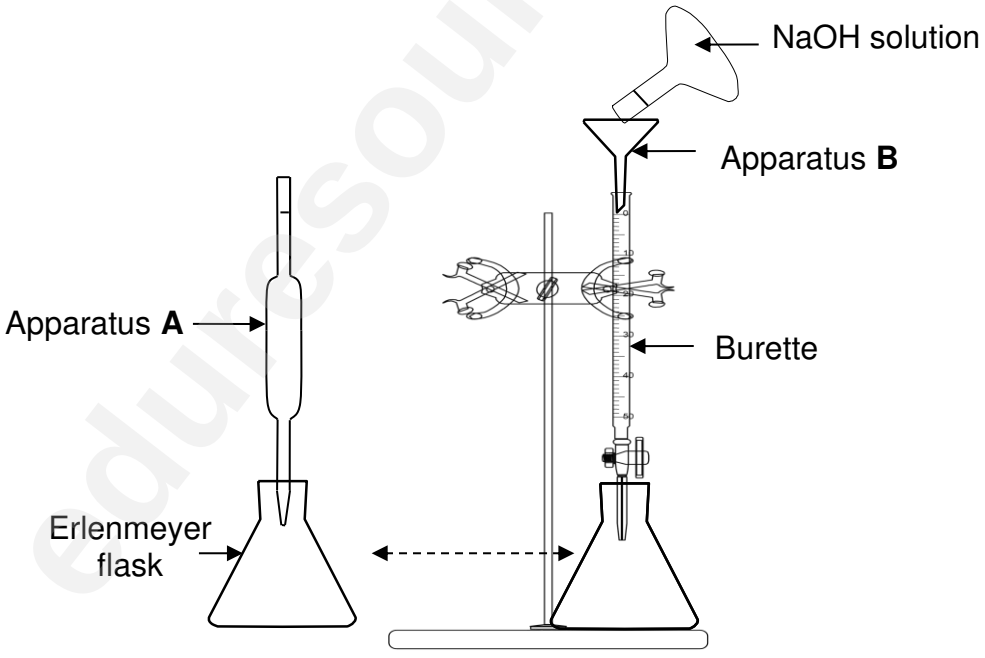
What is the relationship between pressure and the percentage of the product at equilibrium? Use Le Chatelier's principle to explain the answer (3)
[17]

QUESTION 8

Learners use the reaction of a sulphuric acid solution with two different hydroxide solutions. In this reaction, sodium hydroxide is used. The balanced equation for the reaction is:

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(aq)$$

The learner transfers 25 cm^3 of the sulphuric acid solution to an Erlenmeyer flask by using apparatus **A**. It is then titrated with a standard solution of 0,2 $mol \cdot dm^{-3}$ sodium hydroxide. The above is repeated with two other sulphuric acid solutions.



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The results are shown below.

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Sample	Volume of NaOH (cm^3)
1	14,9
2	14,2
3	14,3

8.1 Define the term *standard solution*. (2)

8.2 Write down the name of apparatus:

8.2.1 **A** (1)

8.2.2 **B** (1)

8.3 Explain why the volume of sodium hydroxide used in the calculation is taken as 14,25 cm^3, although this is not the average of the three volumes in the table. (1)

8.4 Calculate the concentration of the sulphuric acid. (5)

8.5 The first step in the ionisation of sulphuric acid is given below:

$$H_2SO_4(aq) + H_2O(\ell) \rightleftharpoons HSO_4^-(aq) + H_3O^+(aq)$$

8.5.1 Why is sulphuric acid considered a strong acid? (2)

8.5.2 For HSO_4^-, identify its:

(a) Conjugate acid (1)

(b) Conjugate base (1)

8.5.3 What is the name given to a substance like HSO_4^- that can act as both an acid and a base? (1)

8.5.4 Use the above equation to write down the name or formula of another substance that can act as the one mentioned in QUESTION 8.5.3. (1)

8.6 In a separate experiment sulphuric acid reacts with calcium hydroxide to form salt **P** and product **Q** as shown.

$$H_2SO_4 + Ca(OH)_2 \rightarrow \text{salt } \mathbf{P} + \text{product } \mathbf{Q}$$

8.6.1 Define a base according to the *Arrhenius theory*. (2)

8.6.2 Write down the FORMULA of salt **P**. (1)

8.6.3 Write down the NAME of product **Q**. (1)

[20]

GRAND TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

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GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	pH = $-\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

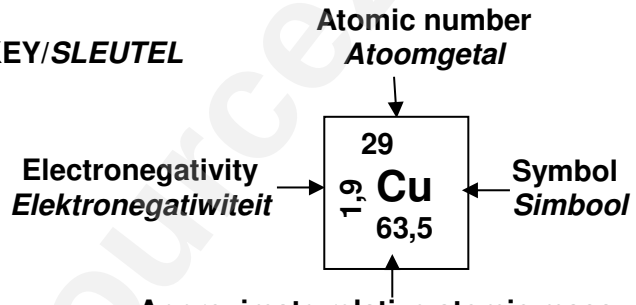
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 Nb 92	1,8 Mo 96	1,9 Tc	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr 87	0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr



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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

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Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
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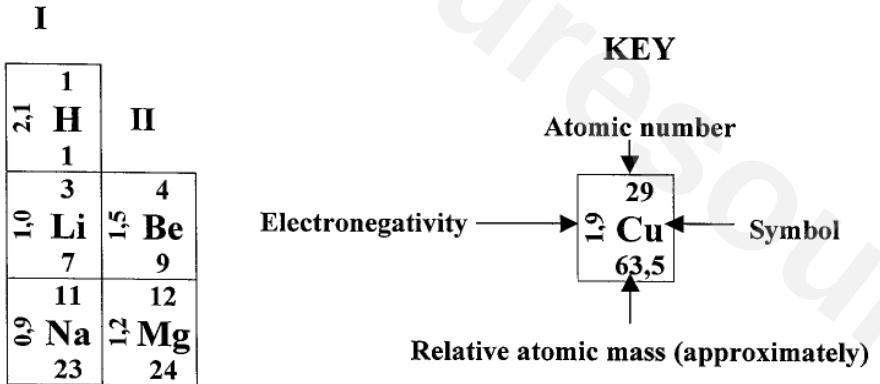
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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TABLE 3: THE PERIODIC TABLE OF ELEMENTS



I	II	III	IV	V	VI	VII	0
1 2,1 H 1							2 He 4
3 1,0 Li 7	4 1,5 Be 9	5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24	13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Half-reactions/*Halfreaksies*	E^{θ} (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**0,00**
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	– 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	– 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	– 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	– 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	– 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	– 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	– 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	– 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	– 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	– 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	– 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	– 1,18
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	– 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	– 2,36
$Na^+ + e^- \rightleftharpoons Na$	– 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	– 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	– 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	– 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	– 2,93
$Li^+ + e^- \rightleftharpoons Li$	– 3,05

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Half-reactions/*Halfreaksies*	E^{θ} (V)
$Li^+ + e^- \rightleftharpoons Li$	– 3,05
$K^+ + e^- \rightleftharpoons K$	– 2,93
$Cs^+ + e^- \rightleftharpoons Cs$	– 2,92
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	– 2,90
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	– 2,89
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	– 2,87
$Na^+ + e^- \rightleftharpoons Na$	– 2,71
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	– 2,36
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	– 1,66
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	– 1,18
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	– 0,91
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	– 0,76
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	– 0,74
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	– 0,44
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	– 0,41
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	– 0,40
$Co^{2+} + 2e^- \rightleftharpoons Co$	– 0,28
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	– 0,27
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	– 0,14
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	– 0,13
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	– 0,06
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**0,00**
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

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education

Department:
Education
PROVINCE OF KWAZULU-NATAL

PHYSICAL SCIENCES: CHEMISTRY (P2)

JUNE EXAMINATION

MARKING GUIDELINE

2020

NATIONAL
SENIOR CERTIFICATE

GRADE 12

Time: 3 hours

Marks: 150

NB. This marking guideline consists of 9 pages.

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QUESTION 1

1.1 D✓✓ (2)

1.2 B ✓✓ (2)

1.3 C ✓✓ (2)

1.4 C✓✓ (2)

1.5 B✓✓ (2)

1.6 B✓✓ (2)

1.7 C ✓✓ (2)

1.8 A✓✓ (2)

1.9 D✓✓ (2)

1.10 C ✓✓ (2)

[20]

QUESTION 2

2.1.1 E✓ (1)

2.1.2 B and F✓✓ (2)

2.1.3 G✓ (1)

2.1.4 F✓ (1)

✓ ✓

2.2.1 1-bromo-2,2-dichloroethane (2)

2.2.2 hexanal✓✓ (2)

2.2.3 2-propanol/propan-2-ol✓ (1)

2.2.4 Carboxyl group✓✓ (2)

2.2.5 C_nH_{2n}✓✓ (2)

2.3. C✓ (1)

2.4 Condensation polymerization. ✓
Molecules of two monomers with different functional groups undergo condensation reactions with the loss of small molecules, usually water. ✓✓ (3)

[18]

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QUESTION 3

3.1 The temperature at which the solid and liquid phases of a substance are at equilibrium. ✓✓ (2)

3.2.1 Compound A, ethane has only weak London forces between the molecules. ✓
Compound B, chloroethane has weak London forces and dipole-dipole forces between the molecules. ✓
Since compound B has stronger intermolecular forces than compound A, compound B has a higher boiling point. ✓ (3)

3.2.2 Compound C, ethanol, has strong hydrogen bonds in addition to dipole-dipole forces and weak London forces are between the molecules. ✓

Compound D, ethanoic acid has very strong hydrogen bonds (2 sites for hydrogen bonding) in addition to dipole-dipole forces and weak London forces (induced dipole forces) are between the molecules. ✓

Since compound D has stronger intermolecular forces than compound C, compound D has a higher melting point. ✓ (3)

3.3 The higher the boiling point, the lower the vapour pressure. ✓✓ (2)

[10]

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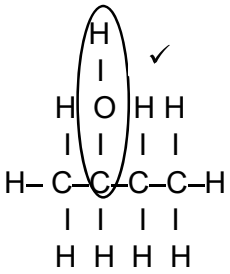
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QUESTION 4

4.1 $2C_5H_{10} + 15O_2 \longrightarrow 10CO_2 + 10H_2O$ ✓ ✓ ✓bal (3)

4.2.1 Br_2 ✓ (2)
Heat/ UV light✓

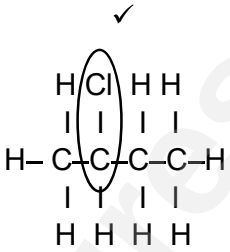
4.2.2 Concentrated strong base(NaOH/KOH) in ethanol✓ (2)
Heat strongly under reflux✓

4.3.1  ✓ ✓ 2-butanol/butan-2-ol✓ (3)

4.3.2 Alcohols✓ (1)

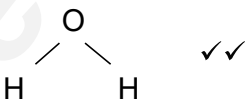
4.3.3 secondary✓
The OH group is joined to the carbon atom that is bonded to two other carbons✓ (2)

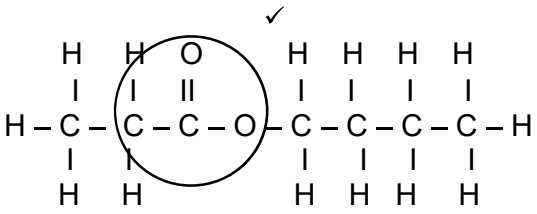
4.3.4 Addition/hydration✓ (1)

4.4  ✓ ✓ (2)

4.5 Substitution✓ (1)

4.6 but-1-ene/1-butene✓✓ (2)

4.7  ✓✓ (2)

4.8  ✓ butyl propanoate✓ ✓whole structure (3)

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4.9 Esterification✓ (1)

[25]

QUESTION 5

5.1 Change in concentration of reactants or products per unit time. ✓✓ (2)

5.2 Temperature✓
Concentration✓ (any 2) (2)
Catalyst

5.3 Sulphur✓ (1)

5.4 What is the relationship between concentration and reaction rate? ✓✓ (2)

5.5 A✓✓ (2)

5.6 In experiment B:

The concentration of $Na_2S_2O_3(aq)$ is higher. /More $Na_2S_2O_3$ particles per unit volume. ✓
More particles with correct orientation✓ (3)
More effective collisions per unit time / Higher frequency of effective collisions. ✓

5.7 Rate of Reaction = $\frac{\Delta V}{\Delta t}$

$= \frac{50 - 0}{125 - 0}$ ✓ ✓

$= 0,4\ cm^3 \cdot s^{-1}$ ✓ (3)

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5.8 $C = \frac{m}{MV}$

$= \frac{100}{(158)(0,25)}$ ✓

$= 2.53 \text{ mol.dm}^{-3}$

$n (Na_2S_2O_3 \text{ in D}) = C \times V$ ✓
$= (2.53)(0,01)$ ✓
$= 0,025\text{mol}$

$n_s : n_{Na_2S_2O_3}$
$1 : 1$ ✓

$n_s = \frac{m}{M}$
✓ $0,025 = \frac{m}{32}$ ✓
$m = 0,8\text{g}$✓ (7)

[22]

QUESTION 6

6.1.1 Homogenous. ✓
The reactants and products are all in the same phase. ✓ (2)

6.1.2 $2CO(g) + 3H_2(g) \longrightarrow 2CH_2OH(g)$ ✓✓ (2)

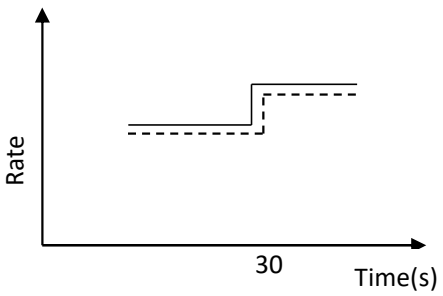
6.1.3 Reactants are being used up to form products. ✓ (1)

6.1.4 Exothermic✓An increase in temperature favoured the endothermic reaction. ✓✓ (3)

6.1.5 Equilibrium is reached.✓✓ / the rate of the forward reaction is equal to the rate of the reverse reaction. (2)

6.1.6 Increases. ✓ (1)

6.1.7



✓ shape
✓ two curves
✓axes
✓ 30 (4)

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6.2.1 When the equilibrium in a closed system is disturbed, the system will reinstate a new equilibrium by favouring the reaction that will oppose the disturbance.✓✓ (2)

6.2.2.1 Decrease✓ (1)

6.2.2.2 Increase✓ (1)

6.2.3

	SO_2	O_2	SO_3
Ratio	2	1	2
Initial mole	0,3	x	0
Change in mole	0,2	0,1	0,2
Equilibrium Mole	0,1	x - 0,1	0,2
Equilibrium concentration	0,01	$\frac{x - 0,1}{10}$	0,02

✓ ✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} \quad ✓$$

$$15 \; ✓ = \frac{(0,02)^2}{(0,01)^2 \left(\frac{X - 0,1}{10}\right)} \quad ✓$$

$$x = 2,77 \text{ mol} \quad ✓$$

$$n = \frac{m}{M}$$

$$2,77 = \frac{m}{32} \quad ✓$$

$$m = 88,64 \text{ g} ✓$$

(8)

[27]

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QUESTION 7

7.1 An acid is a substance that releases hydronium ions in solution. ✓✓ (2)

7.2

$$\frac{C_aV_a}{C_bV_b} = \frac{n_a}{n_b} \quad ✓$$

✓ $\frac{(0,5)(15)}{C_b(12,5)} = \frac{2}{1}$ ✓

$C_b = 0,3 \text{ mol.dm}^{-3}$

$C = \frac{m}{MV}$

$0,03 = \frac{0,795}{M(0,25)}$ ✓

$M = 106 \text{ g.mol}^{-1}$ ✓

$106 = 2M_x + 12 + 3(16)$ ✓

$M_x = 23 \text{ g.mol}^{-1}$ ✓

Therefore X is Na/Sodium✓

$n(HCl) = c \times V$ ✓

$= (0,5)(0,015)$ ✓

$= 0,0075\text{mol}$

$n_{HCl} : n_{X2CO3}$

2 : 1 ✓

$n_{X2CO3} = \frac{0,0075}{2}$

$= 0,00375$ mol ✓

$n_{X2CO3} = \frac{m}{M}$

$0,00375 = \frac{0,798}{M}$ ✓

$M = 106 \text{ g.mol}^{-1}$

$106 = 2M_x + 12 + 3(16)$ ✓

$M_x = 23 \text{ g.mol}^{-1}$ ✓

Therefore X is Na/Sodium ✓ (8)

7.3.1 $n(NaHCO_3) = \frac{m}{M}$

$= \frac{7}{84}$ ✓

$= 0,083\text{mol}$

$n(NaHCO_3) : n(HCl)$

1 : 2 ✓

$n(HCl) = 0,16\text{mol}$ ✓

$C = \frac{n}{V}$ ✓

$5 = \frac{0,16}{V}$ ✓

$V = 0,032 \text{ dm}^3$

$= 32 \text{ cm}^3$ ✓ (6)

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7.3.2 $(C_aV_a)_{initial} = (C_aV_a)_{final}$
✓ $(5)V_a = (0,1)(1)$ ✓
$V_a = 0,02\ dm^3$ ✓

(3)

7.4.1 $M\ (NaHCO_3) = 23 + 1 + 12 + 3(16) = 84\ g.mol^{-1}$ ✓

n = C x V
= (0,052) (0,275) ✓
= 0,0143 mol

m = nM
= (0,0143)(84) ✓
= 1,20g✓

% Purity = $\frac{1,20}{3,68} \times \frac{100}{1}$✓

= 32,61%✓ (6)

7.4.2 pH = -log[H_3O^+]✓
= -log(0,11) ✓
= 0,96✓ (3)

[28]

TOTAL: 150

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basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/
NASIONALE SENIORSERTIFIKAAT-EKSAMEN

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

2019

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 28 pages./
Hierdie nasienriglyne bestaan uit 28 bladsye.

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QUESTION 1/*VRAAG 1*

1.1	A ✓✓	(2)
1.2	B ✓✓	(2)
1.3	D ✓✓	(2)
1.4	C ✓✓	(2)
1.5	C ✓✓	(2)
1.6	C✓✓	(2)
1.7	D✓✓	(2)
1.8	D ✓✓	(2)
1.9	C ✓✓	(2)
1.10	A ✓✓	(2)

[20]

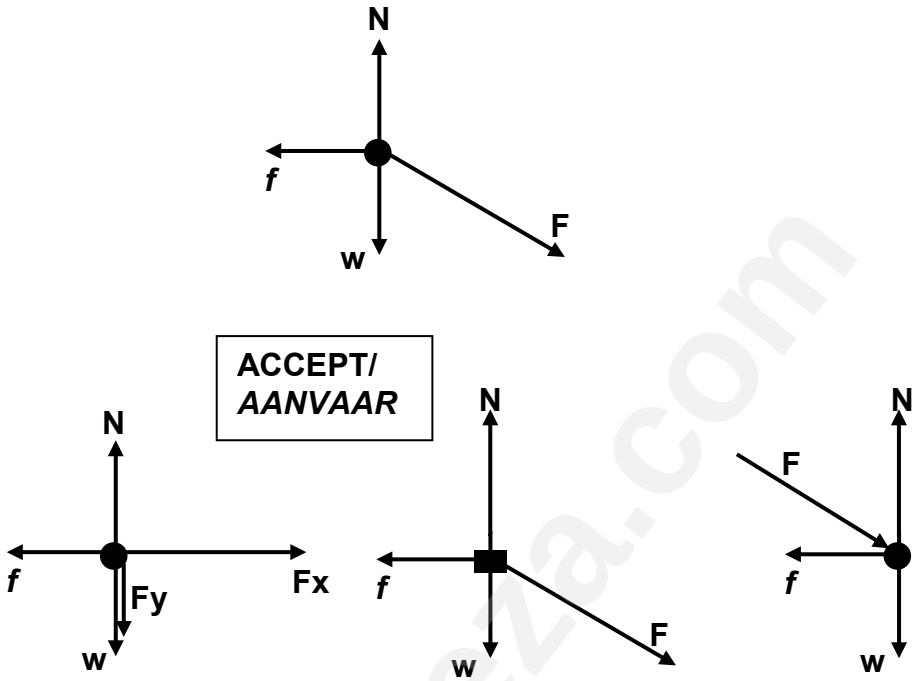
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QUESTION 2/*VRAAG 2*

2.1.1



Accepted labels/*Aanvaarde benoemings*	
F	F_A/90 N/F_{90}
w	F_g / F_w/weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
f	(Kinetic) Friction / F_f / / f_k / *wrywing* / F_w
N	F_{Normal} / Normal/Normaal / F_N

Notes/*Aantekeninge*

- Mark awarded for label and arrow / *Punt toegeken vir benoeming en pyltjie*
- Do not penalise for length of arrows since drawing is not to scale. /*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie*
- Any other additional force(s) / *Enige ander addisionele krag(te)* Max/*Maks* $^3/_4$
- If force(s) do not make contact with body / *Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $^3/_4$
- Deduct 1 mark for an arrow/arrows omitted / *trek 1 punt af indien pyl/pyle weggelaat* (4)

2.1.2 It is moving at constant speed in a straight line/, the acceleration is zero/ the net force (resultant) acting on it is zero/it is moving at constant velocity ✓
Dit beweeg teen konstante spoed in 'n reguit lyn / versnelling is nul / netto krag (resultant) wat daarop inwerk is nul/ dit beweeg teen konstante snelheid (1)

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2.1.3

$F_{net} = ma$
$F_{net} = 0$
$F_x = f$
$F_x - f = 0$
$F\cos 40^o - f = 0$

✓ any one
enige een

$\underline{90 \cos 40^o - f = 0}$✓
$f = 68{,}94$ N✓

OR/OF

$F_{net} = ma$
$F_{net} = 0$
$F_x = f$
$F_x - f = 0$
$F\cos 320^o - f = 0$

✓ any one
enige een

$\underline{90 \cos 320^o - f = 0}$✓
$f = 68{,}94$ N✓

$F_{net} = ma$
$F_{net} = 0$
$F_x = f$
$F_x - f = 0$
$F\sin 50^o - f = 0$

✓ any one
enige een

$\underline{90 \sin 50^o - f = 0}$✓
$f = 68{,}94$ N✓

(3)

NOTE:
1 mark for formula/equation, 1 mark substitution with zero, 1 mark answer.
LW:1 punt vir formule/vergelyking, 1 punt substitusie, 1 punt antwoord.

2.1.4

POSITIVE MARKING FROM 2.1.3 /*POSITIEWE NASIEN VANAF 2.1.3*
OPTION 1/*OPSIE 1*

$v_f = v_i + a\Delta t$
$\underline{2 = 0}$ ✓+ $\underline{a(3)}$ ✓
$a = 0{,}67$ m·s^{-2}

$F_{net} = ma$✓
$\underline{F\cos 40^o}$ ✓$\underline{- 68{,}94}$ ✓ $= 15\,(0{,}67)$

$F = 103{,}11$N✓ (103,05 N – 103,11N)

$F_{net} = ma$✓
$\underline{F\cos 320^o}$ ✓$\underline{- 68{,}94}$✓ $= 15(0{,}67)$
$F = 103{,}11$N✓

POSITIVE MARKING FROM 2.1.3 /*POSITIEWE NASIEN VANAF 2.1.3*
OPTION 2/*OPSIE 2*

$F_{net}.\Delta t = \Delta p$✓

$\underline{F\cos 40^o}$ ✓$\underline{- (68{,}94)}$ ✓$\underline{(3)}$ ✓$= \underline{15(2 - 0)}$ ✓

$F = 103{,}11$ N✓

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POSITIVE MARKING FROM 2.1.3 /*POSITIEWE NASIEN VANAF 2.1.3*
OPTION 3/*OPSIE 3*

$F_{net} = ma$
$F_x - f_k = ma$
✓ any one / *enige een*

$F_x - 68,94$✓ $= 15 \frac{(2-0)}{3}$ ✓✓

$F_x = 78,94$ N

$\tan\theta = \frac{F_y}{F_x}$

$\tan 40^\circ = \frac{F_y}{78,94}$

$F_y = 66,24$ N

$F^2 = F_x^2 + F_y^2$

$F^2 = \underline{(78,94)^2} + \underline{(66,24)^2}$✓

$F = 103,05$ N✓

POSITIVE MARKING FROM 2.1.3 /*POSITIEWE NASIEN VANAF 2.1.3*
OPTION 4/*OPSIE 4*

$\Delta x = \frac{v_i + v_f}{2} \Delta t$

$= \frac{(2+0)}{2}$ ✓ (3) ✓

$\Delta x = 3$ m

$W_{net} = \Delta K$

$W_F + W_f = \Delta K$ ✓

$F\Delta x \cos\theta + f\Delta x \cos\theta = \Delta K$

$\underline{F(3)\cos 40^\circ}$ ✓ + $\underline{68,94(3)\cos 180^\circ}$ ✓ = ½ $(15)(2^2)$ – ½ $(15)(0)^2$

$F = 103.06$ N✓

(6)

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2.2

OPTION 1/*OPSIE 1*

$F = G\frac{m_1 m_2}{r^2}$ ✓

$20 \checkmark = (6{,}67 \times 10^{-11})\frac{m_{planet}(10)}{(6 \times 10^5)^2}$ ✓

m_{planet} = 1,08 x 10^{22} kg✓

OPTION 2/*OPSIE 2*

$w = mg$
$20 = (10)(g)$ ✓
$g = 2\ m \cdot s^{-2}$

✓ Any one
Enige een

$g = \frac{GM}{R^2}$

$2 = \frac{(6{,}67 \times 10^{-11})M}{(6 \times 10^5)^2}$ ✓

M = 1,08 x 10^{22} kg✓

(4)
[18]

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QUESTION 3/*VRAAG 3*

3.1 Motion of an object under the influence of gravity/gravitational force (weight) only✓✓.
Beweging van 'n voorwerp slegs onder die invloed van gravitasie/gravitasie krag (gewig).

OR/*OF*
Motion in which the only force acting on the object is gravity/weight. ✓✓
Beweging waar die enigste krag wat op die voorwerp inwerk, gravitasie/gewig is.

ACCEPT/*AANVAAR*
Vertical motion in which friction/air resistance is absent. ✓✓
Vertikale beweging waar wrywing/lugweerstand afwesig is.

Motion in air with an acceleration of 9,8 $m \cdot s^{-2}$. ✓✓
Beweging in lug met 'n versnelling van 9,8 $m \cdot s^{-2}$. (2)
NOTE: 2 OR ZERO/ *2 of nul*

3.2.1

OPTION 1/*OPSIE 1*
Upwards positive/*Opwaarts positief*:
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (-9,8)(1,53)$ ✓
$\therefore v_i = 14,99\ m \cdot s^{-1}$ $(15\ m \cdot s^{-1})$ ✓
Downwards positive/*Afwaarts positief*
$v_f = v_i + a\Delta t$ ✓
$0 = v_i + (9,8)(1,53)$ ✓
$\therefore v_i = -14,99\ m \cdot s^{-1}$
$v_i = 14,99\ m \cdot s^{-1}$ $(15\ m \cdot s^{-1})$ ✓

OPTION 2/*OPSIE 2*
$F_{net} = ma$
$= 9,8\ (m)$
$F_{net}\ \Delta t = m\Delta v$✓
$(9,8)(m)(1,53) = (m)(v_f - 0)$ ✓
$v_f = 14,99\ m \cdot s^{-1}$ $(15\ m \cdot s^{-1})$ ✓

OPTION 3/*OPSIE 3*
Upwards positive/*Opwaarts positief*:
$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$0 = v_i(3,06) + \frac{1}{2}(-9,8)(3,06)^2$✓
$v_i = 14,99\ m \cdot s^{-1}$✓$(15\ m \cdot s^{-1})$

Downwards positive/*Afwaarts positief*
$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$0 = v_i(3,06) + \frac{1}{2}(9,8)(3,06)^2$✓
$v_i = 14,99\ m \cdot s^{-1}$✓ $(15\ m \cdot s^{-1})$

NOTE: initial and final velocities can be swopped if starting from top, as long as sign of g is changed accordingly.
LW: v_f en v_i kan omgeruil word indien van bopunt begin, solank teken van g dienooreenkomstig verander word. (3)

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3.2.2

OPTION 1/*OPSIE 1*
POSITIVE MARKING FROM 3.2.1/ *Positiewe nasien vanaf 3.2.1*
Upwards positive/*Opwaarts positief*:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= 14,99\ (1,53) + \frac{1}{2}\ (-9,8)(1,53)^2$ ✓
$= 11,47$ m ✓(11,46-11,48)
Maximum height is/*Maksimum hoogte is* 11,47 m

Downwards positive/*Afwaarts positief*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= -14,99\ (1,53) + \frac{1}{2}\ (9,8)(1,53)^2$ ✓
$= -11,47$ m (11,46-11,48)
Maximum height is /*Maksimum hoogte is* 11,47 m✓

OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 3.2.1/ *Positiewe nasien vanaf 3.2.1*
Upwards positive/*Opwaarts positief*:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = (14,99)^2 + 2(-9,8)(\Delta y)$ ✓
$\Delta y = 11,47$ m ✓(11,46-11,48)
Maximum height reached is/*Maksimum hoogte bereik is* 11,47 m

Downwards positive/*Afwaarts positief:*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = (-14,99)^2 + 2(9,8)(\Delta y)$ ✓
$\Delta y = -11,47$ m (11,46-11,48)
Maximum height reached is/*Maksimum hoogte bereik is* 11,47 m✓

OPTION 3/*OPSIE 3*
POSITIVE MARKING FROM 3.2.1/ *Positiewe nasien vanaf 3.2.1*
Upwards positive/*Opwaarts positief*:

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{(14,99 + 0)}{2}\right)(1,53) \quad ✓$$
$\Delta y = 11,47$ m✓
Maximum height reached is /*Maksimum hoogte bereik is* 11,47 m

Downwards positive/*Afwaarts positief:*

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{(-14,99 + 0)}{2}\right)(1,53) \quad ✓$$
$\Delta y = -11,47$ m (11,46-11,48)
Maximum height reached is /*Maksimum hoogte bereik is* 11,47 m✓

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OPTION 4/*OPSIE 4*
POSITIVE MARKING FROM 3.2.1

$\Delta E = \Delta K + \Delta U$
$\frac{1}{2} mv_i^2 + mgh_i = \frac{1}{2} mv_f^2 + mgh_f$ } 1 mark for any✓ / *1 punt vir enige*

$\frac{1}{2} (14,994)^2 + (9,8)(0) = 0 + 9,8\ h_f$ ✓
$h_f = 11,47$ m✓ (11,46-11,48)
Maximum height reached is /*Maksimum hoogte bereik is* 11,47 m

OR/*OF*
$\Delta K = - \Delta U$✓
$\frac{1}{2} m(v_f^2 - v_i^2) = - mg(h_f - h_i)$
$\frac{1}{2} (0 - 14,99^2) = - 9,8(h_f - 0)$ ✓
$h_f = 11,47$ m (11,46-11,48)
Maximum height reached is /*Maksimum hoogte bereik is* 11,47 m✓ (3)

3.3

OPTION 1/*OPSIE 1*
POSITIVE MARKING FROM 3.2.1
Upwards positive/*Opwaarts positief*:
$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= (14,99)\ (4) + \frac{1}{2}\ (- 9,8)(4)^2$✓
$= -18,4$ m
Position is 18,4 m downwards (below the edge of the roof) ✓ / *Posisie is 18,4 m afwaarts (onder die kant van die dak).*

Downwards positive/*Afwaarts positief*
$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$= (-14,99)\ (4) + \frac{1}{2}\ (9,8)(4)^2$✓
$= 18,4$ m
Position is 18,4 m downwards (below the edge of the roof) ✓/ *Posisie is 18,4 m afwaarts (onder die kant van die dak)*

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OPTION 2/*OPSIE 2*
POSITIVE MARKING FROM 3.2.1
Upwards positive/*Opwaarts positief*:

$v_f = v_i + a\Delta t$
$= (14,99) + (-9,8)\ (4)$
$= -\ 24,2\ m\cdot s^{-1}$
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(-24,2)^2 = (14,99)^2 + 2(-9,8)(\Delta y)$ ✓
$\Delta y = -\ 18,4\ m$
Ball is 18,4 m downwards (below the edge of the roof) / *Bal is 18,4 m afwaarts (onder die kant van die dak)* ✓

Downwards positive/*Afwaarts positief:*

$v_f = v_i + a\Delta t$
$= (-14,99) + (9,8)\ (4)$
$= 24,2\ m\cdot s^{-1}$
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(24,2)^2 = (-14,99)^2 + 2(9,8)(\Delta y)$ ✓
$\Delta y = 18,4\ m$
Ball is 18,4 m downwards (below the edge of the roof) ✓/ *Bal is 18,4 m afwaarts (onder die kant van die dak)*

OPTION 3/*OPSIE 3*
POSITIVE MARKING FROM 3.2.1
Upwards positive/*Opwaarts positief*:

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{(14,99 - 24,2)}{2}\right)(4) \quad ✓$$

$v_f = v_i + a\Delta t$
$= (14,99) + (-9,8)\ (4)$
$= -\ 24,2\ m\cdot s^{-1}$

$\Delta y = -\ 18,4\ m$
Ball is 18,4 m downwards (below the edge of the roof) ✓ / *Bal is 18,4 m afwaarts (onder die kant van die dak).*

Downwards positive/*Afwaarts positief:*

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{(-14,99 + 24,2)}{2}\right)(4) \quad ✓$$

$v_f = v_i + a\Delta t$
$= (-14,99) + (9,8)\ (4)$
$= 24,2\ m\cdot s^{-1}$

$\Delta y = 18,4\ m$
Ball is 18,4 m downwards (below the edge of the roof) ✓ / *Bal is 18,4 m afwaarts (onder die kant van die dak.)*

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OPTION 4/*OPSIE 4*

Total time to return to starting point/*totale tyd terug na beginpunt*
= 2(1,53) = 3,06 s
∴ time from reference point to ground/ *tyd vanaf verwysingspunt tot by grond*
= (4 – 3,06) = 0,94 s
$\Delta y = v_i\Delta t + ½ (g)\Delta t^2$ ✓
$= (14,99)(0,94) + ½(9,8)(0,94)^2$ ✓
= 18,43 m ✓downwards (below the edge of the roof) /*afwaarts (onder die kant van die dak.* (3)

3.4 No/*Nee*✓
The motion of the ball is only dependent on its initial velocity✓✓/the initial velocity depends on the time taken to reach maximum height.
Die beweging van die bal is slegs afhanklik van sy beginsnelheid./die aanvanklike snelheid hang af van die tyd wat dit neem om maksimum hoogte te bereik.

ACCEPT for 1 mark/ *AANVAAR vir 1 punt:*

The ball will still be in the air.✓
Die bal sal nog steeds in die lug wees.

OR/*OF*
The ball is still falling.✓
Die bal is steeds besig om te val.

OR/*OF*
The ball would not have reached the ground.✓
Die bal sal nog nie die grond bereik het nie.

OR/OF
The motion of the ball is independent of the height of the building. ✓
Die beweging van die bal is onafhanklik van die hoogte van die gebou.

NOTE: If learners gave separate answers for 3.2 and 3.3, mark them together. Thus, if one answer is correct and the other incorrect 0/3 (3)
LW: Indien leerders twee afsonderlike antwoorde gee vir 3.2 en 3.3, sien as geheel na. Dus, indien een verkeerd is, 0/3 **[14]**

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QUESTION 4/*VRAAG 4*

4.1 The total (linear) momentum in a isolated/closed system remains constant./ is conserved ✓✓
Die totale lineêre momentum in 'n geslote sisteem bly konstant/behoue.

OR/*OF*
In an isolated/closed system the total momentum before a collision is equal to the total momentum after the collision. ✓✓
In 'n geslote/geïsoleerde sisteem is die totale momentum voor die botsing gelyk aan die totale momentum na die botsing.

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.
-1 vir elke sleutel woorde/frase weggelaat.
Take the whole statement in context /*Vat die hele stelling in konteks.* (2)

4.2

OPTION 1/*OPSIE 1*

$\sum p_i = \sum p_f$
$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
$m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$

1 mark for any
1 punt vir enige

$\{0,45(9) + 0,20(0)\}$✓ $= (0,45 + 0,20)v$✓
$v = 6,23\ m{\cdot}s^{-1}$✓

OR
$\Delta p_{ball/bal} = -\Delta p_{cont/houer}$✓
$0,45(v - 9)$ ✓ $= -0,2(v - 0)$ ✓
$v = 6,23\ m{\cdot}s^{-1}$✓

If – sign omitted from formula 0/4
Indien – teken weggelaat uit formula 0/4

OPTION 2/*OPSIE 2*

$\sum p_i = \sum p_f$
$p_{f\ Total} = p_{i\ Total}$

1 mark for any✓
1 punt vir enige

(Thus change in total momentum = 0 /*Dus verandering in momentum is=0*))
0 ✓$= \underline{(0,65v_f)} - \underline{(9)(0,45)}$✓
$v_f = 6,23\ m{\cdot}s^{-1}$✓ (4)

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4.3

POSITIVE MARKING FROM 4.2/*POSITIEWE NASIEN VANAF 4.2* $K = ½ mv^2$✓ (or $E_K = ½ mv^2$) Total kinetic energy before collision:/*Totale kinetiese energie voor botsing:* $½ (0,45)(9)^2 + 0$✓= 18,225J Total kinetic energy after collision:/ *Totale kinetiese energie na botsing:* $½ (0,45 + 0,20)(6,23)^2$✓ = 12,614J $\sum K_{before/voor} \neq \sum K_{after/na}$ Collision is inelastic. /*Botsing is onelasties*✓✓
If start with/ *indien begin met* $\sum E_{Ki} = \sum E_{Kf}$ 4/5 max/*maks* No calculation/ *geen berekening*: 0 Do not accept a conclusion of inelastic collision based on any other calculation (such as that of momentum or mechanical energy)./ *Moet geen afleiding van ' n onelastiese botsing aanvaar wat op enige ander berekening gebaseer is nie (soos byvoorbeeld momentum of meganiese energie).*

(5)
[11]

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QUESTION 5/*VRAAG 5*

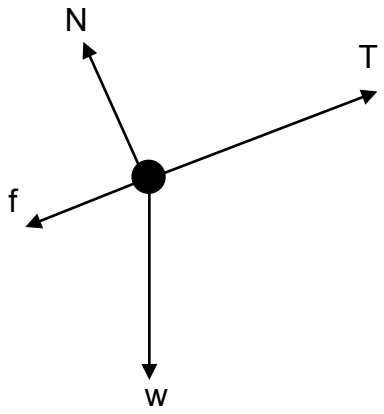
5.1 Tension/*Spanning*✓ (1)

5.2

There is friction/ tension in the system ✓ *Daar is wrywing/spanning in die sisteem* OR/*OF* Friction/tension is a non-conservative force ✓ *Wrywing/spanning 'n 'n nie-konserwatiewekrag* OR/*OF* The system is not isolated because there is friction/tension ✓ *Die sisteem in nie geïsoleerd nie omdat daar wrywing/spanning is*	OR/*OF* The internal energy increases because of friction ✓ *Die interne energie neem toe as gevolg van wrywing.* OR The applied force is non-conservative✓ *Die toegepaste krag is nie-konservatief* OR It is not an isolated system✓

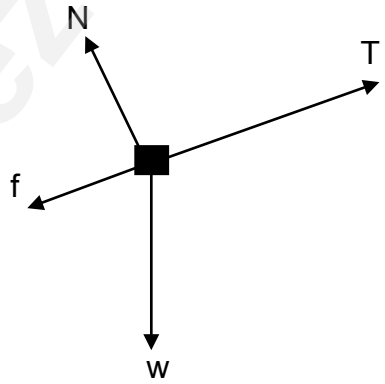
(1)

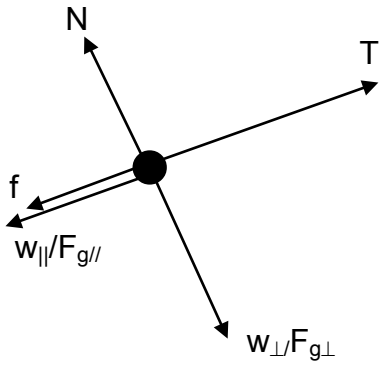
5.3



NOTE: maximum ¾ if friction and tension are not on a straight line
LW: maksimum ¾ indien wrywing en spanning nie in 'n reguitlyn nie.

ACCEPT/*AANVAAR*





NOTE: maximum ¾ if N and $w_{\perp}$ are not on a straight line
LW: maksimum ¾ indien N en $w_{\perp}$ nie in 'n reguitlyn nie.

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Accepted labels/*Aanvaarde benoemings*		
w	F_g/F_w/weight/mg/gravitational force *F_g/F_w/gewig/mg/gravitasiekrag*	✓
f	Friction/F_f/f_k/178,22 N/*wrywing*/*F_w*	✓
N	Normal (force)/$F_{normalL}/F_N/F_{normaal}/F_{reaction/reaksie}$	✓
T	$F_T/F_A/F_{applied/toegepas}$/700 N/Tension	✓

Notes/*Aantekeninge*

- Mark awarded for label and arrow / *Punt toegeken vir benoeming en pyltjie*
- Do not penalise for length of arrows since drawing is not to scale. /*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie*
- Any other additional force(s) / *Enige ander addisionele krag(te)* Max/*Maks* $^3/_4$
- If force(s) do not make contact with body / *Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $^3/_4$

Deduct 1 mark for an arrow/arrows omitted / *trek 1 punt af indien pyl/pyle weggelaat* (4)

5.4

$W = F\Delta x\cos\theta$ ✓
$W_f = [178,22(4)\cos 180^o]$ ✓
$= -712,88$ J ✓ (3)

5.5

OPTION 1/*OPSIE 1*
POSITIVE MARKING FROM QUESTIONS 5.4 *POSITIEWE NASIEN VANAF VRAE 5.4*

$W_{net} = \Delta E_K$
$W_f + W_g + W_T = \Delta K$
$W_f + mg\sin\theta\Delta x\cos\theta + W_T = \Delta K$

1 mark for any one ✓/
1 punt vir enige een

$-712,88 + \underline{(70)(9,8)(\sin 30^o)(4)\cos 180^o}$ ✓ $+ \underline{(700 \times 4 \times \cos 0^o)}$ ✓ $= \underline{½\,70(v_f^2 - 0)}$ ✓
$v_f = 4,52\ m\cdot s^{-1}$ ✓

NOTE: W_g can be obtained using any of the following formulae:
LW: w_g kan verkry word deur enige een van die volgende formules:
$W_{gravity/gravitasie} = mg\Delta x\cos\theta$
$= (70)(9,8)(4).(\cos 120^o)$

∴ $-712,88 + \underline{(70)(9,8)(4)\cos 120^o)}$ ✓ $+ \underline{(700 \times 4 \times \cos 0^o)}$ ✓ $= \underline{½\,70(v_f^2 - 0)}$ ✓
$v_f = 4,52\ m\cdot s^{-1}$ ✓

$W_{gravity/gravitasie} = -\Delta mgh = -mg(h_f - h_{0)}$
$= mg\Delta y\cos\theta$
$= ((70)(9,8)\ 4(\sin 30^o).\cos 180^o$
$W_{gravity/gravitasie} = mg\sin\theta\Delta x\cos\theta$
$= (70)(9,8)\ (\sin 30^o)(4).\cos 180^o$

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OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM 5.4 / *POSITIEWE NASIEN VANAF 5.4*

$W_{nc} = \Delta E_K + \Delta E_p$ ✓

$W_T + W_f = \Delta E_K + \Delta E_p$

$(700)(4)\cos 0^o$✓ + (-712,88) = [(70)(9,8) 4(sin 30°). - 0]✓+ $\frac{1}{2}\ 70(v_f^2 - 0)$✓

$v_f = 4{,}52\ m{\cdot}s^{-1}$✓

OPTION 3

$F_{net} = F_T - [mg\sin\theta + f_k]$

$= \underline{700 - [(70 \times 9{,}8 \sin 30^o) + 178{,}22]}$ ✓

$= 178{,}78\ N$

$W_{net} = \Delta E_K$✓

$F_{net} . \Delta x\cos\theta = \Delta E_K$

$\underline{(178{,}78)(4)\cos 0^o}$ ✓=.$\frac{1}{2}\ 70(v_f^2 - 0)$✓

$v_f = 4{,}52\ m{\cdot}s^{-1}$✓ (5)

5.5

WHERE EQUATIONS OF MOTION ARE USED:/ *WAAR BEWEGINGSvERGELYKING GEBRUIK:* MAX/*MAKS* $\frac{1}{5}$

$F_{net} = ma$

$F_T - [mg\sin\theta + f_k] = ma$

$\underline{700 - [(70 \times 9{,}8 \sin 30^o) + 178{,}22]}$ ✓$= 70a$

$a = 2{,}554\ ms^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$

$= 0 + 2(2{,}554)(4)$

$v_f = 4{,}52\ m{\cdot}s^{-1}$

5.6

POSITIVE MARKING FROM 5.4/*POSITIEWE NASIEN VANAF 5.4*

2(-712,88) = -1425,76 J✓

OR/OF

Double the answer (in question 5.4). ✓

Dubbel die antwoord (in vraag 5.4) (1)

[15]

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QUESTION 6/*VRAAG 6*

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6.1.1

$\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$
$\underline{300 = v_i (10)}$ ✓
$v_i = 30\ m\cdot s^{-1}$✓

$v = \frac{d}{t} = \frac{300}{10}$✓$=30 m\cdot s^{-1}$✓

NOTE/*LET WEL*:
Accept/*Aanvaar* $\Delta x = v_i\Delta t$ (2)

6.1.2 The change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of sound propagation. ✓✓
Die verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/*OF*
An (apparent) change in observed/detected frequency (pitch), (wavelength) as a result of the relative motion between a source and an observer (listener). ✓✓
'n Skynbare verandering in waargenome frekwensie (toonhoogte),(golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/ luisteraar.

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.
-1 vir elke sleutel woorde/frase weggelaat (2)

6.1.3 Car/source (just) passes observer ✓✓
Motor beweeg net verby die waarnemer
Accept:
Car moves away from observer ✓✓
No relative motion between car and observer ✓✓
Car and observer at the same place/position✓✓

***Aanvaar**:*
Motor beweeg verby waarnemer
Geen relatiewe beweging tussen motor en waarnemer
Motor en waarnemer by dieselfde plek/posisie. (2)

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6.1.4

POSITIVE MARKING FROM 6.1.1/*POSITIEWE NAISEN VANF 6.1.1*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ **OR/*OF*** $f_L = \frac{v}{v - v_s} f_s$

✓ $932 = \frac{340}{340 - 30} f_s$ ✓

$f_s = 849{,}76$ Hz ✓ (4)

Notes/*Aantekeninge*:

- Any other Doppler formula, e.g. /*Enige ander Doppler formula b.v.*

  $f_L = \frac{v - v_L}{v - v_S} f_s$ - Max/*Maks.* $^3/_4$

Marking rule 1.5: No penalisation if zero substitutions are omitted.
Nasienreël 1.5. Geen penalisering indein nul vervangings uitgelaat word

6.2 Doppler / Blood flow meter
Dopplervloeimeter/ bloedvloeimeter
Measuring the heartbeat of a foetus
Meting van hartklop van 'n fetus
Radar
Sonar
Used to determine whether stars are receding or approaching earth/
Gebruik om te bepaal of sterre na of weg van die aarde beweeg

Any 2 ✓✓
Enige 2

(2)
[12]

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QUESTION 7/*VRAAG 7*

7.1 The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. ✓✓
Die elektriese veld by 'n punt is die elektrostatiese krag *wat per eenheid positiewe lading wat by daardie punt geplaas word, ervaar word.* ✓✓

NOTE/*LET WEL*:
-1 for each key word/phrase omitted. If definition of electric field: 0/2
-1 vir elke sleutel woorde/frase weggelaat. Indien definisie van elektriese veld 0/2 (2)

7.2 q_2 is positive ✓

-

The electric field due to q_1 points to the right because q_1 is negative. ✓ Since the net field is zero, field due to q_2 must point to the left away from q_2, ✓ hence q_2 is positive.

q_2 is positief

Die elektriese veld as gevolg van q_1 is na regs gerig omdat q_1 negatief is. Aangesien die net veld nul is, moet die veld as gevolg van q_2 na links weg van q_2 wees.

OR/OF

q_2 is positive ✓

-

Since E_{net} is zero, E_1 and E_2 are in opposite directions ✓ therefore q_1 and q_2 are oppositely charged. ✓

q_2 is positief ✓
Omdat E_{net} nul is, is E_1 en E_2 in teenoorgestelde rigtings ✓*daarom is q_1 en q_2 teenoorgesteld gelaai.* ✓ (3)

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7.3

$E = k\frac{Q}{r^2}$ ✓

$E_{net} = 0$

$\therefore k\frac{q_1}{r_1^2} = k\frac{q_2}{r_2^2}$ OR

$\frac{q_1}{r_1^2} = \frac{q_2}{r_2^2}$

$\frac{(9\times10^9)(3\times10^{-9})}{(0,1)^2}$ ✓ = $\frac{(9\times10^9)q_2}{(0,4)^2}$ ✓

$q_2 = +4,8 \times 10^{-8}$ C✓

1 mark for formula
1 mark for equating the two fields
1 mark for both substitutions
1 mark for answer
1 punt vir vergelyking
1 punt vir twee velde gelyk gestel
1 punt vir altwee substitusies
1 punt vir antwoord

(4)

7.4 The electrostatic force (of attraction/repulsion) between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them. ✓✓
Die elektrostatiese krag(aantekking/afstotend) tussen twee puntladings is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle. (2)

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.If masses used instead of charges 0
-1 vir elke sleutel woorde/frase weggelaat Indien massas gebruik 0

7.5

POSITIVE MARKING FROM 7.3/*POSITIEWE NASIEN VANAF 7.3*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^9)(3\times10^{-9})(4,8\times10^{-8})}{(0,3)^2}$ ✓

$= 1,44 \times 10^{-5}$ N✓

(3)

7.6 **POSITIVE MARKING FROM 7.2 AND 7.3/*POSITIEWE NASIEN van 7.2 en 7.3***
YES/*JA*✓
Both charges are equal and positive ✓
Beide ladings is gelyk en positief

Accept calculation which shows charges the same and positive/ *Aanvaar berekening wat toon dat ladings dieselfde en positief is.*

If the answer is YES, mark according to the memo, if NO check 7.2 first for sign of charge. If stated NEGATIVE at 7.2, then answer is:
No✓, the direction is incorrect. ✓
Positiewe nasien vanaf 7.2: Indien antwoord vir 7.2 NEGATIEF, dan is hierdie antwoord: Nee ✓, die rigting is verkeerd. ✓

(2)
[16]

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QUESTION 8/*VRAAG 8*

8.1.1 The rate at which (electrical) energy is converted (to other forms) (in a circuit)
The rate at which energy is used/Energy used per second
The rate at which work is done ✓✓
(2 or zero)
Die tempo waarteen elektriese energie omgesit word (in ander vorms) in 'n stroombaan.
Die tempo waarteen energie verbruik word.
Die tempo waarteen arbeid verrig word.
(2 of nul) (2)

8.1.2

$P = \frac{V^2}{R}$ ✓ $6 = \frac{(12)^2}{R}$ ✓ $R = 24\ \Omega$✓	$W = \frac{V^2\Delta t}{R}$ ✓ $6 = \frac{(12)^2(1)}{R}$ ✓ $R = 24\ \Omega$✓	$P = VI$ $6 = (12)(I)$ $\therefore I = 0,5$ A $P = I^2R$✓ $6 = (0,5)^2 R$✓ $R = 24\ \Omega$✓	$P = VI$✓ $6 = (12)(I)$ $\therefore I = 0,5$ A $V = IR$ $12 = (0,5)R$✓ $R = 24\ \Omega$✓

(3)

8.1.3 **POSITIVE MARKING FROM 8.1.2/*POSITIEWE NASIEN VANAF 8.1.2***
<u>OPTION 1/*OPSIE 1*</u>

$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$
$= \frac{1}{24} + \frac{1}{24}$ ✓
$R_{//} = 12\ \Omega$

$R_{ext} = (R_s + R_{//})$
$R_{ext} = (24 + 12)$ ✓
$= 36\ \Omega$
$V = IR$
OR
$\varepsilon = I(R + r)$
$12 = I(36 + 2)$ ✓
$I = 0,32$ A✓(0,316 A)

✓ any one
Enige 1

$R_{tot} = (R_s + \frac{R_1R_2}{R_1 + R_2})$
$R_{tot} = \{24 + \frac{(24)(24)}{48}$ ✓$\}$ ✓
$= 36\ \Omega$

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POSITIVE MARKING FROM 8.1.2/POSITIEWE NASIEN VANAF 8.1.2
OPTION 2/OPSIE 2

Rext = (Rs + R//)

$\frac{1}{R_{//}} = \frac{1}{R_1} + \frac{1}{R_2}$

$= \frac{1}{24} + \frac{1}{24}$ ✓

R// = 12 Ω

Rext = (24 + 12) ✓

= 36 Ω

$P = I^2R = \frac{V^2}{R}$ ✓

$I^2(36+2) = \frac{(12)^2}{38}$ ✓

I = 0,32 A ✓ (0,316) ✓

$R_{ext} = R_s + \frac{R_1R_2}{R_1 + R_2}$

$R_{ext} = \left\{24 + \frac{(24)(24)}{48}\right\}$ ✓ ✓

= 36 Ω

$I^2R\ I^2R = \frac{V^2}{R}$

$I^2R^2 = V^2$

V = IR

12 = I(38) ✓

I = 0,316 A ✓

(5)

8.1.4

POSITIVE MARKING FROM 8.1.3
POSITIEWE NASIEN VANAF 8.1.3
OPTION 1/*OPSIE 1*
V = IR
$V = I(R_A + r)$
= 0,316(26) ✓
= 8,216 V (8,32 V)
 	
$V_{//}$ = (12 – 8,216) ✓
= 3,784 V(3,68 V)
$\therefore V_C$ = 3,78 V (3,68 V) ✓
	POSITIVE MARKING FROM 8.1.3
	POSITIEWE NASIEN VANAF 8.1.3
	OPTION 2/*OPSIE 2*
	V = IR
	For the parallel portion (or from 8.1.3):
	Vir die parallel gedeelte (of vanaf 8..1.3)
	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ OR $R = \frac{R_1R_2}{(R_1 + R_2)}$
	$R = \frac{(24)(24)}{48}$
	= 12 Ω
	$V_{//} = V_C$ ✓
	$V = IR_{//}$
	= (0,316)(12) ✓
	= 3.79 V (3,84 V) ✓
		(3)

POSITIVE MARKING FROM 8.1.3 ***POSITIEWE NASIEN VANAF 8.1.3*** **OPTION 3/*OPSIE 3*** $I_A = I_B + I_C$ $= 2\ I_B$ $0,316 = 2I_B$ ✓ I_B = 0,158 A V = 0,158 (24) ✓ = 3,79 V ✓		(3)

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8.1.5 **OPTION 1/*OPSIE 1***

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The power rating (output voltage) of the bulb is 6 W; 12 V. /*Die gloeilamp is gemerk 6W ; 12 V*

$P = \frac{V^2}{R}$

[For a given resistance, power is directly proportional to V^2] ✓
[of *Vir 'n gegewe resistor is drywing direk eweredig aan* V^2]
Since the potential difference across light bulb C is less than the operating voltage,✓ the output/power will be less, ✓/ Omdat d*ie potensiaalverskil oor gloeilamp C minder is as die benodigde spanning sal die uitset/drywing minder wees*.

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$

The potential difference across light bulb C is less than the operating voltage. ✓ Thus for the same resistance, ✓ brightness decreases.
Die potensiaalverskil oor gloeilamp C is minder as die benodigde potensiaalverskil. Dus vir dieselfde weerstand, sal die helderheid afneem.

OPTION 3/*OPSIE 3*

$P = I^2 R$
For a given resistance✓, power is directly proportional to I^2 Since current decreases✓, brightness decreases.]
[*vir 'n gegewe resistor is drywing direk eweredig aan* I^2 *Omdat stroom afneem sal die helderheid afneem]*

OPTION 4/*OPSIE 4*

$P = I^2 R$
In the circuit, the total current in light bulb C is less than the optimum current required (0,5 A). ✓ Thus for the same resistance, ✓ the power will be less✓ hence brightness will decrease.
In die stroombaan is die totale stroom in gloeilamp C minder as die optimum stroom benodig (0,5 A). Dus vir dieselfde weerstand, is die drywing minder en die helderheid sal afneem.

OPTION 5/*OPSIE 5*

P = IV✓ [Power is directly proportional/equal to product of V and I. ✓
Since current decreases✓, brightnes decreases/
drywing is direk eweredig/gelyk aan produk van V en I. Omdat stroom afneem sal die helderheid afneem]]
OR/OF
The voltage across light bulb C, as well as the current in the bulb are all less✓ than the optimum values✓ hence power is less✓ and brightness is less.
Die potensiaalverskil oor gloeilamp C sowel as die stroom in die gloeilamp is almal minder as die optimum waardes, dus is die drywing minder en die helderheid minder. (3)
NOTE: No mark if only equation is given.

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8.2.1 The total current passes through resistor A. ✓ For the parallel portion, the current branches, therefore only a portion of the total current passes through resistor C. ✓
Die totale stroom vloei deur resistor A. Vir die parallelle gedeelte verdeel die stroom, dus vloei slegs 'n gedeelte van die stroom deur resistor C. (2)
ACCEPT for 1 mark: Resistor C is connected parallel to resistors B and D together. Current is dividing ✓at the junction.
AANVAAR vir 1 punt: Resistor C is in parallel geskakel met B en D saam. Die stroom breek op ✓ by die koppeling.

8.2.2 The current in B is equal✓ to the current in A. The circuit becomes a series circuit. ✓
Die stroom in B is gelyk aan die stroom in A. Die stroombaan word 'n serie stroombaan. (2)
[21]

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QUESTION 9/*VRAAG 9*

9.1 Slip rings/*Sleep ringe* ✓ (1)

9.2 B ✓ (1)

9.3

$$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}} \checkmark$$
$$= \frac{312}{\sqrt{2}} \checkmark$$
$$= 220{,}62 \text{ V} \checkmark$$

(3)

9.4.1

POSITIVE MARKING FROM 9.3/*POSITIEWE NASIEN VANAF 9.3*
OPTION 1/*OPSIE 1*

$$P_{aver/gemid} = \frac{V^2_{rms/wgk}}{R} \checkmark$$
$$= \frac{(220{,}62)^2}{40} \checkmark$$
$$= 1216{,}83 \text{ W} \checkmark$$

POSITIVE MARKING FROM 9.3/*POSITIEWE NASIEN VANAF 9.3*
OPTION 2/*OPSIE 2*

$$I_{rms} = \frac{V_{rms/wgk}}{R}$$
$$= \frac{(220{,}62)}{40}$$
$$= 5{,}515$$

✓ for any/ *vir enige*

$$P_{ave} = I^2_{rms}R$$
$$= (5{,}515)^2(40) \checkmark$$
$$= 1216{,}61 \text{ W} \checkmark$$

OR

$$P_{ave} = V_{rms}I_{rms}$$
$$= (220{,}62)(5{,}515) \checkmark$$
$$= 1216{,}72 \text{ W} \checkmark$$

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OPTION 3/*OPSIE 3*

$I_{max} = \frac{V_{max}}{R}$

$= \frac{312}{40}$

$= 7,80 \text{ A}$

$P_{ave} = \frac{I_{max} V_{max}}{2}$

$= \frac{(7,8)(312)}{2}$ ✓

$= 1216,80 \text{ W}$ ✓

✓ for any/ *vir enige*

(3)

9.4.2

OPTION 1/*OPSIE 1*

$I_{max/maks} = \frac{V_{max/maks}}{R}$ ✓

$= \frac{312}{40}$ ✓ ✓

$= 7,8 \text{ A}$ ✓

Accept/ *Aanvaar*: $I = \frac{V}{R}$

POSITIVE MARKING FROM 9.3 AND 9.4.1/*POSITIEWE NASIEN VANAF 9.3 EN 9.4.1*

OPTION 2/*OPSIE 2*

$P_{ave/gemid} = V_{rms/wgk} I_{rms/wgk}$

$1\,216,83 = 220,62\ I_{rms/wgk}$ ✓

$I_{rms/wgk} = 5,515 \text{ A}$

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$

$5,515 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$I_{max/maks} = 7,8 \text{ A}$ ✓

✓ for any/ *vir enige*

OPTION 3/*OPSIE 3*

$P_{ave/gemid} = I^2_{rms/wgk} R$

$1\,216,83 = I^2_{rms/wgk}(40)$ ✓

$I_{rms/wgk} = 5,515 \text{ A}$

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$

$5,515 = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$I_{max/maks} = 7,8 \text{ A}$ ✓

✓ for any/ *vir enige*

(4)

[12]

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QUESTION 10/*VRAAG 10*

10.1 The minimum frequency of light needed to eject electrons from a metal (surface)✓✓.
Minimum frekwensie van lig benodig om elektrone vanaf 'n metaal (oppervlak) vry te stel.

NOTE/*LET WEL*:
-1 for each key word/phrase omitted.
-1 vir elke sleutel woorde/frase weggelaat. (2)

10.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$E = h\frac{c}{\lambda}$ ✓ $= \frac{(6{,}63\times10^{-34})(3\times10^{8})}{5\times10^{-7}}$ ✓ $= 3{,}98 \times 10^{-19}$ J✓	$c = f\lambda$ $3 \times 10^{8} = f(5 \times 10^{-7})$ $f = 6 \times 10^{14}$ Hz $E = hf$ $= (6{,}63 \times 10^{-34})(6 \times 10^{14})$ ✓ $= 3{,}98 \times 10^{-19}$ J✓
NOTE: do not penalise if *v* is used in place of *c*.	

✓Both equations
Beide vergelykings

(3)

10.3

OPTION 1/*OPSIE 2*
POSITIVE MARKING FROM QUESTION 10.2/*POSITIEWE NASIEN VANAF VRAAG 10.2*

$E = W_0 + E_{kmax}$

$hf = W_0 + \frac{1}{2}mv^2_{max}$ ✓

$h\frac{c}{\lambda} = W_0 + E_{K(max/maks)}$

$h\frac{c}{\lambda} = hf_0 + E_{K(max/maks)}$

1 mark any one/*1 punt vir enige*

$3{,}98 \times 10^{-19} = (6{,}63 \times 10^{-34})(5{,}55 \times 10^{14}) + E_{K(max/maks)}$ ✓
$E_{K(max/maks)} = 3{,}0 \times 10^{-20}$ J✓

$E_{K(max/maks} > 0$ ✓

(The electrons emitted from the metal plate have kinetic energy to move between the plates, hence the ammeter registers a reading.
Die elektrone vrygestel vanaf die metaalplaat het kinetiese energie om tussen die plate te beweeg en gevolglik registreer die ammeter 'n lesing)

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OPTION 2/OPSIE 2

POSITIVE MARKING FROM QUESTION 10.2/*POSITIEWE NASIEN VANAF VRAAG 10.2*

$W_o = hf_o$ ✓

$= \underline{(6,63 \times 10^{-34})(5,55 \times 10^{14})}$ ✓

$= 3,68 \times 10^{-19}$ J

$E_{photon} > W_o$ ✓

(The energy of the incident photon is greater than the work function of potassium. From the equation $hf = W_0 + E_{Kmax}$, the ejected photoelectrons will move between the plates, ✓ hence the ammeter registers a reading.
Die energie van die invallende foton is hoër as die arbeidsfunksie van kalium. Vanaf die vergelyking $hf = hf_0 + E_{K(maks)}$, *sal die vrygestelde foto-elektrone tussen die plate te beweeg en gevolglik registreer die ammeter 'n lesing.*)

OPTION 3/*OPSIE 3*

$c = f\lambda$ ✓

$3 \times 10^8 = f(5 \times 10^{-7})$ ✓

$f = 6 \times 10^{14}$ Hz

$f > f_0$ ✓

The frequency of the incident photon is higher than the threshold frequency. From the equation $hf = hf_0 + E_{K(max)}$, the ejected photoelectrons will be able to move between the plates ✓ (for the given frequency), hence the ammeter registers a reading.
Die frekwensie van die invallende foton is hoër as die drumpelfrekwensie. Vanaf die vergelyking $hf = hf_0 + E_{K(maks)}$, *sal die vrygestelde foto-elektrone tussen die plate kan beweeg en gevolglik registreer die ammeter 'n lesing.)* (4)

10.4 The increase in intensity increases the *number* of photons per second.✓
Soos die intensiteit toeneem, neem die aantal fotone per sekonde toe.

Since each photon releases one electron✓ the number of ejected electrons per second increases.✓
Aangesien elke foton een elektron vrystel, neem die aantal vrygesteld e elektrone per sekonde toe.
ACCEPT: Flow of electrons per unit time increases ✓ (1 mark)
AANVAAR: vloei van elektrone per eenheidstyd neem toe (1 punt)

This causes the current /ammeter reading to increase.
Dit veroorsaak dat die stroom/ammeterlesing toeneem. (3)

[12]

TOTAL/*TOTAAL*: 150

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PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

2019

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 16 pages./
Hierdie nasienriglyne bestaan uit 16 bladsye.

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QUESTION 1/*VRAAG 1*

1.1	C ✓✓	(2)
1.2	A ✓✓	(2)
1.3	C ✓✓	(2)
1.4	A ✓✓	(2)
1.5	D ✓✓	(2)
1.6	C ✓✓	(2)
1.7	D ✓✓	(2)
1.8	D ✓✓	(2)
1.9	C ✓✓	(2)
1.10	A ✓✓	(2)

[20]

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QUESTION 2/*VRAAG 2*

2.1 Unsaturated/*Onversadig* ✓

ANY ONE/*ENIGE EEN*:

- C/It has a triple/multiple bond. ✓
  C/Dit het 'n trippelbinding/meervoudige-binding.
- C/It has a triple/multiple bond between C atoms.
  C/Dit het 'n trippelbinding/meervoudige-binding tussen C-atome.
- C/It does NOT contain the maximum number of H atoms bonded to C atoms.
  C/Dit bevat NIE die maksimum getal H-atome gebind aan C-atome nie.
- Compound C is an alkyne./*Verbinding C is 'n alkyn.* (2)

2.2

2.2.1 D ✓ (1)

2.2.2 B ✓ (1)

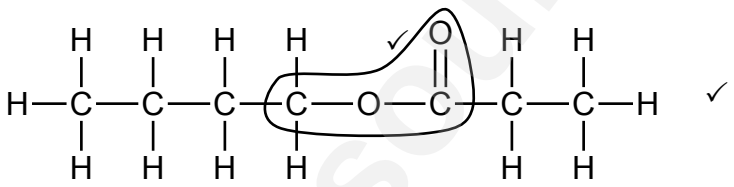
2.2.3 C ✓ (1)

2.2.4 E ✓ (1)

2.3

2.3.1 —C≡C— ✓ (1)

2.3.2



✓ ✓ (2)

Marking criteria/*Nasienriglyne:*

- Whole structure correct:
  Hele struktuur korrek: 2/2
- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2

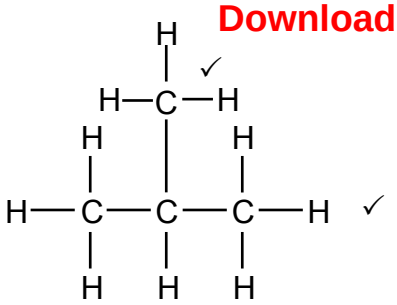
IF/*INDIEN*:

- More than one functional group/*Meer as een funksionele groep:* 0/2
- If condensed or semi structural formula used:/*Indien gekondenseerde of semi-struktuurformule gebruik:*
  Max/*Maks.* 1/2

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2.3.3



Marking criteria/*Nasienriglyne:*
- Three C atoms in longest chain. ✓
  Drie C-atome in langste ketting.
- One methyl substituent on C2. ✓
  Een metielsubstituent op C2.

IF/INDIEN
Any error e.g. omission of H atoms, condensed or semi structural formula/*Enige fout bv weglating van H-atome, gekondenseerde of semi-struktuurformule.* Max/*Maks.*: ½ (2)

2.4

2.4.1 2,3-dibromo-5-methylheptane/2,3-dibromo-5-metielheptaan

Marking criteria/*Nasienriglyne:*
- Correct stem i.e. heptane./*Korrekte stam d.i. heptaan.* ✓
- All substituents (bromo and methyl) correctly identified./*Alle substituente (bromo en metiel) korrek geïdentifiseer.* ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas./*IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas .* ✓ (3)

2.4.2 $2C_4H_{10} + 13O_2$ ✓ → $8CO_2 + 10H_2O$ ✓ Bal ✓

Notes/*Aantekeninge:*
- Reactants ✓ *Reaktanse* Products ✓ *Produkte* Balancing ✓ *Balansering*
- Ignore double arrows and phases./*Ignoreer dubbelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- If condensed structural formulae used:/*Indien gekondenseerde struktuur formules gebruik:* Max/*Maks.* ⅔
- Accept coefficients that are multiples./*Aanvaar koëffisiënte wat veelvoude is.* (3)

[17]

QUESTION 3/*VRAAG 3*

3.1

3.1.1 Yes/*Ja* ✓ (-)

ANY ONE/*ENIGE EEN*:
- Compounds have the same molecular mass. ✓
  Verbindings het dieselfde molekulêre massa.
- Only one independent variable./*Slegs een onafhanklike veranderlike.* (2)

3.1.2 Functional group/Homologous series/Type of (organic) compound ✓
Funksionele groep/Homoloë reeks/Tipe (organiese) verbinding (1)

3.2 A/butane/*butaan* ✓ (-)

Lowest boiling point/weakest intermolecular forces. ✓
Laagste kookpunt/swakste intermolekulêre kragte. (2)

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3.3

Marking guidelines/Nasienriglyne

- Type of IMF in A./*Tipe IMK in A*.
- BOTH B and C have hydrogen bonding./*BEIDE B en C het waterstofbinding*.
- Compare number of sites for hydrogen bonding in B and C./*Vergelyk aantal punte vir waterstofbinding in B en C.*
- Compare strength of IMFs./*Vergelyk sterkte van IMKe.*
- Compare energy required./*Vergelyk energie benodig.*

- Between molecules of butane/compound **A** are London forces/dispersion forces/induced dipole forces. ✓
- Molecules of compound **B**/propan-1-ol have one site for hydrogen bonding. ✓
- Molecules of compound **C**/ethanoic acid have two/more sites for hydrogen bonding. ✓
- Strength of intermolecular forces increases from compound **A**/butane to compound **B**/propan-1-ol to compound **C**/ethanoic acid. ✓
  OR
  Intermolecular forces in compound **A**/butane are the weakest and intermolecular forces in compound **C**/ethanoic acid are the strongest.
- More energy is needed to overcome/break intermolecular forces in compound **C** than in the other two compounds. ✓

- *Tussen molekule van butaan/verbinding **A** is Londonkragte/dispersie-kragte/geïnduseerde dipoolkragte.* ✓
- *Molekule van verbinding **B**/propan-1-ol het een punt vir waterstof-bindings*. ✓
- Molekule van verbinding ***C**/etanoësuur het twee punte vir waterstof-bindings*. ✓
- *Sterkte van intermolekulêre kragte neem toe van verbinding **A**/butaan na verbinding **B**/propan-1-ol na verbinding **C**/etanoësuur.* ✓
  OF
  *Intermolekulêre kragte tussen propaan is die swakste en intermolekulêre kragte in verbinding **C** is die sterkste.*
- *Meer energie word benodig om intermolekulêre kragte in verbinding **C** as in die ander twee verbindings te oorkom/breek*. ✓ (5)

3.4 Butan-1-ol ✓

(-)

Longer chain length./Larger molecule./Larger molecular mass./Larger molecular size./Stronger intermolecular forces./Larger surface area.✓
Langer kettinglengte./Groter molekuul./Groter molekulêre massa/Groter molekuul./Sterker intermolekulêre kragte./Groter oppervlakte. (2)
[12]

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QUESTION 4/*VRAAG 4*

4.1

4.1.1 Addition (polymerisation)/*Addisie-(polimerisasie)* ✓ (1)

4.1.2 Ethene/*eteen* ✓ (1)

4.1.3 Polyethene/polythene ✓
Poli-eteen/politeen (1)

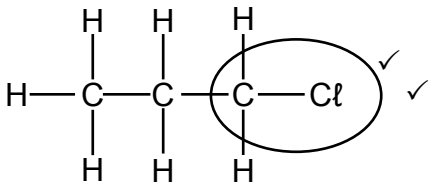
4.2

4.2.1 Dehydration/elimination ✓
Dehidrasie/dehidratering/eliminasie (1)

4.2.2 Catalyst/dehydrating agent/causes dehydration/removes water molecules ✓
Katalisator/dehidreermiddel/veroorsaak dehidrasie/verwyder watermolekule (1)

4.2.3 Prop-1-ene/propene/1-propene ✓✓ **(2 or 0)**
Prop-1-een/propeen/1-propeen **(2 of 0)** (2)

4.2.4



Marking criteria/*Nasienriglyne:*
- Whole structure correct:
  Hele struktuur korrek: 2/2
- Only functional group correct:/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2

IF/*INDIEN*:
- More than one functional group/*Meer as een funksionele groep:* 0/2
- If condensed or semi structural formula used:/*Indien gekondenseerde of semi-struktuurformule gebruik:*
  Max/*Maks.* 1/2

(2)

4.2.5 Addition/Hydration ✓
Addisie/Hidrasie/Hidratering (1)

4.2.6 Propan-2-ol/2-propanol✓✓

Marking criteria/*Nasienriglyne:*
- Correct stem and functional group i.e propanol/*Korrekte stam en funksionele groep d.i* propanol ✓
- Name completely correct/*Naam volledig korrek:* Propan-2-ol/2-propanol ✓✓

(2)

[12]

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QUESTION 5/*VRAAG 5*

5. 1

NOTE/*LET WEL*
Give the mark for per unit time only if in context of reaction rate. *Gee die punt vir per eenheidtyd slegs indien in konteks met reaksietempo.*

ANY ONE/*ENIGE EEN*

- Change in concentration ✓ of products/reactants per (unit) time. ✓
  Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
  Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
  Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.
- Rate of change in concentration/amount/number of moles/volume/mass.
  Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/massa. ✓✓ **(2 or/*of* 0)** (2)

5.2

5.2.1 Rate of the reaction/*Reaksietempo* ✓ (1)

5.2.2

Criteria for conclusion/*Kriteria vir gevolgtrekking*:	
Dependent (reaction rate) and independent (concentration) variables correctly identified./*Afhanklike(reaksietempo) en onafhanklike (konsentrasie) veranderlikes korrek geïdentifiseer.*	✓
Relationship between the independent and dependent variables correctly stated. *Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.*	✓

Example/*Voorbeeld*:
Reaction rate increases with increase in concentration./Reaction rate is proportional to concentration.
Reaksietempo neem toe met toename in konsentrasie./Reaksietempo is eweredig aan konsentrasie.
IF/INDIEN
DIRECTLY proportional/*DIREK eweredig:* Max/*Maks.*: $\frac{1}{2}$ (2)

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5.3

5.3.1 Activation energy/(The boundary line for the) molecules with (adequate) kinetic energy to make effective collisions. ✓
Aktiveringsenergie/(Die grenslyn vir die) molekule met (genoeg) kintiese energie vir effektiewe botsings. (1)

5.3.2 B ✓ (1)

5.3.3
- At a higher temperature particles move faster/have a higher kinetic energy. ✓
  By 'n hoër temperatuur beweeg die deeltjies vinniger/het die deeltjies hoër kinetiese energie.
- More molecules have enough/sufficient (kinetic) energy. ✓
  Meer molekule het genoeg/voldoende (kinetiese) energie.
  OR/*OF*
  More molecules have (kinetic) energy equal to or greater than activation energy.
  Meer molekule het (kinetiese) energie gelyk aan of groter as aktiveringsenergie.
- More effective collisions per unit time/second./Increased frequency of effective collisions.
  Meer effektiewe botsings per eenheidtyd/sekonde./Frekwensie van effektiewe botsings neem toe.
- Reaction rate increases. ✓
  Reaksietempo neem toe. (4)

5.4 Curve **Y/**it was obtained for the reaction where a catalyst was added. ✓
*Kurwe **Y**/dit is vir die reaksie waar 'n katalisator bygevoeg is, verkry.*

OR/*OF*
Curve **X** was obtained for the reaction in the absence of a catalyst.
*Kurwe **X** is verkry vir die reaksie sonder 'n katalisator.* (1)

5.5

Marking guidelines/*Nasienriglyne*

- Any formula/*Enige formule*: $n = \frac{m}{M}$ or/*of* $c = \frac{n}{V}$ ✓
- Substitute/*Vervang* 0,1 dm^3 in n = cV ✓
- Use mole ratio/*Gebruik molverhouding*:
  $n(S)_{expected/verwag} = ½n(HC\ell)_{used/gebruik}$ ✓
- Substitution of/*Vervanging van* 32 $g \cdot mol^{-1}$ in n = $\frac{m}{M}$ ✓
- SUBSTITUTE in/*VERVANG in:*
  $\frac{n(S)_{produced/bereik}}{n(S)_{expected/verwag}} \times 100 / \frac{m(S)_{produced/bereik}}{m(S)_{expected/verwag}} \times 100$ ✓
- Final answer/*Finale antwoord:* 56,25% to 60% ✓

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OPTION 1/*OPSIE 1*

$n(HC\ell)_{used/gebruik} = cV$ ✓
$= 0,2 \times 0,1$ ✓
$= 0,02$ mol

$n(S)_{expected/verwag} = \frac{1}{2}n(HC\ell)_{used/gebruik}$
$= \frac{1}{2}(0,02)$ ✓
$= 0,01$ mol

$n(S)_{produced/berei} = \frac{m}{M}$
$= \frac{0,18}{32}$ ✓
$= 0,0056$ mol

$\%yield/opbrengs = \frac{n(S)_{prod/berei}}{n(S)_{exp/verwag}} \times 100$
$= \frac{0,0056}{0,01} \times 100$ ✓
$= 56,25\%$ ✓

OPTION 2/*OPSIE 2*

$n(HC\ell)_{used/gebruik} = cV$ ✓
$= 0,2 \times 0,1$ ✓
$= 0,02$ mol

$n(S)_{expected/verwag} = \frac{1}{2}n(HC\ell)_{used/gebruik}$
$= \frac{1}{2}(0,02)$ ✓
$= 0,01$ mol

$m(S)_{expected/verwag} = nM$
$= (0,01)(32)$ ✓
$= 0,32$ g

$\%yield/opbrengs = \frac{m(S)_{prod/berei}}{m(S)_{exp/verwag}} \times 100$
$= \frac{0,18}{0,32} \times 100$ ✓
$= 56,25\%$ ✓

(6)
[18]

QUESTION 6/*VRAAG 6*

6.1 Reversible reaction/Both forward and reverse reactions can take place./Products can be converted back to reactants. ✓
Omkeerbare reaksie/Beide voorwaartse en terugwaartse reaksies kan plaasvind./Produkte kan terugverander word na reaktanse. (1)

6.2 To favour the forward reaction/production of ammonia./To increase the yield of ammonia./Prevent the decomposition of NH_3. ✓
Om die voorwaartse reaksie/produksie van ammoniak te bevoordeel./Om die ammoniak-opbrengs te verhoog./Voorkom die ontbinding van NH_3. (1)

6.3 20(%) ✓ (1)

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6.4

6.4.1 At 500 °C lower yield of ammonia:

- The (forward) reaction is exothermic./Reverse reaction is endothermic. ✓
  Die (voorwaartse) reaksie is eksotermies./Terugwaartse reaksie is endotermies.
- An increase in temperature favours the endothermic reaction. ✓
  'n Toename in temperatuur bevoordeel die endotermiese reaksie.
- The reverse reaction is favoured.✓
  Die terugwaartse reaksie word bevoordeel.

OR/*OF*

At 350 °C higher yield of ammonia:

- The (forward) reaction is exothermic./Reverse reaction is endothermic. ✓
  Die (voorwaartse) reaksie is eksotermies./Terugwaartse reaksie is endotermies.
- A decrease in temperature favours the exothermic reaction. ✓
  'n Afname in temperatuur bevoordeel die eksotermiese reaksie.
- The forward reaction is favoured. ✓
  Die voorwaartse reaksie word bevoordeel. (3)

6.4.2 At 350 atm higher yield of ammonia:

- An increase in pressure favours the reaction that produces the lower number of moles/number of molecules/volume of gas. ✓
  'n Toename in druk bevoordeel die reaksie wat die kleiner aantal mol/aantal molekule/volume gas lewer.
- The forward reaction is favoured. ✓
  Die voorwaartse reaksie word bevoordeel.

OR/*OF*

At 150 atm lower yield of ammonia:

- A decrease in pressure favours the reaction that produces the higher number of moles/number of molecules/volume of gas. ✓
  'n Afname in druk bevoordeel die reaksie wat die groter aantal mol/aantal molekule/volume gas lewer.
- Reverse reaction is favoured. ✓
  Die terugwaartse reaksie word bevoordeel. (2)

6.5

6.5.1 1 mol N_2 reacts with 3 mol H_2 to produce 2 mol NH_3
∴ 2 mol N_2 reacts with 6 mol H_2 to produce 4 (mol) NH_3 ✓✓ **(2 or 0)**

1 mol N_2 reageer met 3 mol H_2 om 2 mol NH_3 te lewer
∴ 2 mol N_2 reageer met 6 mol H_2 om 4 (mol) NH_3 te vorm ***(2 of 0)*** (2)

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6.5.2 **POSITIVE MARKING FROM QUESTION 6.5.1.**

Marking criteria/*Nasienriglyne:*

- Calculate 35% of 4 mol NH_3 (answer from Q6.5.1). ✓
- Use mol ratio/*Gebruik molverhouding* $n(N_2) : n(H_2) : n(NH_3) = 1 : 3 : 2$ ✓
- Equilibrium/*Ewewig* $n(N_2)$ = initial/*aanvanklike* $n(N_2) - \Delta n(N_2)$
  Equilibrium/*Ewewig* $n(H_2)$ = initial/*aanvanklike* $n(H_2) - \Delta n(H_2)$ ✓
- Divide by/*Deel deur* 0,5 dm^3. ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c uitdrukking (formules in vierkantige hakies).
- Substitution of concentrations into correct K_c expression. ✓
  Vervanging van konsentrasies in korrekte K_c-uitdrukking.
- Final answer/*Finale antwoord*: 0,002 ✓
  Range/*Gebied*: 0,00155 to 0,002 ($1,55 \times 10^{-3}$ to 2×10^{-3})

$$n(NH_3) = \frac{35}{100} \times 4 \checkmark$$
$$= 1,4 \text{ mol}$$

	N_2	H_2	NH_3
Initial amount (moles) *Aanvangs hoeveelheid (mol)*	6	6	0
Change in amount (moles) *Verandering in hoeveelheid* (mol)	0,7	2,1	1,4
Equilibrium amount (moles) *hoeveelheid* (mol)	5,3	3,9 ✓	1,4
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	10,6	7,8	2,8

ratio ✓ *verhouding*

Divide by 0,5 dm^3 ✓

$$K_c = \frac{[NH_3]^2}{[H_2]^3[N_2]} \checkmark$$
$$= \frac{(2,8)^2}{(7,8)^3(10,6)} \checkmark$$
$$= 0,002 \checkmark$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^6/_7$

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $^4/_7$

(7)
[17]

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QUESTION 7/*VRAAG 7*

7.1 A base forms hydroxide ions (OH^-) in water/aqueous solution. ✓✓
'n Basis vorm hidroksiedione (OH^-) in water/waterige oplossing.

IF/*INDIEN*:
A base ionises to form hydroxide ions (OH^-). ✓
'n Basis ioniseer om hidroksiedione (OH^-) te vorm. *Max./Maks.* $\frac{1}{2}$ (2)

7.2 A strong base ionises/dissociates completely ✓ and a weak base ionises/dissociates incompletely. ✓
'n Sterk basis ioniseer/dissosieer volledig en 'n swak basis ioniseer/dissosieer onvolledig. (2)

7.3 $HCO_3^-(aq) + H_2O(\ell)$ ✓ $\rightleftharpoons H_2CO_3(aq) + OH^-(aq)$ ✓ Bal. ✓

Accept/*Aanvaar*
$NaHCO_3(aq) + H_2O(\ell) \rightleftharpoons H_2CO_3(aq) + NaOH(aq)$

Notes/*Aantekeninge:*
- Reactants/*Reaktanse* ✓ Products/*Produkte* ✓ Balancing/*Balansering* ✓
- Ignore single arrow./*Ignoreer enkelpyl.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*
- Ignore phases/*Ignoreer fases.* (3)

7.4

7.4.1 $pH = -\log[H_3O^+]$ ✓
$= -\log(0,2)$ ✓
$= 0,70$ ✓ (0,699) (3)

7.4.2 Titration of a weak base and a strong acid. ✓
Titrasie van 'n swak basis en 'n sterk suur.

OR/*OF*
The endpoint will be at pH < 7./*Die eindpunt sal by 'n pH < 7.* (1)

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7.4.3

Marking guidelines/*Nasienriglyne:*

- Any formulae/*Enige formule:* $c = \frac{n}{V} / n = \frac{m}{M} / \frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b} / c = \frac{m}{MV}$ ✓
- Substitute/*Vervang* 0,2 mol·dm^{-3} & 20 x 10^{-3}/0,02 dm^3 or 20 cm^3. ✓
- Use mol ratio/*Gebruik molverhouding* n($XHCO_3$) : n(HCℓ) = 1 : 1 ✓
- Substitute/*Vervang* n($XHCO_3$) or/*of* c($XHCO_3$) AND/*EN* 0,4 g. ✓
- M(X) = 39 g·mol^{-1} ✓
- X = K/potassium/*kalium*. ✓

OPTION 1/*OPSIE 1*

c(HCℓ) = $\frac{n}{V}$ ✓

$\therefore$ 0,2 = $\frac{n}{20 \times 10^{-3}}$ ✓

n(HCℓ) = 4 x 10^{-3} mol

n($XHCO_3$) = n(HCℓ) ✓
= 4 x 10^{-3} mol

$n = \frac{m}{M}$

$\therefore 4 \times 10^{-3} = \frac{0,4}{M}$ ✓

M = 100 g·mol^{-1}

M($XHCO_3$) = M(X) + 61
= 100

$\therefore$ M(X) = 39 g·mol^{-1} ✓

X = K ✓
OR/*OF*
potassium/*kalium*

1 mol → M($XHCO_3$) 4 x 10^{-3} mol → 0,4 g ✓

M($XHCO_3$) = 100 g·mol^{-1}

M($XHCO_3$) = M(X) + 61
= 100

$\therefore$ M(X) = 39 g·mol^{-1} ✓

X = K ✓
OR/*OF*
potassium/*kalium*

OPTION 2/*OPSIE 2*

$\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓

$\frac{0,2 \times 20}{c_b \times 100} = \frac{1}{1}$ ✓

c_b = 0,04 mol·dm^{-3}

$c(XHCO_3) = \frac{m}{MV}$

$\therefore 0,04 = \frac{0,4}{M(0,1)}$ ✓

M($XHCO_3$) = 100 g·mol^{-1}

M($XHCO_3$) = M(X) + 61
= 100

$\therefore$ M(X) = 39 g·mol^{-1} ✓

X = K ✓
OR/*OF*
potassium/*kalium*

(6)
[17]

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QUESTION 8/*VRAAG 8*

8.1 It is a conductor of electricity/a solid to connect wires to./Pt is inert or unreactive. ✓
Dit is 'n geleier van elektrisiteit/'n vaste stof waaraan drade geskakel kan word./Pt is inert of onreaktief.

OR/*OF*
$C\ell^-$(aq) and chlorine gas are not solids and cannot be used as an electrode.
$C\ell^-$(aq) en chloorgas is nie vaste stowwe nie en kan nie as 'n elektrode gebruik word nie. (1)

8.2

8.2.1 Chemical (energy) to electrical (energy) ✓
Chemiese (energie) na elektriese (energie) (1)

8.2.2 $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ ✓✓

Marking guidelines/*Nasienriglyne*
- $C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ $\frac{1}{2}$ $2C\ell^- \rightleftharpoons C\ell_2 + 2e^-$ $\frac{0}{2}$
  $2C\ell^- \leftarrow C\ell_2 + 2e^-$ $\frac{2}{2}$ $2C\ell^- \rightarrow C\ell_2 + 2e^-$ $\frac{0}{2}$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on $C\ell^-$/*Indien lading (-) weggelaat op* $2C\ell^-$: Max./*Maks:* $\frac{1}{2}$ Example/*Voorbeeld:* $C\ell_2 + 2e^- \rightarrow 2C\ell$ ✓

(2)

8.2.3 $\underline{Cr(s) \mid Cr^{3+}(aq)}$ ✓✓ $\underline{\| \; C\ell_2(g) \mid C\ell^-(aq) \mid Pt(s)}$ ✓

OR/*OF*
$Cr(s) \mid Cr^{3+}(1\ mol{\cdot}dm^{-3}) \parallel C\ell_2(g) \mid C\ell^-(1\ mol{\cdot}dm^{-3}) \mid Pt(s)$

Accept/*Aanvaar*:
$Cr \mid Cr^{3+} \parallel C\ell_2 \mid C\ell^- \mid Pt$ (3)

8.3

OPTION 1/*OPSIE 1*

$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓
$= 1{,}36$ ✓ $- (-0{,}74)$ ✓
$E^\theta_{cell} = 2{,}10$ V ✓

Notes/*Aantekeninge*
- Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.*
- Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings*: $\frac{3}{4}$

OPTION 2/*OPSIE 2*

$C\ell_2 + 2e^- \rightarrow 2C\ell^-$ ✓ $E^\theta = 1{,}36$ V ✓
$Cr(s) \rightarrow Cr^{3+}(aq) + 3e^-$ $E^\theta = +0{,}74$ V ✓
$2Cr(s) + 3C\ell_2(g) \rightarrow 2Cr^{3+}(aq) + 6C\ell^-(aq)$ $E^\theta = +2{,}10$ V ✓

(4)

8.4 Increases/*Verhoog* ✓✓ (2)

[13]

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QUESTION 9/*VRAAG 9*

9.1 Electrolytic/*Elektrolities* ✓ (1)

9.2 $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ ✓✓

Marking guidelines/*Nasienriglyne*
- $2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-$ ½ $H_2 + 2OH^- \rightleftharpoons 2H_2O + 2e^-$ 0/2
  $H_2 + 2OH^- \leftarrow 2H_2O + 2e^-$ 2/2 $H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ 0/2
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on OH^-/*Indien lading (-) weggelaat op* OH^-: Max./*Maks:* ½ Example/*Voorbeeld:* $2H_2O + 2e^- \rightarrow H_2 + 2OH$ ✓

(2)

9.3
9.3.1 Chlorine (gas) / $C\ell_2$ /*Chloor(gas)* ✓ (1)

9.3.2 P ✓ & Y ✓ (2)

9.4 Cathode/*Katode* ✓
Reduction takes place here./Gains electrons.✓
Reduksie vind hier plaas./Wins van elektrone. (2)

9.5 $CuC\ell_2(aq)$ ✓ → $Cu(s) + C\ell_2(g)$✓ Bal ✓
OR/OF
$Cu^{2+}(aq) + 2C\ell^- \rightarrow Cu(s) + C\ell_2(g)$

Notes/*Aantekeninge:*
- Reactants/*Reaktanse* ✓ Products/*Produkte* ✓ Balancing/*Balansering* ✓
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*
- Ignore phases/*Ignoreer fases.*

(3)
[11]

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QUESTION 10/*VRAAG 10*

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10.1

10.1.1 II – IV – III - I ✓ (1)

10.1.2 $2NH_3 + H_2SO_4$ ✓ → $(NH_4)_2SO_4$ ✓ Bal ✓

Notes/*Aantekeninge:*
- Reactants/*Reaktanse* ✓ Products/*Produkte* ✓ Balancing/*Balansering* ✓
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.* (3)

10.1.3 Vanadium pentoxide/*Vanadiumpentoksied* ✓ (1)

10.1.4 $SO_3(g) + H_2SO_4$ ✓→ $H_2S_2O_7$ ✓ Bal ✓

Notes/*Aantekeninge:*
- Reactants/*Reaktanse* ✓ Products/*Produkte* ✓ Balancing/*Balansering* ✓
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.* (3)

10.1.5 Sulphuric acid will form (white) mists./The reaction is very exothermic/gives off too much heat./Corrosive reaction. ✓
Swawelsuur sal (wit) mis vorm./Die reaksie is té eksotermies/gee te veel warmte af./Vretende reaksie. (1)

10.2

Marking criteria/*Nasienriglyne:*
- Calculate m(fertiliser)./*Bereken m(kunsmis).* ✓
- Use ratio/*gebruik verhouding:* $\frac{2}{X+3}$/m(P) = ½m(K) ✓
- Use/*Gebruik* m(K) = 3,33 kg ✓
- Final answer/*Finale antwoord:* 3 ✓

OPTION 1/*OPSIE 1*

m(fertiliser) = $\frac{20}{100} \times 50$ ✓
= 10 kg

m(K) = $\frac{2}{X+3} \times 10$

∴ 3,33 ✓ = $\frac{2}{X+3}$ ✓ $\times 10$
∴ X = 3 ✓

OPTION 2/*OPSIE 2*

m(K) = $\frac{2}{X+3}$ ✓ $\times \frac{20}{100}$ x 50 ✓ = 3,33 ✓
X = 3 ✓

OPTION 3/*OPSIE 3*

(fertiliser) = $\frac{20}{100} \times 50$ ✓
= 10 kg

m(P) = ½m(K) ✓
= ½(3,33) = 1,665 kg

m(X) = 10 – 3,33 ✓– 1,665
= 5,005

N : P : K = 5,005 : 1,665 : 3,33
= 3 : 1 : 2
∴ X = 3 ✓

(4)

[13]

TOTAL/*TOTAAL*: 150

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education

Department of Education
FREE STATE PROVINCE

EXAMINATION / *EKSAMEN*

GRADE 12 / *GRAAD 12*

PHYSICAL SCIENCES PAPER 1
FISIESE WETENSKAPPE VRAESTEL 1

MEMORANDUM

JUNE 2019 / *JUNIE* 2019

MARKS: 150 / *PUNTE: 150*

TIME: 3 HOURS / *TYD: 3 UUR*

This memorandum consists of TWELVE pages and an addendum.
Hierdie memorandum bestaan uit TWAALF bladsye en 'n bylaag.

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QUESTION 1 / *VRAAG 1*

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1.1	D ✓✓	1.2	D ✓✓	1.3	D ✓✓	1.4	A ✓✓
1.5	C ✓✓	1.6	D ✓✓	1.7	A ✓✓	1.8	B ✓✓
1.9	B ✓✓	1.10	C ✓✓				

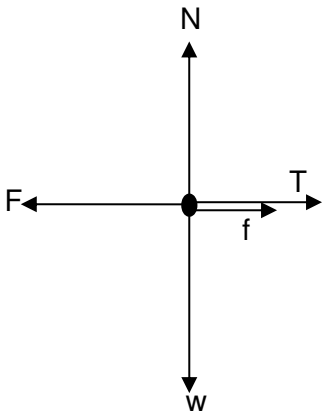
[20]

QUESTION 2 / *VRAAG 2*

2.1 An object continues in a state of rest or uniform (moving with constant) velocity unless it is acted upon by an unbalanced (net or resultant) force. ✓✓
'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid volhard, tensy 'n nie-nul resulterende/netto krag daarop inwerk. (2)

2.2 0 N /Zero✓ (1)

2.3.1



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg / gravitational force/ 98 N *F_g / F_w / gewig / mg / gravitasiekrag* / 98 N
f	$F_{friction}$ / F_f / friction /f_k *$F_{wrywing}$ / F_w / wrywing /f_k*
N	F_N / F_{normal} / normal force *F_N / $F_{normaal}$ / normaalkrag*
F_D	$F_{Applied/toegepas/}$ $F_{driving/dryfkrag/}$
T	F_T/ tension / tension force *F_T/ Spanning*

Note: 1 mark for correct label and orientation.
Deduct 1 mark for: 1. forces not touching the body
2…extra force(s)
Don't consider length of the forces.
Nota: *1 punt vir korrekte etiket en oriëntasie.*
Trek 1 punt af vir: *1. kragte mag nie aan die liggaam te raak nie*
2. ekstra krag(te)
Moenie die lengte van die kragte in ag neem nie.

(5)

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2.3.2

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Option 1: Left + / Opsie 1: Links +

2 kg block / blok:

$F_{net} = ma$
$T + w = ma$
$T - 2 \checkmark \times 9,8 = 2 \times 1,2$
$T = 22$ N

Any / *enigeeen* ✓

Any / *enigeeen* ✓

10 kg block/blok:
$F_{net} = ma$
$F + f + T = ma$
$F + mg + T$
$F - (0,21 \times 10 \times 9,8) - 22 \checkmark = 10 \times 1,2$
$F = 54,58$ N ✓

Option 2: Left – / *Opsie 2: Links –*

2 kg block/*blok*:

$F_{net} = ma$
$T + w = ma$ ✓
$T - 2 \times 9,8 = 2 \times 1,2$
$T = 22$ N

Any / *enigeen* ✓

10 kg block/*blok*:
$F_{net} = ma$
$F + f + T = ma$
$F + \mu mg + T$ ✓
$F - (0,21 \times 10 \times 9,8) - 22 \checkmark = 10 \times 1,2$
$F = 54,58$ N ✓

Option 3 / *Opsie 3*

$F_{net} = ma$ ✓
$10kg: F - (0,21)(10)(9,8) - T = 10(1,2)$ ✓
$2kg: T - 2(9,8) = 2(1,2)$ ✓ ✓
$F - 40,18 = 14,4$
$F = 54,58N$ ✓

(5)

2.4 See addendum. / *Sien bylaag.* (2)

[15]

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QUESTION 3 / *VRAAG 3*

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3.1 Newton's law of universal gravitation: Each particle in the universe attracts every other particle with a gravitational force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.✓✓ /
Newton se Universele Gravitasiewet neer: Elke liggaam in die heelal trek elke ander liggaam aan met 'n krag direk eweredig aan die produk van hul massas en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte. (2)

3.1.2

OPTION 1 / *OPSIE 1*

<u>On Earth / *Op Aarde*</u>

$F = \frac{Gmm}{r^2}$ ✓ Formula / *Formule* $w = mg$

$140 = \frac{(6{,}67x10^{-11})(5{,}98x10^{24})m}{(6{,}38x10^{6})^2}$ ✓ ✓ OR / *OF* ✓ $140 = m(9{,}8)$ ✓

$m = 14{,}287\ kg$ ✓ $m = 14{,}286\ kg$

<u>Above Earth / *Bo Aarde*</u>

$F = \frac{Gmm}{r^2}$

$F = \frac{(6{,}67x10^{-11})(5{,}98x10^{24})(14{,}287)}{(6{,}38x10^{6} + 6{,}7x10^{6})^2}$ ✓ ✓

$= 33{,}31\ N$ ✓

OPTION 2 / *OPSIE 2*

$r_{on/op} : r_{above/bo}$ ✓ $= 6{,}38x10^{6} : 6{,}38x10^{6} + 6{,}7x10^{6}$ ✓

$r_{on/op} : r_{above/bo} = 1 : 2{,}05$

$F_{on/op} : F_{above/bo} = 2{,}05^2 : 1$

$140 : F_{above/bo}$ ✓ $= 2{,}05^2 : 1$ (✓✓)

$F_{above/bo} = 33{,}31$ N ✓

(6)

3.1.3 **POSITIVE MARKING FROM 3.1.2. / *POSITIEWE NASIEN VANAF 3.2.1.***

$g = \frac{Gm}{r^2}$ ✓

$= \frac{(6{,}67x10^{-11})(5{,}98x10^{24})}{(6{,}38x10^{6} + 6{,}7x10^{6})^2}$ ✓ OR / *OF* $w = mg$ ✓

$= 2{,}33\ m \cdot s^{-2}$ ✓ $33{,}31 = 14{,}287g$ ✓

$g = 2{,}33\ m \cdot s^{-2}$ ✓

(3)

3.2 See addendum. / *Sien bylaag.* (✓✓) (2)

[13]

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QUESTION 4 / *VRAAG 4*

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4.1 The total linear momentum of an isolated system remains constant (is conserved).✓✓ / *Die totale lineêre momentum in 'n geslote sisteem bly konstant (behoue).* (2)

4.2

Option 1: Left +/ *Opsie 1: Links +*

$\sum p_i = \sum p_f$ ✓

$m_c v_{ic} + m_T v_{iT} = m_c v_{fc} + m_T v_{fT}$

$1000(40) + 5000(20)$✓ $= (1000 + 5000)v$✓

$v = 23{,}333\ m\cdot s^{-1}$ west / *wes* ✓

Option 2: Left – / *Opsie 2: Links –*

$\sum p_i = \sum p_f$ ✓

$m_c v_{ic} + m_T v_{iT} = m_c v_{fc} + m_T v_{fT}$

$1000(-40) + 5000(-20)$✓ $= (1000 + 5000)v$✓

$v = -23{,}333\ m\cdot s^{-1}$

$v = 23{,}333\ m\cdot s^{-1}$ west / *wes* ✓

(4)

4.3

Car / *Motor*

$F_{net}(\Delta t) = \Delta p$ ✓

$= m(v_f - v_i)$

$F_{net}(0{,}5)$ ✓ $= 1000(23.333 - 40)$ ✓

$F_{net} = -33\ 333{,}33$ N✓

Truck/ Trok

See addendum. / *Sien bylaag.*

$F_{net} <$ 85 000N,✓ Not fatal / *Nie dodelik nie.* (5)

4.4

$\sum k_i = \frac{1}{2}m_c v_{ic}^2 + \frac{1}{2}m_T v_{iT}^2$

$= \frac{1}{2}(1000)(40)^2 + \frac{1}{2}(5000)(20)^2$

$= 1\ 800\ 000$J

$\sum k_f = \frac{1}{2}m_c v_{fc}^2 + \frac{1}{2}m_T v_{fT}^2$

$= \frac{1}{2}(1000)(23{,}333)^2 + \frac{1}{2}(5000)(23{,}333)^2$

$= 1\ 633\ 286{,}67$J

$\sum k_f \neq \sum k_i$ ✓, Inelastic✓ / *Onelasties*

(4)
[15]

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QUESTION 5 / *VRAAG 5*

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5.1 An object upon which the only force acting is the force of gravity.✓✓/
'n Voorwerp waarop die enigste krag wat daarop inwerk swaartekrag is. (2)

5.2 See addendum. / *Sien bylaag.* (1)

5.3 Both objects are in free fall.✓ / *Beide voorwerpe is in vrye val.* (1)

5.4.1

Option 1 / *Opsie 1*	**Option 2 / *Opsie 2***
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓ $= 0(4)$ ✓ + $\frac{1}{2}(-10)(4)^2$ ✓ $= -80$ m Height / *Hoogte* = 80 m✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-40)^2$ ✓$= 0 + 2(-10)\Delta y$ ✓ $\Delta y = -80$ m Height / *Hoogte* = 80 m✓
Option 3 / *Opsie 3*	**Option 4 / *Opsie 4***
See addendum. *Sien bylaag.*	Height = Area between the graph and time axis / *Hoogte = Area tussen die grafiek en tyd as* = ½bh ✓ = ½(4) ✓(−40) ✓ = − 80 m Height / *Hoogte* = 80 m ✓

(4)

5.4.2

Option 1: whole motion / ***Opsie 1**:Die hele beweging* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= (20)^2$ ✓$+2(-10)(-80)$ ✓ $v_f = -44{,}72$ $v_f = 44{,}72$ m·s^{-1}down / *af* ✓	**Option 2:** down from point of projection / ***Opsie 2**: af vanaf punt van projeksie* $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= (-20)^2$ ✓$+2(-10)(-80)$ ✓ $v_f = -44{,}72$ $v_f = 44{,}72$ m·s^{-1} down / *af* ✓
Option 3: whole motion ***Opsie 3**: Die hele beweging* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t2$ $-80 = 20\Delta t + \frac{1}{2}(-10)(\Delta t)^2$ $\Delta t = 6{,}472$ s $v_f = v_i + a\Delta t$ ✓ $= 20$✓ + $(-10)(6{,}472)$ ✓ $= -44, 72$ m·s^{-1} $v_f = 44{,}72$ m·s^{-1} down / *af* ✓	**Option 4:** down from point of projection ***Opsie 4:** af vanaf punt van projeksie* $\Delta t = 6{,}472 - 4$ $v_f = v_i + a\Delta t$ ✓ $= -20$ ✓ + $(-10)(2{,}472)$ ✓ $= -44, 72$ $v_f = 44{,}72$ m·s^{-1}down / *af* ✓

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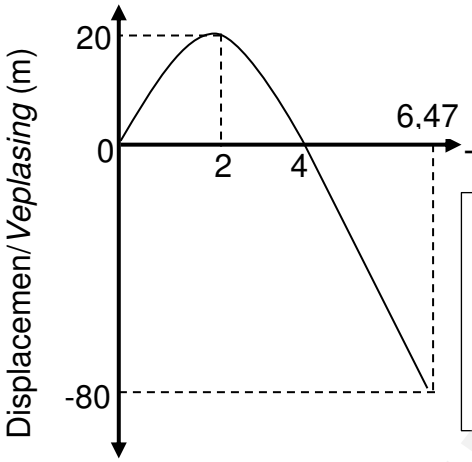
Option 5: down from maximum height
$\Delta t = 6,472 - 2$

$v_f = v_i + a\Delta t$ ✓
$= 0$ ✓ $+ (-10)(4,472)$ ✓
$= -44, 72$
$v_f = 44,72\ m{\cdot}s^{-1}$down ✓

(4)

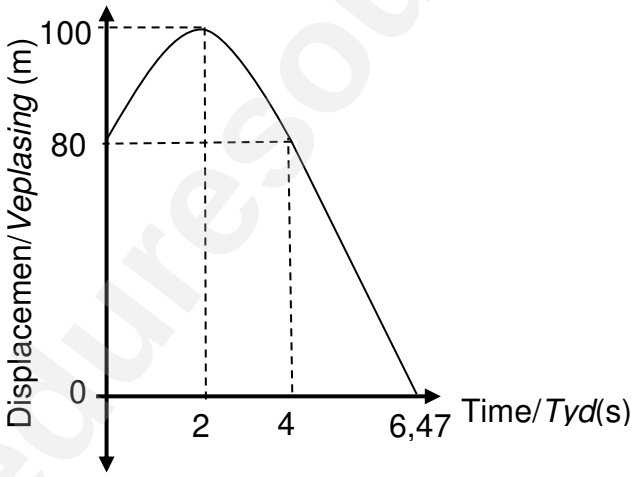
5.5 NOTE: Deduct one mark if down is taken as positive (-1)
LET WEL: Trek een punt af as af as positief beskou word (-1)

Projection point as reference / *Projeksiepunt as verwysingpunt*



Marking criteria / Kriteria vir nasien
✓ Shape/ *Vorm*
✓ 2 s at maximum height /
2 s op maksimum hoogte
✓ (20 m, 80 m or 80 m, 100 m

Ground as reference point / *Grond as verwysingspunt*



(3)
[15]

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QUESTION 6 / *VRAAG 6*

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6.1.1 $K = \frac{1}{2}mv^2$ ✓
$= \frac{1}{2}(10)(12)^2$ ✓
$= 720$ J ✓ (3)

6.1.2 The net/total work done on an object is equal to the change in the object's kinetic energy.✓✓ / *Die netto / totale arbeid verrig op 'n voorwerp is gelyk aan die verandering in kinetiese energie van die voorwerp.*
OR / *OF*
The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy. / *Die arbeid verrig op 'n voorwerp deur 'n resultant / netto krag is gelyk aan die verandering in kinetiese energie van die voorwerp.* (2)

6.1.3

Option 1 / *Opsie 1*
$W_{net} = \Delta K$ ✓
$f\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$
$54,9(6)\cos 180º$ ✓ $= \frac{1}{2}(10)(v_f^2 - 144)$ ✓
$v_f = 8,84\ m\cdot s^{-1}$ ✓

Option 2 / *Opsie 2*

$W_{nc} = \Delta U + \Delta K$
$W_f = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ ✓
$f\Delta x\cos\theta = 0 + \frac{1}{2}m(v_f^2 - v_i^2)$

$54,9(6)\cos 180º$ ✓ $= \frac{1}{2}(10)(v_f^2 - 144)$ ✓
$v_f = 8,84\ m\cdot s^{-1}$ ✓

Option 3 / *Opsie 3*

$F_{net} = ma$
$-54,9 = 10a$ ✓
$a = -5,49$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$v_f^2 = 144 + 2(-5,49)(6)$ ✓
$v_f = 8,84\ m\cdot s^{-1}$ ✓

(4)

6.1.4

Option 1 / *Opsie 1*
$W_{net} = \Delta K$
$W_f + W_{Fg//} = \frac{1}{2}m(v_f^2 - v_i^2)$ ✓
$f(\Delta x)\cos 180º + mg\sin\theta\Delta x\cos 180º = \frac{1}{2}(m)(v_f^2 - v_i^2)$
$45(\Delta x)\cos 180º$ ✓ $+ (10)(9,8)\sin 35º\Delta x\cos 180º$ ✓ $= \frac{1}{2}(10)(0 - 8,84^2)$ ✓
$x = 3,86$ m ✓

Option 2 / *Opsie 2*
$W_{nc} = \Delta U + \Delta K$
$W_f = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$ ✓
$f\Delta x\cos\theta = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$
$45\Delta x\cos 180°$ ✓ $= (10)(9,8)(h_f - 0)$ ✓ $+ \frac{1}{2}(10)(0 - 8,84^2)$ ✓
$x = 3,86$ m ✓

(5)

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6.2.1 The rate at which work is done or energy is expended.✓✓ / *Die tempo waarteen arbeid verrig of energie verbruik word* (2)

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6.2.2

$f_k = \mu_k N$ ✓
$= (0,19)(300 \times 9,8 \times \cos 25°)$✓
$= 506,26$ N✓

(3)

6.2.3 **POSITIVE MARKING FROM 6.5.2 / *POSITIEWE NASIEN VAN 6.5.2***

Option 1 / *Opsie 1*

$F_{net} = 0$ ✓
$F + f + F_{g//} = 0$
$F - 506,26$ ✓ $- (300 \times 9,8 \times \sin 25°)$ ✓ $= 0$
$F = 1\,748,76$ N
$P_{ave} = Fv_{ave}$ ✓
$= 1\,748,76(0,5)$ ✓
$= 874,38$ W ✓

Option 2 / *Opsie 2*

$W_F + W_f + W_{Fg//} = 0$
$F\Delta x\cos\theta + f\Delta x\cos\theta + mg\sin\theta\Delta x\cos\theta = 0$ ✓

$F\Delta x\cos 0° + 506,26\Delta x\cos 180°$ ✓ $+ (300 \times 9,8\sin 25°\Delta x\cos 180°)$ ✓$= 0$
$F = 1\,748,76$ N

$P_{ave} = Fv_{ave}$✓
$= 1\,748,76(0,5)$ ✓
$= 874,38$ W✓

Accept. **Option 3**
Calculate **F** by either using option 1 or 2 for **three marks**. /
*Aanvaar **Opsie 3***
*Bereken F deur óf gebruik te maak van opsie 1 of 2 vir **drie punte**.*

$$P_{ave} = \frac{W}{\Delta t} \checkmark$$
$$= \frac{F\Delta x\cos\theta}{\Delta t}$$
$$= \frac{1748,76(0,5)\cos 0°}{1} \checkmark$$
$$= 874,38 \text{ W} \checkmark$$

(6)
[25]

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QUESTION 7 / *VRAAG 7*

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7.1.1 The change in frequency (or pitch) of the sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓ /
Die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar is omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word. (2)

7.1.2 Away / *Weg van hom af.*✓

The detected frequency is lower than the actual frequency.✓/
Die waargenome frekwensie is laer as die werklike frekwensie. (2)

7.1.3

$v = f\lambda$✓
$345 = f(0{,}2875)$✓
$f = 1200\text{Hz}$✓ (3)

POSITIVE MARKING FROM 7.1.3 / *POSITIEWE NASIEN VAN* 7.1.3

7.1.4

$f_L = \left(\frac{v \pm v_L}{v \pm v_s}\right) f_s$ ✓ or $f_L = \left(\frac{v}{v+v_s}\right) f_s$

1128✓ $= \left(\frac{345}{345+v_s}\right)$ ✓1200 ✓

$v_s = 22{,}02\ \text{m}\cdot\text{s}^{-1}$✓ (5)

7.2 Away / *Weg*✓

The spectral lines are shifted towards red end of the spectrum✓
or red shifted./ *Die spektrale lyne word verskuif na die rooi einde van die spektrum of rooiverskuiwings.* (2)

[14]

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QUESTION 8 / *VRAAG 8*

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8.1 Electric field as a region of space in which an electric charge experiences a force.✓✓ / *Elektriese veld as 'n gebied in die ruimte waarin 'n elektriese lading 'n krag* ondervind. (2)

8.2 **Option 1 / *Opsie 1***

$E_{net} = 0$

$E_1 + E_2 = 0$

$\frac{kQ_1}{r^2} + \frac{kQ_2}{r^2}$ ✓ $= 0$ ✓

$\frac{9 \times 10^9(2 \times 10^{-6})}{x^2}$ ✓ $- \frac{9 \times 10^9(3 \times 10^{-6})}{(0,2-x)^2}$ ✓ $= 0$

$\frac{2}{x^2} = \frac{3}{(0,2-x)^2}$

$\frac{1,414}{x} = \frac{1,732}{0,2-x}$

x = 0,09 m ✓

Option 2 / *Opsie 2*

E (due to 2 μC) = $\frac{kQ}{r^2}$ ✓ = $\frac{9x10^9(2x10^{-6})}{x^2}$ ✓

E (due to 3 μC) = $\frac{kQ}{r^2} = \frac{9x10^9(3x10^{-6})}{(0,2-x)^2}$ ✓

✓

$\frac{18000}{x^2}$ ✓ = $\frac{27000}{(0,2-x)^2}$ ✓

x = 0,09 m ✓

(7)

8.3 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{42} = \frac{9\times10^9(4\times10^{-6})(2\times10^{-6})}{(0,1)^2}$ ✓

= 7,2 N

$F_{32} = \frac{9\times10^9(3\times10^{-6})(2\times10^{-6})}{(0,2)^2}$ ✓

=1,35 N

$F_{net} = \sqrt{F_{42}^2 + F_{32}^2}$

$= \sqrt{(7,2)^2 + (1,35)^2}$ ✓

= 7,325 N ✓ (5)

[14]

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QUESTION 9 / *VRAAG 9*

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9.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.✓✓ /
Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur. (2)

9.2 See addendum. / *Sien bylaag.* (1)

9.3.1 $V = IR$✓
$(4x0,9)$✓ $= I_{6\Omega}(6)$✓
$I_{6\Omega} = 0,6A$✓

See addendum for another option.
Sien bylaag vir 'n ander opsie. (4)

9.3.2

Option 1 / *Opsie 1*	**Option 2 / *Opsie 2***
$I_{total} = I_{6\Omega} + I_{4\Omega}$ $= 0,6 + 0,9$ ✓ $= 1,5$ A ✓	$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{4}$ $R_p = 2,4\Omega$ $V_{total} = I_{total}R_p$ $3,6 = I_{total}(2,4)$ ✓ $I_{total} = 1,5$ A ✓

(2)

9.3.3

Option 1 / *Opsie 1*	**Option 2 / *Opsie 2***	**Option 3 / *Opsie 3***
$V_x = 6 - V_1$ $= 6 - 3,6 = 2,4V$ $V_x = I_xR_x$ ✓ $2,4 = 1,5R_x$ ✓ $R_x = 1,6\ \Omega$ ✓	$Emf = I(R_x + R_p)$ ✓ $6 = 1,5(R_x + 2,4)$ ✓ $R_x = 1,6\ \Omega$ ✓	See addendum. *Sien bylaag.*

(3)

9.3.4

Option 1 / *Opsie 1*	**Option 2 / *Opsie 2***	**Option 3 / *Opsie 3***
$W = VI\Delta t$✓ $= 2,4(1,5)$ ✓ (90)✓ $= 324$ J ✓	$W = I^2R\Delta t$✓ $= (1,5)^2(1,6)$ ✓(90) ✓ $= 324$ J ✓	$W = \frac{V^2}{R}\Delta t$ ✓ $= \frac{(2,4)^2}{1,6}$ ✓(90) ✓ $= 324$ J ✓

(4)

9.4 See addendum. / *Sien bylaag.* (3)
[19]

GRAND TOTAL/*GROOTTOTAAL*: 150

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ADDENDUM TO MEMORANDUM / *BYLAAG TOT MEMORANDUM*

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GRADE 12 PHYSICAL SCIENCES P1

CORRECTIONS / MODIFICATIONS

2.4 Less than ✓/ *Kleiner as*
The normal force is less ✓/ *Die normaalkrag is kleiner.* (2)

3.2 $ZY = \frac{1}{9}XY$ ✓✓ (2)

4.3
Truck/ *Trok*
$F_{net}(\Delta t) = \Delta p$ ✓
$= m(v_f - v_i)$
$F_{net}(0,5)$ ✓ $= 5000(23,333 - 20)$ ✓
$F_{net} = 33\ 333,33$ N✓

5.2 (Gravitational) acceleration ✓ / *(Gravitasie)versnelling* (1)

5.4.1 **OPTION 3**

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{0+(-40)}{2}\right) \quad ✓ \quad (4) \quad ✓$$
$$= -80 \text{ m}$$

Height/Hoogte = 80 m ✓ (4)

9.2 6 V ✓ (1)

9.3.1
OPTION 2
Ratios
$R_{6\Omega}:R_{4\Omega} = 6:4$
$I_{6\Omega}:I_{4\Omega} = 4:6$ ✓
$I_{6\Omega} = \frac{0,9x4}{6}$ ✓
$= 0,6$ A✓ ✓ (4)

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9.3.3

$$R_{Total} = \frac{V_{Total}}{I_{Total}}$$
$$= \frac{6}{1,5} \checkmark$$
$$= 4\Omega$$
$$R_{Total} = R_p + R_s$$
$$4 = \left(\frac{1}{6}+\frac{1}{4}\right)+R_x \checkmark$$
$$R_x = 4-2,4$$
$$= 1,6\ \Omega \checkmark$$

(3)

9.4 Current through 4Ω is bigger than through 6Ω / *stroom deur 4Ω is groter as deur 6Ω* ✓

From the formula/*van die formule*: P = VI (V same/ *dieselfde*) ✓

The lower the resistance the higher the power✓, hence 4Ω is getting hotter. /

Hoe laer die weerstand hoe hoër die drywing dus 4Ω word warmer.

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FREE STATE PROVINCE

Examination / *Eksamen*

GRADE 12 / *GRAAD 12*

PHYSICAL SCIENCES
FISIESE WETENSKAPPE

MEMORANDUM P2

JUNE 2019 / *JUNIE* 2019

MARKS: 150 / *PUNTE: 150*

TIME: 3 HOURS / *TYD: 3 UUR*

This paper consists of ELEVEN pages
Hierdie memorandum bestaan uit ELF bladsye.

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QUESTION 1 / *VRAAG 1*

1.1 B ✓✓
1.2 C ✓✓
1.3 C ✓✓
1.4 A ✓✓
1.5 A ✓✓
1.6 A ✓✓
1.7 D ✓✓
1.8 C ✓✓
1.9 B ✓✓
1.10 B ✓✓ **[20]**

QUESTION 2 / *VRAAG 2*

2.1 An organic compound with ONLY C-H ✓and C-C single bonds.✓ / *'n Organiese verbinding met SLEGS C-H en C-C enkel bindings* (2)

2.2.1 B ✓ (1)

2.2.2 E ✓ (1)

2.2.3 1-bromo-3-chloro ✓propane ✓/ *1-bromo-3-chloro ✓propaan* ✓ (2)

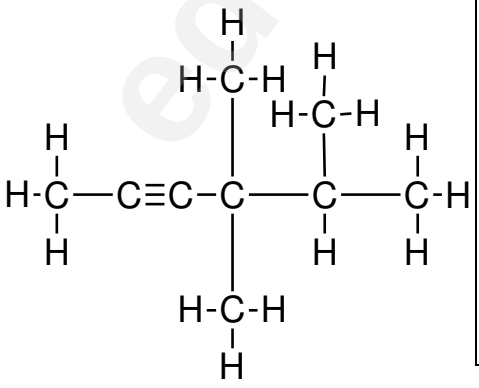
2.2.4 2,2,3-trimethyl butane */ 2,2,3-trimetielbutaan*

Criteria for marking/*Nasien kriteria*
• Butane ✓/*Butaan* • Trimethyl ✓ /*Trimetiel* • Correct numbering and use of punctuation ✓/*Korrekte numering en gebruik van leestekens*

(3)

2.2.5 Alkynes ✓ / *Alkyne* (1)

2.2.6

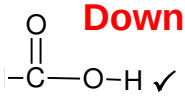


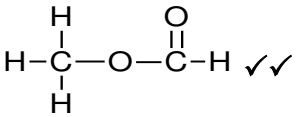
Criteria for marking/*Nasien kriteria*
• Correct chain length ✓/ *Korrekte kettinglengte* • Three methyl groups on correct C atoms ✓ / *Drie metielgroepe op die korrekte koolstowwe* • Triple bond between correct C atoms ✓/ *Trippel binding tussen korrekte C atome*

(3)

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2.3.1  (1)

2.3.2  (2)

[16]

QUESTION 3 / *VRAAG 3*

3.1 The pressure exerted by a vapour at equilibrium with its liquid✓ in a closed system ✓ *Die druk uitgeoefen deur die damp wanneer dit in ewewig is met 'n vloeistof in 'n geslote sisteem.* (2)

3.2.1 A✓



Highest vapour pressure✓ / *Hoogste dampdruk* (2)

3.2.2 A✓ (1)

3.3 Positional (isomers) ✓ / *Posisionele (isomere)* (1)

3.4 $C_nH_{2n+2}O$ ✓ **OR**/***OF*** $C_nH_{2n+1}OH$ (1)

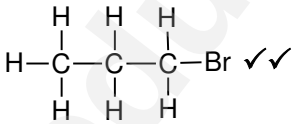
3.5 Both have hydrogen bonds and London forces. ✓ D has a longer chain length✓ and thus stronger London forces✓ and lower vapour pressure./ *Beide het waterstofbindings en Londonkragte. D het 'n langer kettinglengte en dus sterker London kragte.* (3)

[10]

QUESTION 4 / VRAAG 4

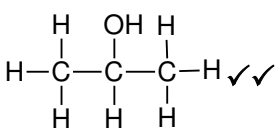
4.1.1 Heat or sunlight ✓/*Hitte of sonlig* (1)

4.1.2 Substitution OR Halogenation ✓ / *Substitusie OF Halogenasie* (1)

4.1.3  (2)

4.2.1 Ellimination OR Dehydrohalegenation Or Dehydrobromonation ✓ / *Elliminasie OF Dehidrohalogenasie OF dehidrobrominasie* (1)

4.2.2 HBr ✓ (1)

4.3.1 

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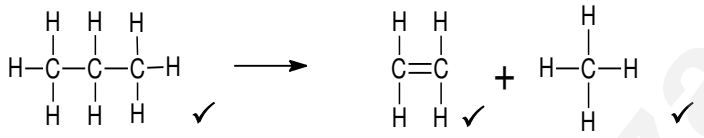
Criteria for marking/*Nasien kriteria*
• Correct chain length and only single bonds ✓/ *Korrekte kettinglengte en slegs enkel bindings* • -OH correctly indicated ✓ / *korrek geteken*

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(2)

4.3.2 Secondary. ✓ The C atom to which the -OH is bonded is bonded to two other C atoms. ✓ / *Sekondêr. Die C-atoom waaraan die –OH gebind is, is aan twee ander C-atome gebind.* (2)

4.4.1 Ellimination Or Cracking ✓ / *Elliminasie OF Kraking* (1)

4.4.2  (3)

4.4.3 Methane ✓ / *Metaan* (1)

4.4.4 Saturated ✓ / *Versadig* (1)

4.5.1 Esters ✓ (1)

4.5.2 Sulphuric acid ✓/ *Swawelsuur* **OR/OF** H_2SO_4 (1)

4.5.3 Propan-1-ol: $n = \frac{m}{M}$ ✓ $= \frac{7,4}{60}$ ✓ $= 0,123\ mol$ ✓

$n_{product/produk} = 0,123\ mol$ ✓

$m = nM = 0,123 \times 102 = 12,58g$ ✓

mass/*massa* = 12,58 x 10% = 1,26 g ✓ (6)

[24]

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QUESTION 5 / *VRAAG 5*

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5.1 Temperature ✓ OR Concentration H_2SO_4 / *Temperatuur OF konsentrasie H_2SO_4* (1)

5.2 Rate of reaction/ *Reaksietempo* ✓**OR**/**OF** Volume gas **OR**/**OF** Volume H_2 (1)

5.3 $\text{Ave. rate} = \text{Gradient} = \frac{\Delta V}{\Delta t} = \frac{60-(0)}{30-(0)}$ ✓ ✓ $= 2\ \text{cm}^3 \cdot \text{s}^{-1}$ ✓

$Gemiddelde\ tempo = Gradiënt = \frac{\Delta V}{\Delta t} = \frac{60-(0)}{30-(0)} = 2\ cm^3 \cdot s^{-1}$ (3)

5.4 Less than ✓/*Minder as* (1)

5.5 The gradient of graph is less at 50 s ✓ OR the $[H_2SO_4]$ is less thus the reaction rate will be less. / *Die gradiënt van die grafiek is minder by 50 s OF die $[H_2SO_4]$ is minder dus is die reaksietempo laer* (1)

5.6 Decrease ✓ / *Verminder* (1)

5.7 (In EXPERIMENT I), larger surface area results in:
- More particles with correct orientation/more contact points ✓
- More effective collisions per unit time/higher frequency of effective collisions ✓
- Therefore higher reaction rate ✓

OR

(In EXPERIMENT II), smaller surface area results in:
- Less particles with correct orientation/less contact points
- Less effective collisions per unit time/lower frequency of effective collisions
- Therefore lower reaction rate

(In EKSPERIMENT I), groter kontakoppervlak veroorsaak:
- *Meer deeltjies met die regte orientasie/meer kontakpunte*
- *Meer effektiewe botsings per tydseenheid/ hoër frekwensie van effektiewe botsingse*
- *Dus 'n hoër reaksietempo*

OF

(In EKSPERIMENT II), kleiner kantakoppervlak veroorsaak:
- *Minder deeltjies met korrekte orientasie/ minder kontakpunte*
- *Minder effektiewe botsings per tydseenheid/ laer frekwensie effektiewe botsings*
- *Dus laer reaksietempo* (3)

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5.8 **Option 1/*Opsie 1*:**

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$n(Zn) = \frac{m}{M} = \frac{19,5}{65}$ ✓ $= 0,3 mol$

$n(H_2SO_4)$ = c x V
= 1 x 0,1 ✓
= 0,1 mol

0,1 moles of Zn will react with 0,1 moles of H_2SO_4✓
n_{Zn} left = 0,3 - 0,1 moles✓ = 0,2 moles thus
m(Zn) = n x M = 0,2 x 65 = 13 g ✓ /

0,1 mol Zn reageer met 0,1 mol H_2SO_4✓
$n_{Zn\ oor}$ = 0,3 - 0,1 mol = 0,2 mol dus:
m(Zn) = n x M = 0,2 x 65 = 13 g

Option 2/Opsie 2:

$n(H_2SO_4)$ = cV
= 1 x 0,1
= 0,1 mol

0,1 mol Zn reacts will 0,1 mol H_2SO_4 */ 0,1 mol Zn reageer met 0,1 mol H_2SO_4*

$n(Zn_{reacted/reageer}) = \frac{m}{M}$

$0,1 = \frac{m}{65}$

$m\ (Zn_{reacted/reageer}) = 6,5\ g$

$m(Zn_{unreacted/nie\ gereageer})$ = 19,5 – 6,5
= 13 g

Criteria for marking/*Nasien kriteria*
• Substitute/*vervang* 65 in $n = \frac{m}{M}$ ✓ • $\times V H_2SO_4 = 0,1\ dm^3$ ✓ • Ratio – $n(H_2SO_4)$:n(Zn) = 1:1 ✓ • Subtract mol or mass of Zn ✓/*Aftrek van mol of massa* • Final answer/ *Finale antwoord* = 13 g ✓

(5)

5.9.1 A substance that increases the rate of a chemical reaction without undergoing a permanent change. ✓✓ OR provides an alternative path of lower activation energy/decreases the (net/total) activation energy. /
'n Stof wat die tempo van 'n chemiese reaksie verhoog sonder om self 'n permanente verandering te ondergaan OF vind 'n alternatiewe pad van laer aktiveringsenergie/ verminder die netto aktiverings energie. (2)

5.9.2 C ✓ **(**The value of C will) decrease. ✓/ **(***Die waarde van C sal) verminder* (2)
[20]

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QUESTION 6 / *VRAAG 6*

6.1 $Kc = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓ (1)

6.2 $Kc = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{0{,}4^2}{\{N_2\}0{,}4^3}$ ✓ = 4 ✓

$[N_2] = 0.625\ mol \cdot dm^{-3}$ ✓ (3)

6.3 OPSION 1/*OPSIE 1*

	N_2	H_2	NH_3
Initial moles /*Aanvanklike aantal mol*	1,65✓	2 ✓	0
Change in moles / *Verandering in mol*	0,4	1,2 ✓	0,8 ✓
Moles at equilibrium/ *Mol by ewewig*	1,25	0,8	0,8 x 2 ✓
Concentration/ *Konsentrasie* ($mol \cdot dm^{-3}$)	0,625	0,4	0,4

OPSION 2/*OPSIE 2*

Moles at equilibrium/ *Mol by ewewig:*
$n(N_2)$ = c x V = 0,625 x 2 = 1,25 mol
$n(H_2)$ = c x V = 0,4 x 2 = 0,8 mol
$n(NH_3)$ = c x V = 0,4 x 2 = 0,8 mol ✓

Moles reacted or produced/ *Mol gereageer of produk gevorm:*
$n(NH_3)$ = 0,8 mol ✓
$n(N_2)$ = 0,4 mol
$n(H_2)$ = 1,2 mol ✓ Using balanced equation/ *Uit gebalanseerde reaksie*

Initial mole / *Aanvanklike mol*
$n(N_2)$ = 1,25 + 0,4 = 1,65 mol ✓
$n(H_2)$ = 0,8 + 1,2 = 2 mol ✓

Criteria for marking/*Nasien kriteria*
• [ ] x 2 to get equilibrium moles/ *om mol by ewewig te kry* ✓ • Change in mole NH_3 / *Verandering in mol* NH_3 ✓ • Δn N_2 or/*of* H_2 ✓ • Initial/Aanvanlike $n(H_2)$ ✓ and/ *en* $n(N_2)$ ✓

(5)

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6.4 Exothermic ✓ / *Eksotermies* (1)

6.5

- When temperature decreases, K_C increases ✓
- Decrease in temperature favours an exothermic reaction ✓
- The forward reaction is favoured/ amount/concentration of NH_3 increases ✓ OR
- When temperature increases, K_C decreases ✓
- Increase in temperature favours an endothermic reaction ✓
- The reverse reaction is favoured/ amount/concentration of NH_3 decreases ✓ thus forward reaction must be exothermic

- *Indien temperatuur verminder, K_C verhoog*
- *Vermindering in temperatuur bevoordeel die eksotermiese reaksie*
- *Die voorwaartse reaksie is bevoordeel/ hoeveelheid/konsentrasie van die NH_3 verhoog OF*
- *Indien die temperatuur verhoog, K_C verminder*
- *Verhoging in temperatuur bevoordeel endotermiese reaksie*
- *Die terugwaartse reaksie is bevoordeel/hoeveelheid/konsentrasie NH_3 verminder en die voorwaartse reaksie moet eksotermies wees.* (3)

6.6.1 Remains the same ✓/ *Bly dieselfde* (1)

6.6.2 Decreases ✓ / *Verminder* (1)

6.7.1 Decreases ✓ / *Verminder*

Option 1/*Opsie 1*:

At temperature less than 400 °C / *By temperature laer as 400 ° C* :

- Average E_k is less ✓/ *Gemiddelde E_k is minder*
- Less particles have sufficient E_k/less partickes have E_k more or equal to E_a ✓/ *Minder deeltjies het genoegsame E_k / minder deeltjies het E_k gelyk of hoër as E_a*
- Less effective collisions per unit time/ frequency of effective collisions dcreases ✓ / *Minder effektiewe botsings per tydseenheid/ frekwensie van botsings laer*

Option 2/*Opsie 2*:

At temperature more than 400 °C:/ *By temperature hoër as 400 ° C* :

- Average E_k is more ✓ / *Gemiddelde E_k is hoër*
- More particles have sufficient E_k/more partickes have E_k higher or equal to E_a ✓ / *Meer deeltjies het genoegsame E_k / meer deeltjies het E_k gelyk of hoër as E_a*
- More effective collisions per unit time/ frequency of effective collisions increases ✓ / *Meer effektiewe botsings per tydseenheid/ frekwensie van botsings hoër* (4)

6.7.2 Decrease ✓/ *Verlaag* (1)

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6.8 **If Question 6.4 correct Exothermic then:**

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- Equilibrium position shifts to products✓/ *Ewewigsposisie skuif na produkte*
- Decrease in temperature favour the exothermic reaction✓/ *Verlaging in temperatuur bevoordeel die eksotermiese reaksie.*
- Forward reaction is favoured✓/ *Voorwaartse reaksie word bevoordeel*

If Question 6.4 incorrect Endothermic then:

- Equilibrium position shifts to reactants✓/ *Ewewigsposisie reagense*
- Decrease in temperature favour the exothermic reaction✓/ *Verlaging in temperatuur bevoordeel die eksotermiese reaksie.*
- Reverse reaction is favoured✓/ Terugwaartse *reaksie word bevoordeel*

(3)

[23]

QUESTION 7 / VRAAG 7

7.1.1 Increases ✓ / *Verhoog* (1)

7.1.2

- Increase in pressure favours a reaction that results in a decrease in number of moles. ✓/ *Toename in druk bevoordeel die afname in aantal mol deeltjies*
- The forward reaction is favoured. ✓/ *Die voorwaartse reaksie word bevoordeel*

OR/*OF*

- The increase in pressure will be opposed by favouring the reaction where less moles of gas will form ✓ **(**as to decrease the pressure). / *Toename in druk bevoordeel die reaksie waar minder mol gasdeeltjies vorm (om druk te verlaag)*
- Eqillibrium position will shift towards the products ✓ / *Die ewewig skuif na die produkte* (2)

7.1.3 Decrease temperature ✓ / *Verlaag temperatuur*
Increase [reactants]/add more reactants ✓/ *Verhoog [reagense]/ voeg reagense by.* (2)

7.1.4 Remains the same ✓/ *Bly dieselfde* (1)

7.2.1 Curve A – the same ✓ / *Grafiek A - dieselfde*
Activation energy line – shifts left ✓ / *Aktiveringsenergie-lyn – skuif links* (2)

7.2.2 Curve A – increases (upwards) ✓ / *Grafiek A – skuif opwaarts (verhoog)*
Activation energy line – the same ✓ / *Aktiveringsenergie-lyn - dieselfde* (2)

[10]

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QUESTION 8 / *VRAAG 8*

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8.1.1 A solution with a known concentration ✓✓/ *'n Oplossing met 'n bekende konsentrasie* (2)

8.1.2 n = c x V ✓ = 0,1 x 0,25 ✓ = 0,025 mol

m = n x M = 0,025 x 62 ✓ = 1,55 g ✓

Criteria for marking/*Nasien kriteria*
• Formula/ *Formule* $c = \frac{n}{V}$ ✓ • × 0,25✓ • × 62 ✓ • Final answer ✓/ *Finale antwoord*

(4)

8.2.1 A base is a substance that produces hydroxide ions/OH^- ✓ when it dissolves in water. ✓ /*'n Basis is stof wat hidroksied-ione (OH^-) vrystel in water.* (2)

8.2.2 Phenolphthalein ✓/ *Fenolftaleïen* (1)

8.2.3 To indicate the endpoint of a titration ✓ with a colour change. / *Dui die eindpunt aan van 'n titrasie met behulp van 'n kleursverandering.* (1)

8.2.4 OPTION 1/*OPSIE 1*:

$n(LiOH) = c \times V$ ✓ $= 0{,}1 \times 0{,}025$✓ $= 0{,}0025$ mol✓

$n(H_2CO_3)$ = ½ n(LiOH) ✓ = 0,00125 mol

$v = \frac{n}{c} = \frac{0{,}00125}{0{,}2} = 0{,}00625\ dm^3$✓

OPTION 2/ *OPSIE 2*

$\frac{n_a}{n_b} = \frac{C_a V_a}{C_b V_b}$✓

$\frac{1}{2}$✓ $= \frac{0{,}2 \times V_a$✓$}{0{,}1 \times 0{,}025$✓$}$

$V_a = 0{,}00625\ dm^3$✓ (5)

8.3.1 H_2CO_3 ✓and/*en* H_3O^+ ✓ (2)

8.3.2 $HCO_3^- + H_2O$ ✓ $\rightleftharpoons CO_3^{2-}$✓ $+ H_3O^+$✓ (3)

[20]

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QUESTION 9 / VRAAG 9

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9.1 An acid which can donate 2 protons ✓✓ / *'n Suur wat 2 protone kan vrystel* (2)

9.2.1 Hydronium ion ✓/ *Hidronium ioon,* H_3O^+ ✓ (2)

9.3.1 SO_4^{2-} ✓✓ (2)

9.3.2 OH^- ✓ (1)
[7]

GRAND TOTAL/ *GROOT TOTAAL*: 150

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education

Department of Education
FREE STATE PROVINCE

EXAMINATION / *EKSAMEN*

GRADE 12 / *GRAAD 12*

PHYSICAL SCIENCES PAPER 1
FISIESE WETENSKAPPE VRAESTEL 1

MEMORANDUM

JUNE 2018 / *JUNIE* 2018

MARKS: 150 / *PUNTE: 150*

TIME: 3 HOURS / *TYD: 3 UUR*

This memorandum consists of 11 pages.
Hierdie memorandum bestaan uit 11 bladsye.

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QUESTION 1 / *VRAAG 1*

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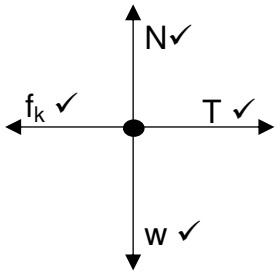
1.1	A	1.2	A	1.3	C	1.4	D
1.5	D	1.6	A	1.7	D	1.8	C
1.9	A	1.10	B				

[20]

QUESTION 2 / *VRAAG 2*

2.1.1 When a resultant / net force acts on an object, the object will accelerate in the direction of the force ✓ at an acceleration that is directly proportional to the force ✓and inversely proportional to the mass of the object. ✓/
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die krag teen 'n versnelling direk eweredig aan die krag en omgekeerd eweredig aan die massa van die voorwerp. (3)

2.1.2



Each arrow plus label: One mark except for components /
Elke pyl plus byskrif: Een punt behalwe komponente
Any other additional force(s): -1 /
Enige ander addisionele krag(te): -1
If force(s) do not make contact with body: -1 /
As krag(te) nie kontak met liggaam maak nie: -1

If a force diagram is given: **Max ¾**
*As 'n kragtediagram gegee word: **Maks ¾***

	Acceptable symbols		***Aanvaarbare simbole***
N	F_N / Normal / Normal force	N	*F_N / Normaal / Normaalkrag*
T	Tension / F_{rope}	T	*Spanning / F_{tou}*
f_k	f / friction / frictional force	f_k	*f / Wrywing / Wrywingskrag*
w	F_g / F_w / force of Earth on object / weight / mg / gravitational force	w	*F_g / F_w / krag van Aarde op voorwerp / gewig /mg / gravitasiekrag*
Numbers as labels are not accepted./*Getalle as byskrifte word nie aanvaar nie.*			

(4)

2.1.3

$F_{net} = ma$ ✓
8kg: $T + f_k = ma$
$T - 39,2$ ✓ $= 8a$

22kg: $T + F_g = ma$
$-T + (22)(9,8)$ ✓ $= 22a$ ✓

$a = 5,88\ m.s^{-2}$ ✓

(5)

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2.1.4 **Positive marking from 2.1.3 / *Positiewe nasien van 2.1.3***

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Option 1: /*Opsie 1:*	**Option 2: /*Opsie 2:***
(22)(9,8) -T = 22 (5,88) ✓ T = 86,24 ✓ T = 86,24 N; up✓	T – 39,2 = 8 (5,88) ✓ T = 86,24 ✓ T = 86,24 N; up✓

(3)

2.1.5 The force that opposes the motion of an object ✓and which acts parallel to the surface ✓/ *Die krag wat die beweging van 'n voorwerp teenwerk en wat parallel met die oppervlak inwerk.* (2)

2.1.6 **OPTION 1/*OPSIE 1***

$w_{//}$ = w sin θ
= 8 (9,8) sin 30° ✓
= 39,20 N

F_s^{max} = μ_sN✓
= 0,53 (8)(9,8) cos 30°✓
= 35,99 N

$w_{//} > f_s^{max}$ ✓ ; velocity increases down slope ✓
snelheid neem toe teen helling af

OPTION 2/*OPSIE 2*

+ ↙ F_{net} = ma ✓
$f + w_{//}$ = ma
-(0,53)(8)(9,8)cos30° + (8)(9,8)sin30° = 8a
✓ ✓
a = 0,40 m·s^{-2}
a > 0 ✓ ; velocity increases down slope ✓
snelheid neem toe teen helling af

OPTIONS 1-3
Correct for the last mark
Object accelerates down slope ✓

OPSIES 1-3
Korrek vir die laaste punt:
Voorwerp versnel teen helling af

OPTION 3/*OPSIE 3*

+ ↗ F_{net} = ma ✓
$f + w_{//}$ = ma
(0,53)(8)(9,8)cos30° - (8)(9,8)sin30° = 8a
✓ ✓
a = -0,40 m·s^{-2}
a < 0✓ ; velocity increases down slope ✓
snelheid neem toe teen helling af

(5)

2.2.1 w = mg ✓
= (11 600)(9,8) ✓
= 1,14 x 10^5 N ✓ (113680N)

(3)

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2.2.2

$$F = \frac{Gm_1m_2}{d^2} \checkmark$$

$$= \frac{(6{,}67 \times 10^{-11})(11\,600)(5{,}98 \times 10^{24})}{(596 \times 10^3 + 6{,}38 \times 10^6)^2} \checkmark \checkmark$$

$$= 9{,}51 \times 10^4 \text{ N} \checkmark$$

$$g = \frac{GM}{r^2}$$

$$= \frac{(6{,}67x10^{-11}x5{,}98x10^{24})}{(596x10^3 + 6{,}38x10^6)^2} \checkmark \checkmark$$

$$= 8{,}196\ m \cdot s^{-2}$$

$$w = mg \checkmark$$

$$= 11\,6000\ x\ 8{,}196 \checkmark$$

$$= 9{,}51\ x10^4 N \checkmark$$

(5)
[30]

QUESTION 3 / VRAAG 3

3.1 The product of the resultant / net force acting on an object and the time the resultant / net force acts on the object. ✓✓ / *Die produk van die resulterende/netto krag wat op 'n voorwerp inwerk en die tyd wat die resulterende/netto krag op die voorwerp inwerk.* (2)

3.2

Down +

$$F_{net}\Delta t = m(v_f - v_i)$$
$$(F_{roof} + w)\Delta t = m(v_f - v_i) \quad \checkmark$$

$$\underbrace{\left[-0{,}9 + \frac{0{,}03}{1\,000}(9{,}8)\right]}_{\checkmark}\Delta t = \underbrace{\frac{0{,}03}{1\,000}}_{\checkmark}(0 - 15) \checkmark$$

$$\Delta t = 5{,}00x10^{-4}s \checkmark$$

(5)

3.3. Greater than. ✓ / *Groter as*

According to the equation $F_{net} = \frac{\Delta p}{\Delta t}$ ✓
If Δt remains constant, then F_{net} is directly proportional to Δp. ✓
The Δp of the hailstone is greater than that of the raindrop✓ therefore the F_{net} of the hailstone is also greater.
Volgens die vergelyking $F_{net} = \frac{\Delta p}{\Delta t}$
As Δt konstant bly, is F_{net} *direk eweredig aan Δp.*
Die Δp van die haelkorrel is groter as dié van die reëndruppel, daarom is F_{net} *van die haelkorrel ook groter.* (4)
[11]

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QUESTION 4 / *VRAAG 4*

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4.1 An object upon which the only force acting is the force of gravity. ✓✓
'n Voorwerp waarop die enigste krag wat daarop inwerk swaartekrag is. (2)

4.2 9,8 $m.s^{-2}$ ✓ down / *af* ✓ (2)

4.3

OPTION 1: UP: +/ ***OPSIE 1: OP: +***	**OPTION 2: DOWN: +** ***OPSIE 2: AF: +***
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
21 ✓ $= v_i(3,1) + \frac{1}{2}(-9,8)(3,1)^2$ ✓	-21 ✓ $= v_i(3,1) + \frac{1}{2}(9,8)(3,1)^2$ ✓
$v_i = 21,96\ m.s^{-1}$ Speed/*Spoed* $= 21,96\ m.s^{-1}$ ✓	$v_i = -21,96\ m.s^{-1}$ Speed/*Spoed* $= 21,96\ m.s^{-1}$ ✓

(4)

4.4 **Positive marking from 4.3 / *Positiewe nasien van 4.3***

Option 1: Up: + / ***Opsie 1: Op: +***	**Option 2: Up: + / *Opsie 2: Op: +***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0 = 21,96^2 + 2(-9,8)\Delta y}$ ✓ $\Delta y = 24,6$ m Max height / *Maksimum hoogte* $= 24,6 + \underline{0,6}$ ✓ $= 25,2$ m ✓ **OR / *OF*** **Down / *Af*:+** $v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0 = -(21,96)^2 + 2(9,8)\Delta y}$ ✓ $\Delta y = 24,6$ m Max height / *Maksimum hoogte* $= 24,6 + \underline{0,6}$ ✓ $= 25,2$ m ✓	$v_f = v_i + a\Delta t$ $0 = 21,96 + (-9,8)\Delta t$ ✓ $\Delta t = 2,24$ s $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ $= \underline{(21,96)(2,24) + \frac{1}{2}(-9,8)(2,24)^2}$ ✓ $= 24,6$ m Max height / *Maksimum hoogte* $= 24,6 + 0,6$ ✓ $= 25,2$ m(25,17 m) ✓ **OR / *OF*** **Down / *Af*:: +** $v_f = v_i + a\Delta t$ $0 = -21,96 + (9,8)\Delta t$ ✓ $\Delta t = 2,24$ s $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ $= (-21,96)(2,24) + \frac{1}{2}(9,8)(2,24)^2$ ✓ $= -24,6$ m Max height / *Maksimum hoogte* $=24,6+ \underline{0,6}$ ✓ $= 25,2$ m(25,17 m) ✓

(4)

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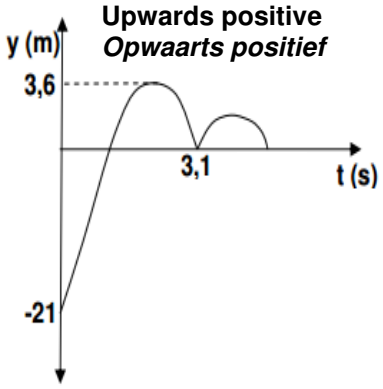
4.5 Inelastic. ✓

The maximum height reached after the bounce is less than the maximum height reached before the bounce. ✓ /
Onelasties.

Die maksimum hoogte wat bereik word na die bons is minder as die maksimum hoogte wat bereik is voor die bons. (2)

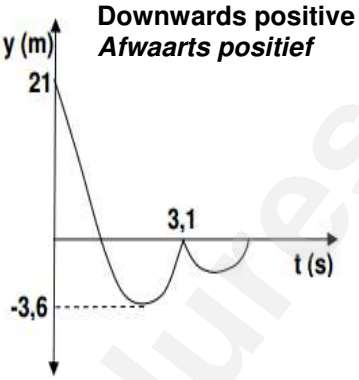
4.6 **Positive marking from 4.4 / *Positiewe nasien van 4.4***

OPTION 1/OPSIE 1



CRITERIA FOR MARKING / *KRITERIA VIR NASIEN*	
Graph starts at -21 m at t = 0 s *Grafiek begin by -21 m by t = 0 s*	✓
Correct shape as shown up to t = 3,1 s / *Korrekte vorm soos aangetoon tot t = 3,1 s*	✓
Maximum height = 3,6 m [(Answer of h in Q 4.4) – 21,6] / *Maksimum hoogte = 3,6 m* *[(Antwoord van h in V 4.4) – 21,6]*	✓
Time of bounce as t = 3,1 s / *Tyd van wip as t = 3,1 s*	✓
Correct shape for second part from t > 3,1 s *Korrekte vorm vir tweede deel van t > 3,1 s*	✓

Option 2 / *Opsie 2*



CRITERIA FOR MARKING / *KRITERIA VIR NASIEN*	
Graph starts at 21 m at t = 0 s *Grafiek begin by 21 m by t = 0 s*	✓
Correct shape as shown up to t = 3,1 s / *Korrekte vorm soos aangetoon tot t = 3,1 s*	✓
Maximum height = 3,6 m [(Answer of h in Q 4.4) + 21,6] / *Maksimum hoogte = 3,6 m* *[(Antwoord van h in V 4.4) + 21,6]*	✓
Time of bounce as t = 3,1 s / *Tyd van wip as t = 3,1 s*	✓
Correct shape for second part from t > 3,1 s *Korrekte vorm vir tweede deel van t > 3,1 s*	✓

(5)
[19]

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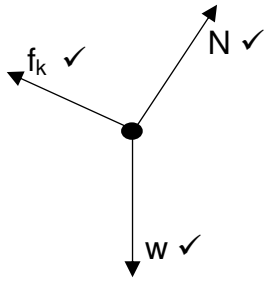
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QUESTION 5 / *VRAAG 5*

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5.1.1 The total / net work done on an object is equal to the change in the object's kinetic energy. ✓✓ / *Die netto/totale arbeid verrig op 'n voorwerp is gelyk aan die verandering in kinetiese energie van die voorwerp.* (2)

5.1.2



Each arrow plus label: One mark except for components / *Elke pyl plus byskrif: Een punt behalwe komponente* Any other additional force(s): -1 / *Enige ander addisionele krag (te): -1* If force(s) do not make contact with body: -1 / *As krag (e) nie kontak met liggaam maak nie: -1*
If a force diagram is given: **Max ⅔** *As 'n kragtediagram gegee word:* ***Maks ⅔***

5.1.2

	Acceptable symbols		**Aanvaarbare simbole**
N	F_N / Normal / Normal force	N	F_N / Normaal / Normaalkrag
f_k	Kinetic frictional force	f_k	Kinetiese wrywingskrag
w	F_g / F_w / force of Earth on object / weight / mg / gravitational force	w	F_g / F_w / krag van Aarde op voorwerp / gewig /mg / gravitasiekrag
Numbers as labels are not accepted./*Getalle as byskrifte word nie aanvaar nie.*			

(3)

5.1.3 weight / gravitational force ✓/ *gewig / gravitasie krag* (1)

5.1.4 No. ✓

The normal force is perpendicular to the motion of the skier. ✓/

Nee.

Die normale krag is loodreg op die beweging van die skiër. (2)

5.1.5 Not an isolated system/friction/non-conservative force present/ $F_{nc} > 0$. ✓/ *Dit is nie 'n geïsoleerde stelsel nie / wrywing/ Nie-konservatiewe krag is teenwoordig/* $F_{nc} > 0$. (1)

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5.1.6

$W_{net} = \Delta E_k$ ✓

$W_{fk} + W_{wx} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$\underset{\checkmark}{(70)(57)\cos 180^o} + \underset{\checkmark}{(58)(9,8)\sin 25^o} \times \underset{\checkmark}{(57)\cos 0^o} = \underset{\checkmark}{(0,5)(58)v_f^2 - (0,5)(58)(3,6)^2}$

$9702,32 = (29)v_f^2 - 376,84$

$v_f = 18,64\ m.s^{-1}$ ✓

May be used./*Mag gebruik word.*
$W_{nc} = \Delta K + \Delta U$

(6)

5.1.7 **Positive marking from 5.1.6 / *Positiewe nasien van 5.1.6***

Option 1 / *Opsie 1*

$W_{net} = F_{net}\Delta x\cos\theta$
$W_{net} = ma\Delta x\cos\theta$ ✓ Any one/ *Enige een*

$9702,32$ ✓ $= 58a(57)\cos 0°$ ✓

$a = 2,93\ m.s^{-2}$ ✓

Option 2 / *Opsie 2*

+ ↘ $F_{net} = ma$ ✓
$w_{//} + F = ma$

$(58)(9,8)\sin 25° + (-70)$ ✓ $= 58a$ ✓

$a = 2,93\ m\cdot s^{-1}$ ✓

(4)

5.2

Option 1/*Opsie 1:*

$W_{nc} = \Delta E_k + \Delta E_p$

$= \underset{\checkmark}{0 + (600)(9,8)}\ \underset{\checkmark}{(50) - 0}$

$= 294\ 000\ J$

$P = \frac{W}{\Delta t}$ ✓ $= \frac{294\ 000}{60}$ ✓

$= 4\ 900\ W$ ✓

Option 2: / *Opsie 2:*

$P = \frac{W}{\Delta t}$ ✓ $= \frac{(600)(9,8)\checkmark(50)\checkmark}{60}$ ✓

$= 4\ 900\ W$ ✓

Omission of zeros in correct formula is not penalised.
Weglating van nulle in korrekte formule word nie gepenaliseer nie.

(5)
[24]

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QUESTION 6 / *VRAAG 6*

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6.1 The change in frequency (pitch) of the sound detected by a listener ✓ because the sound source and listener have different velocities relative to the medium of sound propagation. ✓ /
Die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium het waarin die klank voortgeplant word. (2)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ ✓ $= \frac{343 \times 415}{343 - 44,7}$ ✓ $= 477,19$ Hz

$v = f\lambda$ ✓
$343 = 477,19\ \lambda$ ✓
$\lambda = 0,72$ m ✓

(6)

6.3 The spectral lines of the star are/should be shifted towards the higher frequency ✓ end, which is the blue end (blue shift) of the spectrum. ✓ /
Die spektrale lyne van die ster verskuif na die hoër frekwensie gedeelte wat die blou gedeelte van die spektrum is en word blouverskuiwing genoem. (2)
[10]

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QUESTION 7 / *VRAAG 7*

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7.1 The electrostatic force experienced per unit positive charge placed at that point. ✓✓/ *Die elektrostatiese krag wat per eenheidspositiewe-lading wat by daardie punt geplaas is, ondervind word.* (2)

7.2 $E = \frac{kQ_s}{r^2}$ ✓ $= \frac{9 \times 10^9 \times 4 \times 10^{-9}}{(15 \times 10^{-3})^2}$ ✓ $= 1{,}6 \times 10^5$ N·C^{-1} ✓ right/regs ✓

(5)

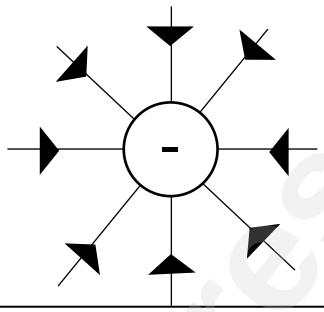
7.3 **Positive marking from 7.2/ *Positiewe nasien van 7.2***
Right + / *Regs +*

$E_{net} = E_s + E_T$
$2{,}0 \times 10^5$ ✓ $= 1{,}6 \times 10^5 + E_T$ ✓
$E_T = 4{,}0 \times 10^4$ N.C^{-1}
$E = \frac{kQ_s}{r^2}$
4×10^4 ✓ $= \frac{(9 \times 10^9)\, Q_T}{(45 \times 10^{-3})^2}$ ✓
$Q_T = 9{,}0 \times 10^{-9}$ C ✓

(6)

7.4 negative /*negatief* ✓ (1)

7.5



Criteria / *Kriteria*	**Marks *Punte***
Correct shape / *Korrekte vorm*	✓
Correct direction / *Korrekte rigting*	✓
Field lines not touching each other/ *Veldlyne raak nie aan mekaar nie*	✓

(3)

7.6 $E = \frac{F}{Q}$ ✓
$2{,}0 \times 10^5$ ✓ $= \frac{F}{1{,}6 \times 10^{-19}}$ ✓
$F = 3{,}2 \times 10^{-14}$ N ✓

(4)
[21]

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QUESTION 8 / *VRAAG 8*

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8.1 The potential difference across a conductor is directly proportional to the current in the conductor ✓ at constant temperature. ✓ / *Die potensiaalverskil oor 'n geleier is direk eweredig aan die stroom in die geleier by konstante temperatuur.* (2)

8.2

Option 1 / *Opsie 1*
$V_{6\Omega} = IR_{6\Omega}$ ✓ = (0,6)(6) ✓ = 3,6 V
$I = \frac{V}{R}$
$I_{4\Omega} = \frac{3,6}{4}$ ✓
= 0,9 A ✓

Option 2: / *Opsie 2:*
$V_{4\Omega} = V_{6\Omega}$ ✓
$IR_{4\Omega} = IR_{6\Omega}$
$I_{4\Omega}$ x 4 ✓ = (0,6)(6) ✓
$\therefore I_{4\Omega} = 0,9$ A ✓

Option 3: / *Opsie 3:*
$R_{4\Omega} : R_{6\Omega} = 4 : 6$ ✓
$I_{4\Omega} : I_{6\Omega} = 3 : 2$ ✓
$I_{4\Omega} : 0,6 = 3 : 2$ ✓
$I_{4\Omega} = 0,9$ A ✓

(4)

8.3 **Positive marking from 8.2 / *Positiewe nasien van 8.2***

$I_{total/\ totaal}$ = 0,6 + 0,9 ✓ = 1,5 A ✓

(2)

8.4 **Positive marking from 8.2 and 8.3 / *Positiewe nasien van 8.2 en 8.3***

$V_x = 6 - 3,6$ ✓
= 2,4 V

$V = IR_X$
$2,4 = 1,5\ R_x$ ✓
R_x = 1,6 Ω ✓

(3)

8.5 The 4Ω resistor. ✓ (-)

According to the equation $P = \frac{V^2}{R}$ ✓
If V is the same, then P is inversely proportional to R. ✓
$R_4 < R_6$ ✓

Die 4Ω resistor. (-)

Volgens die vergelyking $P = \frac{V^2}{R}$ ✓
As V dieselfde bly, dan is P omgekeerd eweredig aan R.✓
$R_4 < R_6$ ✓

(4)
[15]

GRAND TOTAL/GROOTTOTAAL: [150]

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FREE STATE PROVINCE

EXAMINATION / EKSAMEN

GRADE 12 / *GRAAD 12*

PHYSICAL SCIENCES PAPER 2
FISIESE WETENSKAPPE VRAESTEL 1

MEMORANDUM

JUNE 2018 / *JUNIE 2018*

MARKS: 150 / *PUNTE*: 150

TIME: 3 HOURS / *TYD: 3 UUR*

This memorandum consists of 14 pages.
Hierdie memorandum bestaan uit 14 bladsye.

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QUESTION 1 / *VRAAG 1*

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1.1 A ✓✓ (2)

1.2 D ✓✓ (2)

1.3 B ✓✓ (2)

1.4 D ✓✓ (2)

1.5 C ✓✓ (2)

1.6 D ✓✓ (2)

1.7 A ✓✓ (2)

1.8 D ✓✓ (2)

1.9 C ✓✓ (2)

1.10 D ✓✓ (2)

[20]

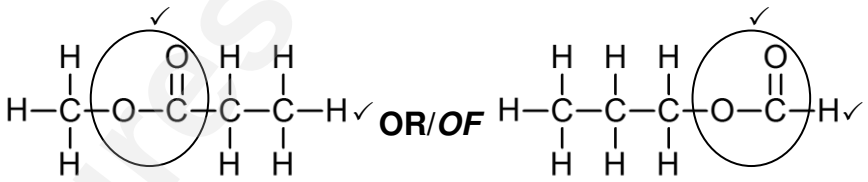
QUESTION 2 / *VRAAG 2*

2.1

2.1.1 Not all (of the ethanoic acid) will react ✓
Nie alles (etanoësuur) sal reageer nie✓ (1)

2.1.2 Esters ✓ (1)

2.1.3



Methyl propanoate ✓✓
Metielpropanoaat✓✓

Propyl methanoate ✓✓
Propielmetanoaat ✓✓ (4)

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2.1.4

OPTION 1

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$n(ethanol)_{used} = \frac{2,3}{46}$ ✓
n(etano)l$_{gebruik}$
$= 0,05$ mol

n(etieletanoaat) = n(etanol)
n(ethyl ethanoate) = n(ethanol) ✓
$= 0,05$ mol

$n(\text{ethyl ethanoate})_{produced} = \frac{2,6}{88}$ ✓
$n(\text{etieletanoaat})_{gevorm}$
$= 0,0295$ mol

$$\% \text{ yield} = \frac{\text{Actual mol}}{\text{Theoretical mol}} \times 100$$
$$= \frac{0,0295}{0,05} \times 100 \checkmark$$
$$= 59\ \% \checkmark$$

$$\% \, opbreng = \frac{Werklike\ mol}{Teoretiese\ mol}$$

Marking criteria:
- Use M = 46 g·mol^{-1} to calculate $n(ethanol)_{used}$ ✓
- Use mol ratio n(ethanol):n(ethyl ethanoate) = 1:1 ✓
- Use M = 88 g·mol^{-1} to calculate $n(\text{ethyl ethanoate})_{produced}$ ✓
- $\frac{\text{Actual yield/mol}}{\text{Theoretical yield/mol}} \times 100$ ✓
- Final answer: 59 % ✓
  Range: 59 % to 60 %

Nasienkriteria:
- Gebruik M = 46 g·mol^{-1} en bereken $n(ethanol)_{gebruik}$ ✓
- Gebruik mol ratio n(etanol):n(etieletanoaat) = 1:1 ✓
- Gebruik M = 88 g·mol^{-1} en bereken $n(\text{etieletanoaat})_{gevorm}$ ✓
- $\frac{Werklike\ opbrengs/mol}{Teoretiese\ opbrengs/mol} x100$ ✓
- Finale antwoord: 59 % ✓
  Aanvaar: 59 % tot 60 %

OPTION 2

46 g ✓ ethanol forms 88 g ✓ ethyl ethanoate
2,3 g ✓ ethanol forms x g ethyl ethanoate
x = 4,4 g

46 g ✓ etanol vorm 88 g ✓ etieletanoaat
2,3 g ✓ etanol vorm x g etieletanoaat
x = 4,4 g

$$\%\text{yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}}$$
$$= \frac{2,6}{4,4} \times 100\% \checkmark$$
$$= 59,09\ \% \checkmark$$

(5)

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2.2.1 A bond or an atom or a group of atoms ✓ that determine(s) the physical and chemical properties ✓ of a group of organic compounds / *'n Binding of 'n atoom of 'n groep atome* ✓ *wat die fisiese en chemiese eienskappe* ✓ *van 'n groep organiese verbindings bepaal* (2)

2.2.2 C_nH_{2n} ✓ (1)

2.2.3 3-ethyl-2,4-dimethylhex-3-ene / *3-etiel-2,4-dimetielheks-3-een*
OR/***OF*** 3-ethyl-2,4-dimethyl-3-hexene / *3-etiel-2,4-dimetiel-3-hekseen*

Marking criteria/***Nasienkriteria*:**
- Correct stem i.e. hex-3-ene. / *Stam korrek heks-3-een*✓
- All substituents (ethyl and dimethyl) correctly identified. / *Alle substituente korrek geidentifiseer (etiel en dimetiel)*✓
- Substituents correctly numbered, in alphabetical order, hyphens and commas correctly used./ *Substituente korrek genommer, alfabeties en skryftekens korrek gebruik* ✓

(3)

2.2.4 Carbonyl (group) ✓ / *karboniel (groep)* ✓ (1)

2.2.5 4-methyl✓pentan-2-one✓ / 4-metiel ✓pentan-2-oon✓
OR/***OF*** 4-methyl-2-pentanone / 4-metiel-2-pentanoon (2)
[20]

QUESTION 3 / *VRAAG 3*

3.1 Compounds with the same molecular formula ✓but different structural formulae ✓/ *Verbindings met dieselfde molekulêre formule*✓ *maar verskillende struktuurformules* ✓ (2)

3.2 Chain (isomers) ✓ / *Ketting (isomere)* ✓ (1)

3.3 **For A**/***Vir A*:**
- **Structure**/***Struktuur*:**
  No branching. ✓
  Geen vertakking ✓
- **Intermolecular forces**/***Intermolekulêre kragte*:**
  Stronger / more intermolecular forces / Van der Waals forces / London forces / dispersion forces. ✓
  Sterker / meer intermolekulêre kragte / Van der Waalskragte / Londonkragte / Dispersiekragte ✓
- **Energy**/***Energie*:**
  More energy needed to overcome / break intermolecular forces / Van der Waals forces / London forces / induced dipole forces / dispersion forces. ✓
  Meer energie benodig om intermolekulêre kragte/Van der Waalskragte/ Londonkragte/geïnduseerde dipoolkragte/dispersiekragte te breek/oorkom ✓

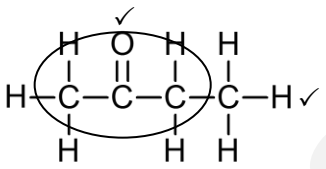
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From A to B/*Van A na B*:

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- **Structure/*Struktuur*:**
  Increase in branching. ✓/ *Meer sytakke*✓
- **Intermolecular forces/*Intermolekulêre kragte*:**
  Weaker / less intermolecular forces / Van der Waals forces / London forces / dispersion forces. ✓/ *Swakker intermolekulêre kragte/ van der Waalskragte/ Londonkragte/ Dispersiekragte*✓
- **Energy/*Energie*:**
  Less energy needed to overcome / break intermolecular forces / Van der Waals forces / London forces / induced dipole forces / dispersion forces. ✓
  Minder energie benodig om intermolekulêre kragte/Van der Waalskragte/ Londonkragte/geïnduseerde dipoolkragte/dispersiekragte te breek/oorkom ✓ (3)

3.4



(4)

butan-2-one ✓✓ *butan-2-oon*✓✓

3.5 118 °C ✓ (1)

3.6

- Between molecules of **A** / butanal / aldehydes are dipole-dipole forces ✓ in addition to London forces / induced dipole forces / dispersion forces./ *Tussen die molekule van **A** / butanal / aldehiede is dipool-dipoolkragte*✓ *benewens die Londonkragte / geïnduseerde dipoolkragte / dispersiekragte.*
- Between molecules of **C** / butan-1-ol / alcohols are hydrogen bonds ✓ in addition to London forces / induced dipole forces / dispersion forces and dipole-dipole forces./ Tussen die molekules van **C** / butan-1-ol / *alkohole is waterstofbindings*✓ *benewens Londonkragte / geïnduseerde dipoolkragte / dispersiekragte en dipool-dipool kragte.*
- Intermolecular forces in **A** are weaker ✓than those in **C**. */Intermolekulêre kragte in **A** is swakker* ✓ *as die in **C**.*
  OR/*OF*
  Intermolecular forces in **C** are stronger than those in **A**.
  Intermolekulêre kragte in **C** is sterker as die in **A**.
  OR/*OF*
  Less energy is needed to overcome / break intermolecular forces in **A**. / *Minder energie is nodig om intermolekulêre kragte in **A** te oorkom / breek.*
  OR/*OF*
  More energy is needed in **C** to break/overcome intermolecular forces. /*Meer energie is nodig in **C** om intermolekulêre kragte te breek / te oorkom.* (3)

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3.7.1 2-methyl✓propanal✓/ *2-metiel✓propanal✓* (2)

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3.7.2 butan-1-ol/ 1-butanol / *butan-1-ol / 1-butanol*

- butanol ✓
- 1 with correct hyphen(s) ✓/ *1 indien leestekens korrek*
- allocate mark for 1 only when butanol is correct / *slegs 1 punt as butanol korrek is*

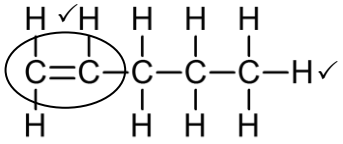
(2)
[18]

QUESTION 4 / *VRAAG 4*

4.1.1 Unsaturated ✓/ *Onversadig*✓

- Has a double/multiple bond (between C atoms) ✓/ *Het 'n dubbel/meervoudige binding (tussen C atome)* ✓ (2)

4.1.2



(2)

4.2.1 Primary ✓/ *Primêre*✓

- The carbon bonded to the -OH group is bonded to ONE other C atom ✓/ *Die koolstof gebind aan die –OH groep is gebind aan EEN ander C atoom*✓ (2)

4.2.2 Water/H_2O ✓ (1)

4.2.3 H_2SO_4 **OR/OF** H_3PO_4 ✓ (1)

4.3.1 Substitution ✓/ *Substitusie* ✓ (1)

4.3.2 1-bromo✓pentane ✓ / *1-bromo✓pentaan*✓ (2)

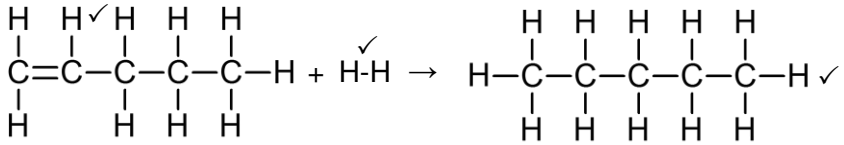
4.4.1 Hydration ✓ / *Hidrasie* ✓ (1)

4.4.2 Dehydrohalogenation/ dehydrobromination ✓
Dehidrohalogenasie/ dehidrobrominasie ✓ (1)

4.4.3 Hydrogenation ✓ / *Hidrogenasie*✓ (1)

4.5 Concentrated strong base/NaOH, KOH, LiOH ✓ Heat ✓
Gekonsentreerde sterk basis/NaOH, KOH, LiOH ✓ *Hitte*✓ (2)

4.6.1



(3)

4.6.2 Pentane ✓ / *Pentaan*✓ (1)
[20]

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QUESTION 5 / *VRAAG 5*

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5.1.1 Activated complex ✓ / *Geaktiveerde kompleks*✓

Accept / *Aanvaar*
Transition state/ *Oorgangsfase* (1)

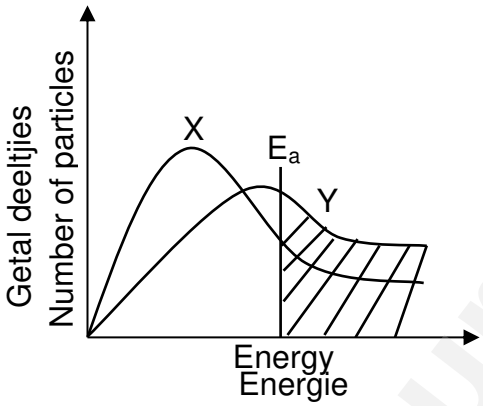
5.1.2 -9,6 (kJ) ✓ (1)

5.1.3 Exothermic ✓ / *Eksotermies*✓

- It releases energy/energy of the products is less than that of the reactants/ΔH<0 ✓ / *Dit stel energie vry / die energie van die produkte is minder as die van die reagense*✓ (2)

5.1.4 Decrease ✓ *Verminder*✓ (1)

5.2.1



Marking criteria for Y:
- Lower peak ✓
- Peak shifted to right ✓
- More particles with sufficient kinetic energy ✓

Nasienkriteria vir Y:
- *Laer kruin* ✓
- *Kruin skuif regs* ✓
- *Meer deeltjies met genoeg kinetiese energie* ✓

(3)

5.2.2 Higher than ✓ / *Hoër as*✓ (1)

5.2.3 **At 400°C / *BY* 400°C:**
- (Average) kinetic energy of the particles is higher ✓
  (Gemiddelde) kinetiese energie van deeltjies is hoër✓
- More particles have sufficient kinetic energy./More particles have kinetic energy greater or equal to the activation energy ✓
  Meer deeltjies het genoeg kinetiese energie/ Meer deeltjies het kinetiese energie wat groter of gelyk aan die aktiveringsenergie is✓
- More effective collisions per unit time./Higher frequency of effective collisions ✓
  Meer effektiewe botsings per eenheidstyd/ Groter frekwensie van effektiewe botsings✓ (3)

[12]

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QUESTION 6 / *VRAAG 6*

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6.1 A substance that increases the rate of a chemical reaction without itself undergoing a permanent change ✓✓ (2 or 0)/
'n Stof wat die tempo van 'n chemiese reaksie verhoog sonder dat dit self 'n permanente verandering ondergaan ✓✓ (2 of 0) (2)

6.2.1 No ✓ / *Nee* ✓ (1)

6.2.2 0-20 s ✓

- high concentration (of H_2O_2/reactant) ✓ / *Hoë konsentrasie (van H_2O_2/reagens)* ✓ (2)

6.2.3

$n(H_2O_2) = cV$ ✓
$= 0,1 \times 20 \times 10^{-3}$ ✓
$= 2 \times 10^{-3}$ mol

$n(O_2) = \frac{1}{2} n(H_2O_2)$
$= \frac{1}{2} \times 2 \times 10^{-3}$ ✓
$= 1 \times 10^{-3}$ mol

$n = \frac{V}{V_m}$

$1 \times 10^{-3} = \frac{V}{24}$ ✓

$V = 0,024\ dm^3$ ✓

Criteria/ *Kriteria*:

- Formula/*Formule*: $n = cV$/ $n = \frac{V}{V_m}$ ✓
- Substitution of c and V ✓ / *Substitusie van c en V*
- Use/ *Gebruik*: mol ratio 1:2 ✓
- Substitution of/ *Substitusie van*: 24 in $n = \frac{V}{V_m}$ ✓

Final answer/ *Finale antwoord*: 0,024 dm^3 ✓

(5)

6.2.4 Ave rate/*Gem Tempo* $= \frac{\Delta V}{\Delta t}$

$= \frac{16 - 8}{20 - 10}$ ✓✓
$= 0,8\ (dm^3 \cdot s^{-1})$ ✓

Accept:

- Volume range 15 to 16 cm^3
- Answer range 0,7 to 0,8 $dm^3 \cdot s^{-1}$

Aanvaar:

- Volume 15 tot 16 cm^3
- Antwoord 0,7 tot 0,8 $dm^3 \cdot s^{-1}$

(3)

6.3.1 C ✓ (1)

6.3.2 B ✓

- Experiment **3** has a higher temperature ✓ / *Eksperiment 3 het 'n hoër temperatuur*✓
- Steeper gradient/ higher reaction rate ✓ / *Groter gradient / Hoër reaksietempo*✓ (3)

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6.4 Lower than ✓/ *Laer as*✓ (1)

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6.5 For experiment **2**/ *Vir eksperiment **2***

- Less particles (of H_2O_2) per unit volume ✓
  Minder deeltjies (H_2O_2) per eenheidsvolume✓
- Less effective collisions per unit time ✓
  Minder effektiewe botsings per eenheidstyd✓

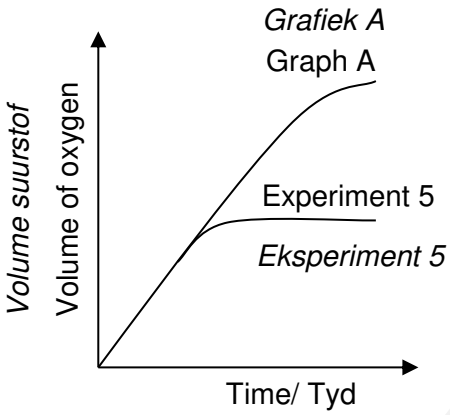
OR/OF

For experiment **1**/ *Vir eksperiment **1***

- More particles (of H_2O_2) per unit volume
  Meer deeltjies (H_2O_2) per eenheids volume
- More effective collisions per unit time
  Meer effektiewe botsings per eenheidstyd (2)

6.6 No effect ✓/ *Geen effek*✓ (1)

6.7



Marking criteria for graph of experiment 5:

- Same reaction rate as graph **A** ✓
- Ends below graph **A** ✓

Nasienkriteria:

- Selfde reaksietempo as grafiek A
- Eindig onder grafiek A

((2)

[23]

QUESTION 7 / *VRAAG 7*

7.1 When the equilibrium in a closed system is disturbed ✓, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓
Wanneer die ewewig in 'n geslote sisteem versteur word ✓, stel die sisteem 'n nuwe ewewig in deur die reaksie wat die versteuring teenwerk, te bevoordeel. ✓ (2)

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7.2.1

Marking criteria/ Nasienkriteria

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- Use/*Gebruik* M(ICℓ) = 162,5 g·mol^{-1} in n = $\frac{m}{M}$ ✓
- $n(IC\ell)_{change/verander} = n(IC\ell)_{initial/begin} - n(IC\ell)_{equilibrium/ewewig}$ ✓
- **USING** ratio/ **GEBRUIK** verhouding: $C\ell_2$:ICℓ = 1:1 ✓

OPTION 1:/OPSIE 1:

	ICℓ(ℓ)	$C\ell_2$(g)
Initial quantity (mol) *Beginhoeveelheid*	$\frac{32}{162,5} = 0,197$	
Change (mol) *Verandering*	✓ 0,1355 ✓	0,1355 ✓
Quantity at equilibrium (mol) / *Hoeveelheid by ewewig*	$\frac{10}{162,5} = 0,0615$	

OPSION 2/ OPSIE 2

$n(IC\ell)_{ini} = \frac{m}{M}$

$= \frac{32}{162,5}$ ✓

$= 0,197$ mol

$n(IC\ell)_{eqm/ewewig} = \frac{m}{M}$

$= \frac{10}{162,5}$

$= 0,0615$ mol

$n(IC\ell)_{change/verandering} = 0,197 - 0,0615$ ✓

$= 0,1355$ mol

$n(Cl_2)_{change/verandering} = n(IC\ell)_{change/verandering}$

$= 0,1355$ mol ✓ (3)

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7.2.2 **POSITIVE MARKING FROM QUESTION 7.2.1**
POSITIEWE NASIEN VANAF 7.2.1

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Marking criteria/Nasienkriteria:

(a) Correct K_C expression (formulae in square brackets). ✓
Kc-uitdrukking reg (formule in vierkantige hakies)

(b) Substitution of K_C value. ✓/ *Substitusie van Kc-waarde*

(c) Multiply by 2 dm^3. ✓/ *Vermenigvuldig met 2 dm^3*

(d) Initial $n(C\ell_2)$ = equilibrium $n(C\ell_2)$ + change in $n(C\ell_2)$ ✓
Aanvanklike $n(C\ell_2)$ = ewewig $n(C\ell_2)$ + verandering in $n(C\ell_2)$

(e) $\frac{n(C\ell_2)_{change/verandering}}{n(C\ell_2)_{ini/\,aanv}}$ ✓

(f) Final answer/*Finale antwoord*: 83,18% - 87,5% ✓

OPTION 1/OPSIE 1:

$$K_C = \frac{1}{[C\lambda_2]} \checkmark$$

$$73 \checkmark = \frac{1}{[C\lambda_2]}$$

$$[C\ell_2] = 0{,}0137 \text{ mol·dm}^{-3}$$

$$n(C\ell_2)_{eqm} = 0{,}0137 \times 2 \checkmark = 0{,}0274 \text{ mol}$$

$$n(C\ell_2)_{ini} = 0{,}0274 + 0{,}1355 \checkmark = 0{,}1629 \text{ mol}$$

$$\%(C\ell_2)_{used} = \frac{0{,}1355}{0{,}1629} \times 100 \checkmark = 83{,}18\ \% \checkmark$$

OPTION 2/OPSIE 2:

$$K_C = \frac{1}{[C\lambda_2]} \checkmark$$

$$73 \checkmark = \frac{1}{[C\lambda_2]}$$

$$[C\ell_2] = 0{,}0137 \text{ mol·dm}^{-3}$$

$$m(Cl_2)_{change} = 0{,}1355 \times 35{,}5 \times 2 = 9{,}6205 \text{ g}$$

$$n(C\ell_2)_{eqm} = 0{,}0137 \times 2 \checkmark = 0{,}0274 \text{ mol}$$

$$n(C\ell_2)_{ini} = 0{,}0274 + 0{,}1355 \checkmark = 0{,}1629 \text{ mol}$$

$$m(C\ell_2)_{ini} = 0{,}1629 \times 35{,}5 \times 2 = 11{,}5659 \text{ g}$$

$$\%(C\ell_2)_{used} = \frac{9{,}6205}{11{,}5659} \times 100 \checkmark = 83{,}18\ \% \checkmark$$

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Marking criteria:

(a) Correct K_C expression (formulae in square brackets). ✓
Kc-uitdrukking reg (formule in vierkantige hakies)
(b) Substitution of K_C value. ✓ *Substitusie van K- waarde*
(c) Multiply by 2 dm^3. ✓ /*Vermenigvuldig met 2 dm^3*
(d) Initial $n(C\ell_2)$ = equilibrium $n(C\ell_2)$ + change in $n(C\ell_2)$ ✓
Begin $n(C\ell_2)$ = ewewig $n(C\ell_2)$ + verandering in $n(C\ell_2)$
(e) 100 - equilibrium percentage ($C\ell_2$) ✓
100- *ewewigspersentasie* ($C\ell_2$)
(f) Final answer/*Finale antwoord*: 83,18% - 87,5% ✓

OPTION 3/OPSIE 3:

$$K_C = \frac{1}{[C\lambda_2]}\checkmark$$

$$73\ \checkmark = \frac{1}{[C\lambda_2]}$$

$$[C\ell_2] = 0{,}0137\ \text{mol·dm}^{-3}$$

$$n(C\ell_2)_{eqm} = 0{,}0137 \times 2\ \checkmark = 0{,}0274\ \text{mol}$$

$$n(C\ell_2)_{ini} = 0{,}0274 + 0{,}1355\ \checkmark = 0{,}1629\ \text{mol}$$

$$\%(C\ell_2)_{eqm} = \frac{0{,}0274}{0{,}1629} \times 100 = 16{,}82\ \%$$

$$\%(C\ell_2)_{used} = 100 - 16{,}82\ \checkmark = 83{,}18\ \%\ \checkmark$$

OPTION 4/OPSIE 4:

$$K_C = \frac{1}{[C\lambda_2]}\checkmark$$

$$73\ \checkmark = \frac{1}{[C\lambda_2]}$$

$$[C\ell_2] = 0{,}0137\ \text{mol·dm}^{-3}$$

$$n(C\ell_2)_{eqm} = 0{,}0137 \times 2\ \checkmark = 0{,}0274\ \text{mol}$$

$$m(C\ell_2)_{eqm} = 0{,}0274 \times 35{,}5 \times 2 = 1{,}9545\ \text{g}$$

$$n(C\ell_2)_{ini} = 0{,}0274 + 0{,}1355\ \checkmark = 0{,}1629\ \text{mol}$$

$$m(C\ell_2)_{ini} = 0{,}1629 \times 35{,}5 \times 2 = 11{,}5659\ \text{g}$$

$$\%(C\ell_2)_{eqm} = \frac{1{,}9454}{11{,}5659} \times 100 = 16{,}82\ \%$$

$$\%(C\ell_2)_{used} = 100 - 16{,}82\ \checkmark = 83{,}18\ \%\ \checkmark$$

(6)

7.3 Exothermic ✓/ *Eksotermies*✓

(-)

- Increase in temperature favours an endothermic reaction ✓
  'n Toename in temperatuur bevoordeel die endotermiese reaksie✓
- The reverse reaction is favoured ✓
  Die terugwaartse reaksie word bevoordeel. ✓ (3)

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7.4 Increase in pressure results in an increase in the percentage of the product/ they are proportional to one another ✓ (Do not accept directly proportional)
- Increase in pressure favours the reaction that results in a decrease in number of moles ✓
- The forward reaction is favoured ✓

Toename in druk lei tot 'n toename in die persentasie van die produk / hulle is eweredig aan mekaar ✓ (moenie direk eweredig aanvaar nie)
• Toename in druk bevoordeel die reaksie wat tot 'n afname in aantal mol lei✓
• Die voorwaartse reaksie word bevoordeel ✓ (3)
[17]

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QUESTION 8 / *VRAAG 8*

8.1.1 Solution of accurately/exactly/precisely ✓ known concentration ✓
Oplossing met 'n bekende/akkurate ✓konsentrasie ✓ (2)

8.2.1 Pipette ✓/ *Pipet✓* (1)

8.2.2 Funnel ✓/ *Tregter✓* (1)

8.3 Any ONE of:
- You take the average of close results ✓
- The first volume is too far away from the others
- The first titration is the rough/approximate result/practice
- The first volume/titration is not accurate/not reliable /

Enige EEN van:
• Jy neem die gemiddeld van naaste resultate ✓
• Die eerste volume is te ver weg van die ander
• Die eerste titrasie is die rowwe / benaderde resultaat / oefening
• Die eerste volume / titrasie is nie akkuraat / nie betroubaar nie (1)

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8.4

OPTION 1:

$n(NaOH) = cV$ ✓

$= (0,2)(14,25 \times 10^{-3})$ ✓

$= 2,85 \times 10^{-3}$ mol

$n(H_2SO_4) = \frac{1}{2} \times n(NaOH)$

$= \frac{1}{2} \times 2,85 \times 10^{-3}$ ✓

$= 1,425 \times 10^{-3}$ mol

$c(H_2SO_4) = \frac{1,425 \times 10^{-3}}{25 \times 10^{-3}}$

$= 0,057$ mol·dm^{-3} ✓

Marking criteria:

(a) Formula: n = cV/ $\frac{n_a}{n_b} = \frac{c_a V_a}{c_b V_b}$ ✓

(b) Substitute 0,2 and 14,25 x 10^{-3}/ 14,25 ✓

(c) Use mol ratio 2:1 ✓

(d) Subtitute 25 x 10^{-3}/ 25 ✓

(e) Final answer: 0,057 mol·dm^{-3} ✓

Nasienkriteria:

(a) Formule: n = cV/ $\frac{n_s}{n_b} = \frac{c_s V_s}{c_b V_b}$ ✓

(b) Substitusie 0,2 en 14,25 x 10^{-3}/ 14,25 ✓

(c) Gebruik molverhouding 2:1 ✓

(d) Subtitusie 25 x 10^{-3}/ 25 ✓

(e) Finale antwoord: 0,057 mol·dm^{-3} ✓

OPTION 2:

$\frac{n_a}{n_b} = \frac{c_a V_a}{c_b V_b}$ ✓

$\frac{1}{2}$ ✓$= \frac{c_a \times 25}{0,2 \times 14,25}$ ✓

$c_a = 0,057$ mol · dm^{-3} ✓

(5)

8.5.1 It ionises completely ✓ in water ✓/*Dit ioniseer volledig*✓ *in water*✓ (2)

8.5.2 (a) H_2SO_4 ✓ (1)

(b) SO_4^{2-} ✓ (1)

8.5.3 Ampholyte ✓ / *Amfoliet*✓ (1)

8.5.4 H_2O/water ✓ (1)

8.6.1 A base is a substance that <u>produces hydroxide ions</u> ✓/OH^- <u>in water</u> ✓ /
'n Basis is 'n stof wat hidroksiedione / OH^-✓ *in water vrystel* ✓ (2)

8.6.2 $CaSO_4$ ✓ (1)

8.6.3 Water ✓ (1)

[20]

TOTAL/*TOTAAL*: 150

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NATIONAL SENIOR CERTIFICATE

GRADE/*GRAAD* 12

JUNE/*JUNIE* 2016

PHYSICAL SCIENCES P1
FISIESE WETENSKAPPE V1
MEMORANDUM

MARKS/*PUNTE*: **150**

This memorandum consists of 9 pages.
Hierdie memorandum bestaan uit 9 bladsye.

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QUESTION/*VRAAG* 1

1.1	**B**	1.2	**C**	1.3	**D**	1.4	**C**	1.5	**A**
1.6	**D**	1.7	**C**	1.8	**C**	1.9	**A**	1.10	**C**

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[20]

QUESTION/*VRAAG* 2

2.1	9,8 $m \cdot s^{-2}$ ✓ , downwards/*afwaarts* ✓	(2)
2.2	Yes/*Ja* ✓ Only gravitational force is acting on the ball/*Slegs gravitasiekrag word op die bal uitgeoefen.* ✓ OR/*OF* The ball is moving under the influence of its weight/*Die bal beweeg onder die invloed van sy gewig.* ✓	(2)
2.3	**Upwards +/*Opwaarts* +** **OPTION/*OPSIE* 1** $V_f^2 = V_i^2 + 2g\Delta y$ ✓ $= (-8)^2$ ✓ $+ \underline{2(-9,8)(-1,8)}$ ✓ $V_f = 9,96\ m \cdot s^{-1}$ ✓ **Downwards +/*Afwaarts* +** **OPTION/*OPSIE* 2** $V_f^2 = V_i^2 + 2g\Delta y$ ✓ $= (8)^2$ ✓ $+ \underline{2(9,8)(1,8)}$ ✓ $V_f = 9,96\ m \cdot s^{-1}$ ✓ **OPTION/*OPSIE* 3** $\Delta y = v_i\Delta t + \frac{1}{2} g\Delta t^2$ $\underline{1,8 = 8\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓ $\therefore \Delta t = 0,2$ s ✓ Both formulae/ *Beide formules* $V_f = V_i + g\Delta t$ $= \underline{8 + (9,8)(0,2)}$ ✓ $= 9,96\ m \cdot s^{-1}$ ✓ **OPTION/*OPSIE* 4** $E_{M\ (Top/Bo)} = E_{M\ (Floor/Vloer)}$ $(mgh+\frac{1}{2}mv^2)_{Top} = (mgh+\frac{1}{2}mv^2)_{Floor}$ ✓ $\underline{m(9,8)(1,8) + \frac{1}{2} m(8)^2}$ ✓$= \underline{0 + \frac{1}{2} mv^2}$ ✓ $17,64 + \frac{1}{2}(64) = \frac{1}{2} v^2$ $\therefore v = 9,96\ m \cdot s^{-1}$ ✓	(4)
2.4	**POSITIVE MARKING FROM/*POSITIEWE NASIEN VANAF VRAAG* 2.3** **OPTION/*OPSIE* 1** **Downwards +/*Afwaarts* +** $V_f = V_i + g\Delta t$ ✓ $\underline{9,96 = 8 + 9,8\Delta t}$ ✓ $\Delta t = 0,2$ s ✓ **Upwards +/*Opwaarts*+** $V_f = V_i + g\Delta t$ ✓ $\underline{-9,96 = -8 + (-9,8)\Delta t}$ ✓ $\Delta t = 0,2$ s ✓ **OPTION/*OPSIE* 2** **Downwards +/*Afwaarts* +** $\Delta y = v_i\Delta t + \frac{1}{2} g\Delta t^2$ ✓ $\underline{1,8 = 8\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓ $\therefore \Delta t = 0,2$ s ✓ **Upwards +/*Opwaarts*+** $\Delta y = v_i\Delta t + \frac{1}{2} g\Delta t^2$ ✓ $\underline{-1,8 = -8\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓ $\therefore \Delta t = 0,2$ s ✓ **OPTION/*OPSIE* 3** **Downwards +/*Afwaarts* +** $\Delta y = \frac{V_f + V_i}{2} \Delta t$ ✓ $1,8 = \frac{9,96+8}{2} \Delta t$ ✓ $\therefore \Delta t = 0,2$ s ✓ **OPTION/*OPSIE* 4** **Upwards +/*Opwaarts*+** $\Delta y = \frac{V_f + V_i}{2} \Delta t$ ✓ $-1,8 = \frac{-9,96+(-8)}{2} \Delta t$ ✓ $\therefore \Delta t = 0,2$ s ✓	(3)

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2.5 **POSITIVE MARKING FROM/*POSITIEWE NASIEN VANAF VRAAG* 2.3**

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OPTION/*OPSIE* 1

80% of/*van* 9,96 = 7,97 m·s^{-1}

Upwards +/*Opwaarts*+

$V_f^2 = V_i^2 + 2g\Delta y$ ✓

$0^2 = (7,97)^2$ ✓ + $2(-9,8)\ \Delta y$ ✓

∴ $\Delta y = 3,24$ m ✓

No, the ball will not reach the ceiling/ *Nee, die bal sal nie die plafon bereik nie.* ✓

Downwards +/*Afwaarts* +

$V_f^2 = V_i^2 + 2g\Delta y$ ✓

$0^2 = (-7,97)^2$ ✓ + $2(-9,8)\ \Delta y$ ✓

$\Delta y = -3,24$ m

∴ $\Delta y = 3,24$ m ✓

No, the ball will not reach the ceiling/ *Nee, die bal sal nie die plafon bereik nie.* ✓

OPTION/*OPSIE* 2

80% of/*van* 9,96 = 7,97 m·s^{-1}

Upwards +/*Opwaarts*+

$V_f = V_i + g\Delta t$

$0 = 7,97 + (-9,8)\ \Delta t$

$\Delta t = 0,81$ s ✓ Both formulae/ *Albei formules*

$\Delta y = v_i\Delta t + ½\ g\Delta t^2$

$= (7,97)(0,81)$ ✓ + ½ $(-9,8)(0,81)^2$ ✓

$= 3,24$ m ✓

No, the ball will not reach the ceiling/ *Nee, die bal sal nie die plafon bereik nie.* ✓

Downwards +/*Afwaarts* +

$V_f = V_i + g\Delta t$

$0 = -7,97 + (9,8)\ \Delta t$

$\Delta t = 0,81$ s ✓ Both Formulae/ *Albei formules*

$\Delta y = v_i\Delta t + ½\ g\Delta t^2$

$= (-7,97)(0,81)$ ✓ + ½ $(-9,8)(0,81)^2$ ✓

$= -3,24$ m

∴ $\Delta y = 3,24$ m ✓

No, the ball will not reach the ceiling/ *Nee, die bal sal nie die plafon bereik nie.* ✓

OPTION/*OPSIE* 3

80% of/*van* 9,96 = 7,97 m·s^{-1}

Upwards +/*Opwaarts*+

$V_f = V_i + g\Delta t$

$0 = 7,97 + (-9,8)\ \Delta t$

$\Delta t = 0,81$ s ✓ Both formulae/ *Albei formules*

$\Delta y = \frac{V_f + V_i}{2}\ \Delta t$

$= \frac{0+(7,97)}{2}$ ✓0,81 ✓

∴ $\Delta y = 3,23$ m ✓

No, the ball will not reach the ceiling/ *Nee, die bal sal nie die plafon bereik nie.* ✓

OPTION/*OPSIE* 4

80% of/*van* 9,96 = 7,97 m·s^{-1}

Downwards +/*Afwaarts* +

$V_f = V_i + g\Delta t$

$0 = -7,97 + (9,8)\ \Delta t$

$\Delta t = 0,81$ s ✓ Both formulae/ *Albei formules*

$\Delta y = \frac{V_f + V_i}{2}\ \Delta t$

$= \frac{0+(-7,97)}{2}$ ✓0,81 ✓

$= -3,23$ m

∴ $\Delta y = 3,23$ m ✓

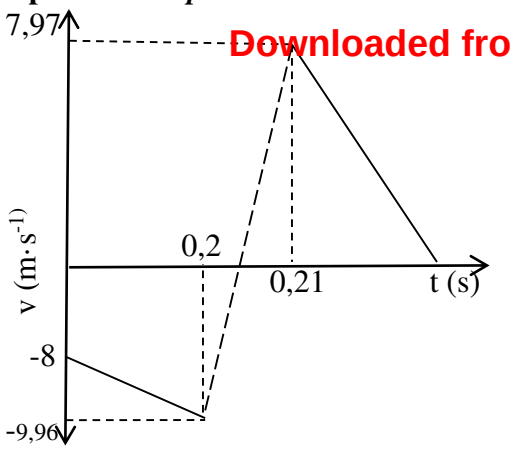
No, the ball will not reach the ceiling/ *Nee, die bal sal nie die plafon bereik nie.* ✓

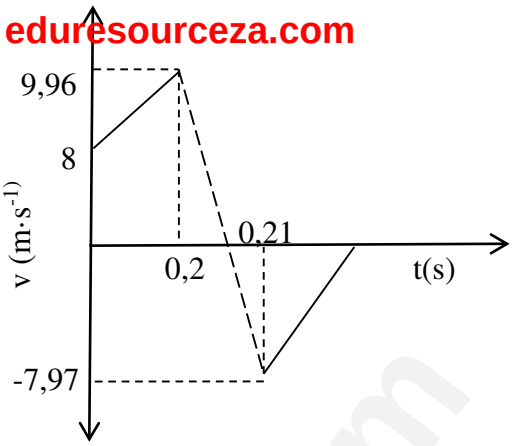
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2.6

Upwards +/*Opwaarts+*





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Upwards as positive/*Opwaarts as positief*

Marking guidelines/*Nasienriglyne*	Marks/*Punte*
Initial v at -8 m.s-1/*Beginsnelheid by -8m.s^{-1}*	✓
Positive marking from/*Positiewe nasien vanaf* 2.3 & 2.4 Time and velocity shown with which ball hits the floor/ Velocity (-9,96 m.s^{-1}) and time (0,2 s) with which ball hits the floor. Snelheid (-9,96 m.s^{-1}) en tyd (0,2 s) waarmee die bal die vloer tref.	✓
Positive marking from/*Positiewe nasien vanaf* 2.3 & 2.4 Time and velocity shown with which ball leaves the floor/ Velocity (7,97 m.s^{-1}) and time (0,21 s) with which ball leaves the floor./*Snelheid (7,97 m.s^{-1}) en tyd (0,21 s) waarmee die bal die verlaat.*	✓
Two parallel lines ending at v = 0 m.s^{-1} on t-axis./ *Twee parallel lyne wat eindig by v = 0 m.s^{-1} op t-as.*	✓

Upwards as positive/*Opwaarts as positief*

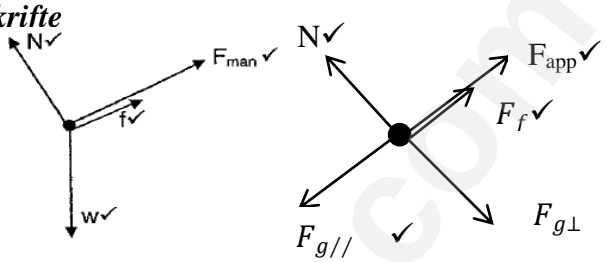
Marking guidelines/*Nasienriglyne*	Marks/*Punte*
Initial v at 8 m.s-1/*Beginsnelheid by 8m.s^{-1}*	✓
Positive marking from/*Positiewe nasien vanaf* 2.3 & 2.4 Time and velocity shown with which ball hits the floor/ Velocity (9,96 m.s^{-1}) and time (0,2 s) with which ball hits the floor. *Snelheid* (9,96 m.s^{-1}) *en tyd (0,2 s) waarmee die bal die vloer tref.*	✓
Positive marking from/*Positiewe nasien vanaf* 2.3 & 2.4 Time and velocity shown with which ball leaves the floor/ Velocity (-7,97 m.s^{-1}) and time (0,21 s) with which ball leaves the floor. *Snelheid* (-7,97 m.s^{-1}) *en tyd* (0,21 s)*waarmee die bal die verlaat.*	✓
Two parallel lines ending at v = 0 m.s^{-1} on t-axis./ *Twee parallel lyne wat eindig by v = 0 m.s^{-1} op t-as.*	✓

(4)

[20]

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QUESTION/*VRAAG* 3

3.1	A force for which the net work done in any closed path is dependent on the path the object travelled/*Die krag waarvoor die arbeid verrig word om 'n voorwerp tussen twee punte te beweeg, afhanklik is van die roete wat gevolg word.* ✓✓	(2)
3.2	$F_k = \mu_k N = 0,22 \times 86 \times 9,8 \text{ Cos } 25°$✓ = 168,04 N ✓	(2)
3.3	The net work done on the object is equal ✓to the change in the object's kinetic energy/*Die netto/totale arbeid verrig op 'n voorwerp is gelyk aan die verandering in die kinetiese energie van die voowerp.* ✓ OR/*OF* The work done on an object by a resultant/net force is equal ✓to the change in the object's kinetic energy/ *Die energie van 'n voorwerp deur 'n resulterende/ netto krag is gelyk aan die verandering in die kinetiese krag van die voorwerp.* ✓	(2)
3.4	**Accepted labels/*Aanvaarde byskrifte*** 	(4)
3.5	**OPTION/*OPSIE* 1 *Downwards as +/Afwaarts as +*** $V^2_f = v^2_i + 2a\Delta x$ $V^2_f - v^2_i = 2(1,54)(0,9)$ ✓ $= 2,772$ $W_{net} = E_k$✓ $W_{man} + W_{grav} + W_f = 1/2m(v^2_f - v^2_i)$ $W_{man} + (86 \times 9,8) \sin 25° (0,9) \cos 0° + 168,04(0,9) \text{ Cos } 180°$ ✓$= 1/2 (86)(2,772)$ ✓ $W_{man} = -50,13$ J ✓	
	OPTION/*OPSIE* 2 *Downwards as +/Afwaarts as +* $F_{net} = ma$ $-F_{man} + F_g \sin\theta + f = ma$ $-F_{man} + 86 \times 9,8 \sin 25° - 168,04 = 86(1,54)$ ✓ $F_{man} = -356,18 + 168\ 04 + 132,44$ $F_{man} = -55,7$N $W_{man} = F_{man} \times \cos\theta$ ✓ $W_{man} = (55,7)$ ✓ (0,9) cos 180° ✓ $W_{man} = -50,13$ J ✓	

w	F_g/F_w/Weight/Gravity/Gravitational force/$F_{g\parallel}$ and $F_{g\perp}$ *F_g/F_w/Gewig/Gravitasie/Gravitasiekrag/*$F_{g\parallel}$ en $F_{g\perp}$
N	Normal/*Normaal*
f	F_f/frictional force/*F_f/wrywingskrag*
F	Applied force/ $F_A/F_{applied}$ *Toegepaste krag/$F_a/F_{toegepas}$*

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	OPTION/*OPSIE* 3 ***Upwards as +/Opwaarts as +*** F_{net}= ma F_{man} - Fgsin+ f =ma F_{man} - 86x9,8sin25 + 168,04=86(-1,54) ✓ F_{man} = 356,18 -168 04 -132,44 F_{man} =55,7 N $W_{man} = F_{man} \times \cos\theta$✓ W_{man} =(55,7) ✓ (0,9) cos 180✓ W_{man} = -50,13 J ✓	(5)

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[15]

QUESTION/*VRAAG* 4

4.1	The total Mechanical Energy is conserved/ remains constant ✓ in an isolated system / in absence of external forces/ non-conservative forces/*Die totale meganiese energie bly behoue/bly konstant in 'n geslote sisteem/in afwesigheid van eksterne kragte/nie-konserwatiewe kragte*. ✓ OR/*OF* The sum of gravitational potential energy and kinetic energy of an object remains constant ✓ in an isolated system/*Die som van die potensiële gravitasie energie en die kinetiese energie van 'n voorwerp in 'n geslote houer bly konstant*. ✓	(2)
4.2	**OPTION/*OPSIE* 1** $E_{m \text{ at } A} = E_{m \text{ at } B}$ $(mgh+½mv^2)_A = (mgh+½mv^2)_B$ ✓ [(5)(9,8)(5)+½(5)(0)²]✓=[(5)(9,8)(1)+½(5)v²]✓ ∴ v = 8,85 m·s^{-1}✓ **OPTION/*OPSIE* 2 When B is taken as ground surface/*As B die grond is*** $E_{m \text{ at } A} = E_{m \text{ at } B}$ $(mgh + ½ mv^2)_A = (mgh + ½ mv^2)_B$ ✓ $[(5)(9,8)(4)+½(5)(0)^2]$✓=$[(5)(9,8)(0)+½(5)v^2]$ ✓ ∴ v = 8,85 m·s^{-1}✓	(4)
4.3	Weight / force of gravity (*Gewig/Gravitasiekrag*) ✓ Normal force/*Normale krag* ✓	(2)
4.4	C to/*na* B ✓	(1)
4.5	Equal to/*Gelyk aan* ✓	(1)

[10]

QUESTION/*VRAAG* 5

5.1.1	The apparent change in the detected frequency (pitch) or (wavelength) ✓as a result of the relative motion between a source and an observer (listener) ✓ *Die verandering in die frekwensie (toonhoogte) van die klank waargeneem deur 'n luisteraar is omdat die klankbron en die luisteraar veskillende snelhede relatief tot die medium waarin klank voortgeplant word, het*	(2)
5.1.2	Away/*Weg van* (from submarine/*vanaf duikboot*) ✓ The detected /observed frequency is lower than the actual frequency/ *Die waargenome frekwensie is laer as die werklike frekwensie* ✓	(2)
5.1.3	**OPTION/*OPSIE* 1** $F_L = \frac{v \pm V_l}{v \pm v_S} F_s$✓ 0,985 F_s✓ = $\frac{1470}{1470+ v_S}$ ✓ × F_s✓ v_S = 22,39 m·s^{-1}✓ **OPTION/*OPSIE* 2** $F_L = (0,985)F_s$ 437 = (0,985) F_s F_s = 443,655 Hz $F_L = \frac{v \pm V_l}{v \pm v_S} F_s$✓ 437✓ = $\frac{1470}{1470+ v_S}$ ✓ × 443,655✓ v_S = 22,39 m·s^{-1}✓	(5)

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5.2	Red shift implies that light emitted by stars shows a shift towards the lower frequencies of the spectrum/*Rooi verskuiwing van lig vrygestel deur die sterre wys 'n verskuiwing na die laer frekwensie van die spektrum.* ✓✓	(2)
5.3	Blue shift/*Blou verskuiwing* ✓	(1)

[12]

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QUESTION/*VRAAG* 6

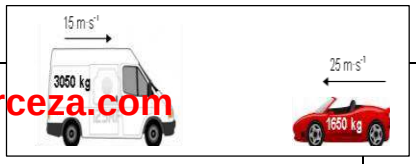
6.1	F ✓ ⟷ T✓	(2)
6.2	**OPTION/*OPSIE* 1** Fnet = ma ***At/by A:4 kg block/blok*** *In x-direction./In rigting x* $T - f_f = m_Aa$ $T - \mu N = m_Aa$✓ $T - \mu m_Ag = m_Aa$ (equation/*vergelyk* 1) ***At/by A:4 kg block/blok*** In *y* direction (up/ $N - F_g = 0$ $N = F_g = mg$ ***At/by B:8 kg block/blok*** **In the *x* direction/*In die x-rigting*** $-T + F_g = m_Ba$✓ $-T + m_Bg = m_Ba$ (equation/*vgl* 2) Solving the system of equations/ *Los op die sisteem van vgl* $T - \mu m_Ag - T + m_Bg = m_Aa + m_Ba$✓ Removing T and isolating a:/ *Verwyder T en isoleer a:* $-\mu m_Ag + m_Bg = (m_A + m_B)a$✓ $-(0,6)(4)(9,8) +(8)(9,8)$✓ $= (4+8)a$✓ $54,88 = 12a$ $a = 4,57\ m\cdot s^{-2}$ ✓	**OPTION/*OPSIE* 2** Fnet = ma ***At/by A:4 kg block/blok*** $T - \mu N = m_Aa$✓ $T - \mu m_Ag = m_Aa$ $T - 0,6(4)(9,8)$ ✓ $= 4a$ $T = 4a + 23,52$ …… equation/*vgl* 1 Any/*Enige* ✓ ***At/by B:8 kg block/blok*** $-T + F_g = m_Ba$✓ $-T + m_Bg = m_Ba$ $-T + 8(9,8)$ ✓$= 8a$ $-T = 8a - 78,4$ …. equation/*vgl* 2 Adding Eq 1 & Eq 2/*Tel Vgl 1 & 2* $4a + 23,52 + 8a - 78,4 = 0$✓ $12a = 54,88$ $\therefore a = 4,57\ m\cdot s^{-2}$✓	(7)
6.3	**<u>OPTION 1</u>** $T - f_f = m_Aa$ $T - \mu m_Ag = m_Aa$ $T - 23,52$ ✓$= 4(4,57)$ ✓ $T = 41,8$ N ✓	**<u>OPTION 2</u>** $-T + m_Bg = m_Ba$ $-T + (8)(9,8)$ ✓ $= (8)(4,57)$ ✓ $T = 41,84$ N✓	(3)
6.4	**OPTION/*OPSIE* 1** $F_F = \mu N$✓ $N = mg$ $F_F = \mu mg = (0,6)(4)$✓ $(9,8)$ ✓$= 23,52$N✓	**OPTION/*OPSIE* 2** $T - F_F = m_Aa$ ✓ $41,8 - F_F$✓ $= 4(4,57)$ ✓ $F_F = 23,52$ N✓	(4)

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QUESTION/*VRAAG* 7



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7.1	Choose RIGHT as positive/ Kies REGS as positief. $(m_{mb}\ v_{imb} + m_c v_{ic}) = (m_{mb}\ v_{fmb} + m_c v_{fc})$ ✓ (3050)(15) ✓ + (1650)(-25) ✓ = v_f(3050 + 1650) ✓ v_f = 0,96 m.s^{-1} to the right/*na regs*✓	(5)
7.2	$\sum K_i = ½\ m_{MB}\ v^2_{iMB} + ½\ m_C\ v^2_{iC}$ ✓ $= ½(3\ 050)(15)^2 + ½(1\ 650)(-25)^2$✓ = 85 8750 J✓ $\sum K_f = ½ m_{MB}\ v^2_{fMB} + ½\ m_C\ v^2_{fC}$ ✓ $= ½(3\ 050)(0,96)^2$✓ + ½(1 650)(0,96)^2✓ = 2 165,76 J ✓ Since/*Aangesien* $\sum K_i \neq \sum K_f$ ✓, ∴ the collision was inelastic/*was die botsing onelasties*✓	(9)
7.3	Crumple zones in a car ensure that the car comes to rest over a longer period of time✓, (Δt), during an accident / stopping time is increased./ *Frommelsone in 'n motor verseker dat 'n motor tot stilstand kom oor 'n langer tydsverloop./Δt neem toe/tyd om te stop neem toe* From $F_{NET} \propto \frac{1}{\Delta t}$, it follows that F_{NET} decreases with an increase in Δt. ✓ *Van* $F_{net} \propto \frac{1}{\Delta t}$, F_{net} *neem af met toename in* Δt ∴ The magnitude of F_{NET} determines the extent of passenger's injuries. ✓ *Die grootte van* F_{net} *bepaal die mate van passasier se beserings*	(3)

[17]

QUESTION/*VRAAG* 8

8.1	Every object in the universe attracts every other object with a force ✓that is directly proportional to the product of the masses and inversely proportional to the square of the distance between their centers. ✓ *Elke liggaam in die heelal trek elke ander liggaam aan met 'n krag direk eweredig aan die produk van hul massas en omekeerde eweredig aan die kwadraat van die afstand tussen hul middelpunte*	(2)
8.2	Data: M_E (Mass of the earth/*Massa van aarde*) = 5,98 × 10^{24} kg M_S (mass of the spaceship/*massa van ruimteskip*) = 3 500 kg r = 8,53 × 10^6 m G = 6,67 × 10^{-11} N·m^2·kg^{-2} $F = \frac{G M_E \cdot M_S}{r^2}$✓ = $\frac{(6,67 \times 10^{-11})(5,98 \times 10^{24})(3500)}{(8,53 \times 10^6)^2}$✓ = 19 186,55 N✓	(4)
8.3	Equal to/*Gelyk aan* ✓	(1)
8.4	Newton's third law of motion/ *Newton se derde bewegingwet* ✓ When object A exerts a force on object B, object B simultaneously exerts an equal force✓ on object A in an opposite direction✓. *Wanneer een liggaam 'n krag op 'n tweede liggaam uitoefen, oefen die tweede liggaam 'n gelyk in grootte*✓ *en teenoorgesteld van rigting van eerste liggaam uit.*✓	(3)
8.5	$F = \frac{G M_E \cdot M_S}{r^2}$✓ 4 × 19 186,55 ✓ = $\frac{(6,67 \times 10^{-11})(5,98 \times 10^{24})(3500)}{r^2}$✓ $r^2 = \frac{(6,67 \times 10^{-11})(5,98 \times 10^{24})(3\ 500)}{76\ 746,2}$ r^2 = 1,82 × 10^{13} m^2 r = 4 265 000,54 m✓ = 4,27 × 10^6 m	(4)

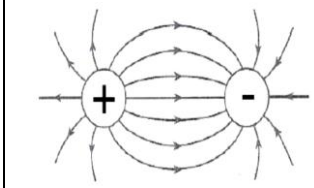
[14]

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QUESTION/*VRAAG* 9

9.1	Impulse/*Impuls* = Area under graph/*Area onder grafiek* ✓ Any ONE/*Enige EEN* = ½ bh + ½ bh + lb = ½(2)(10) ✓ + ½ (2)(-10) ✓ + 6(-10) ✓ = - 60 N.s in opposite direction/ *in teenoorgestelde rigting*✓	(5)
9.2	Greater than/*Groter as* ✓✓	(2)
9.3	East positive/*Oos positief* *Impulse/Impuls* = $mv_f - mv_i$ ✓ -60 ✓= $10v_f - (10)(5,5)$ ✓ $V_f = 0,5\ m\cdot s^{-1}$✓	(4)
		[11]

QUESTION/*VRAAG* 10

10.1		**CRITERIA TO MARK THE PATTERN** Shape of the pattern/*Korrekte patroon* ✓ Direction (arrows from positive to negative)/ *Rigting (pyltjies vanaf positief na negatief* ✓ Angle of contact / field lines not touching each other/*Hoek van kontak / veldlyne moet nie kruis nie* ✓	(3)
10.2	$E_A = \frac{K\,Q_A}{r^2}$✓ $= \frac{(9\times10^9)(4\times10^{-9})}{(20\times10^{-3})^2}$✓ = 90 000 N·C^{-1}, to the right/*na regs* $E_C = \frac{K\,Q_C}{r^2} = \frac{(9\times10^9)(6\times10^{-9})}{(22\times10^{-3})^2}$ ✓ = 86 400 N·C^{-1}, to the right/*na regs* ∴ $E_{NET} = E_A + E_C$ = 90 000 + 86 400✓ (for adding E_A and E_C) (*tel* E_A *en* E_C *op)* = 176 400 NC^{-1} = $1,76\times10^5$ N·C^{-1}✓, to the right/*na regs* ✓	(7)
10.3	$F = \frac{K\,Q_A Q_C}{r^2}$✓ $= \frac{(9\times10^9)(4\times10^{-9})✓(6\times10^{-9})✓}{(30\times10^{-3})^2}$✓ = $7,2\times10^{-3}$ N, (attraction/ *aantrekkend*)✓	(5)
		[15]
		TOTAL/*TOTAAL*: 150

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NATIONAL SENIOR CERTIFICATE

GRADE/*GRAAD* 12

JUNE/*JUNIE* 2016

PHYSICAL SCIENCES P2
FISIESE WETENSKAPPE V2
(CHEMISTRY/*CHEMIE*)
MEMORANDUM

MARKS/*PUNTE*: **150**

This memorandum consists of 7 pages.
Hierdie memorandum bestaan uit 7 bladsye.

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QUESTION / *VRAAG* 1

1.1 C√√ 1.2 A √√ 1.3 B√√ 1.4 D√√ 1.5 C√√
1.6 A√√ 1.7 A√√ 1.8 A√√ 1.9 B√√ 1.10 D√√ **[20]**

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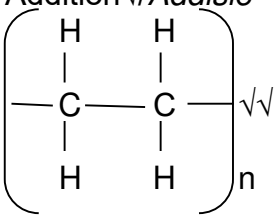
QUESTION / *VRAAG* 2

2.1.1 C_nH_{2n}√ (1)
2.1.2 Ketone√/ *Ketoon* (1)
2.1.3 E√ (Methanal/ *Metanaal*) (1)

2.2.1 Contains double bonds (or multiple bonds) between C atoms. √√
Besit dubbelbindings (meervoudige binding) tussen C atome. (2)

NOTES/*AANTEKENINGE*
2 marks or 0/ *2 punte of 0*

2.2.2 Addition√/*Addisie* (1)

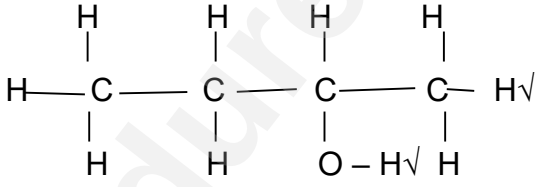
2.2.3  √√ Accept /Aanvaar $\left(CH_2CH_2\right)_n$ (2)

2.3.1 2-bromo√-4-methyl√ hexane√
2-broom-4-metielheksaan (3)

Marking criteria/Nasienriglyne
2-bromo√ or 2 bromo *2-broom of 2 broom*
4-methyl√ or 4 methyl *4-metiel of 4 metiel*
hexane√ heksaan
Any error e.g. omission of hyphens, incorrect order etc.
Enige foute bv. uitlating van koppeltekens, verkeerde orde ens. (2/3)

2.3.2 4-methyl√pentan-2-one√ *Accept* 4-methyl-2-pentanone
4-metielpentan-2-oon *Aanvaar 4-metiel-2-pentanoon* (2)

Marking criteria/Nasienriglyne
4-methyl√ or 4 methyl *4-metiel or 4 metiel*
pentan-2-one√ or pentan 2 one *pentan-2-oon or pentan 2 oon*
Any error e.g. omission of hyphens, incorrect order etc.
Enige foute bv. weglating van koppeltekens, verkeerde orde ens. (1/2)

2.4.1  (2)

Marking criteria/Nasienriglyne
Functional group√ /*funksionele groep*
Whole structure correct√ /*Hele struktuur*

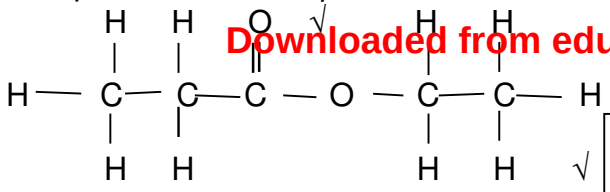
2.4.2 2-methyl√propan-2-ol√ *Accept* 2-methyl-2-propanol
2-metiel propan-2-ol *Aanvaar 2-metiel-2-propanol* (2)

Marking criteria/Nasienriglyne
2-methyl√ *2-metiel*
propan-2-ol√ *propa-2-ol*

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2.5.1 Propanoic acid√ /*Propanoësuur* (1)

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2.5.2  (2)

Marking criteria/Nasienriglyne
Functional group√/*Funksionele groep*√
Whole structure correct√/ *Hele struktuur korrek*√

2.6.1 $C_2H_4Br_2$√ (1)

NOTES/ANTEKENINGE
Ignore order of atoms in formula e.g. $C_2Br_2H_4$√
Ignoreer orde van atome in formule bv. $C_2Br_2H_4$√ (1/1)

2.6.2

Positive marking from 2.6.1/*Positiewe nasien vanaf 2.6.1*

% C = (2x12)/188 × 100 √
= 12,76% or/*of* 12,77% √
% H = (4×1)/188 × 100√
= 2,13% or/*of* 2,12%√
% Br = 100 – (12,76 + 2,13) = 85,11%√
OR/OF
% Br = (2×80) /188 × 100
= 85,11% or/*of* 85,10%√ (6)
[27]

QUESTION / *VRAAG* 3

3.1 Positional√ (isomer) /*Posisionele (isomeer)* (1)

3.2.1 Substitution√ /*Substitusie* (1)
3.2.2 Hydrogen bromide√/HBr
Waterstof bromied/HBr (1)

3.3.1 (concentrated) potassium hydroxide√/KOH
(gekonsentreerde) kaliumhidroksied/KOH *(1)*
3.3.2 strong heat√/*sterk hitte* (1)

3.4 Hydration√/Hidrasie (1)

3.5 (concentrated) H_2SO_4√/Sulphuric acid
(gekonsentreerde) H_2SO_4*/Swawelsuur* (1)

3.6 $C_4H_8 + 6O_2$ √ ⟶ $4\ CO_2 + 4H_2O$√ √ Balancing/*Balansering* (3)
[10]

QUESTION / *VRAAG* 4

4.1 **A**√ (Butane/*Butaan*) (1)

4.2 A group of organic compounds with the same functional group√√ / where one member differs from the next member with a $–CH_2–$ group.
'n Groep organiese verbindings met dieselfde funksionele groep / waarin een lid van die volgende verskil met 'n $–CH_2–$ *groep.* (2)

NOTES/*AANTEKENINGE*
2 marks or 0/ *2 punte of 0*

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4.3 London force√ /induced-dipole force/dispersion force
London kragte/geïnduseerde-dipool kragte/dispersie kragte (1)

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4.4.1 In **A** there are London forces√ /dispersion/induced-dipole forces
In **B** there are dipole-dipole forces √ (in addition to London forces)
Intermolecular forces in **B** are stronger√ than in **A**.OR Intermolecular forces in **A** are weaker than in **B.**
*In **A** is daar London-kragte/dispersie/geïnduseerde-dipool kragte.*
*In **B** is daar dipool-dipool kragte (in addisie met London-kragte)*
*Intermolekulêre kragte in **B** is sterker as in **A**.OF Intermolekulêre kragte in **A** is swakker as in **B**.* (3)

4.4.2 Both **C** and **D** have hydrogen bonds√
Hydrogen bonds are stronger in **D** than **C**√ because **D** has more sites for Hydrogen bonds√ /two sites for hydrogen bonding/ **D** forms dimers/**D** is more polar.
*Beide **C** en **D** het waterstofbindings.*
*Waterstofbindings is sterker in **D** as in **C** omdat **D** meer kante vir waterstofbindings het./twee kante vir waterstofbindings/**D** vorm dimere/**D** is meer polêr.* (3)

4.5.1 **D**√ (Butanoic acid/*Butanoësuur*) (1)
4.5.2 Compound **E** has a larger surface area than **D**√/longer carbon chain length than **D**.
London forces√/induced dipole/dispersion forces in **E** are stronger√ than in **D**.
OR
London forces/induced dipole/dispersion forces in **D** are weaker than in **E**.

*Verbinding **E** het groter oppervlaksarea as D/ langer koolstofketting as **D**.*
*London-kragte/geïnduseerde dipole/ dispersie kragte in **E** is sterker as in **D**.*
OF
*London-kragte/geïnduseerde dipole/ dispersie kragte in **D** is swakker as in **E.***
(3)
[14]

QUESTION / *VRAAG* 5

5.1 HETEROGENEOUS√/*HETEROGEEN* (1)

5.2 CO_2 escapes√/*CO_2 ontsnap* (1)

5.3 t = 5√ (minutes/*minute*) (1)

5.4 Rate/*Reaksietempo* = - $\Delta m/\Delta t$ = -(188,8–192,4) √ /(1-0) √
= 3,6 √ (grams per minute/*gram per minuut*).
Accept/Aanvaar
Rate/Reaksietempo = $\Delta m/\Delta t$ = (188,8–192,4) √ /(1-0) √
= -3,6 √ (grams per minute/*gram per minute*) (3)

5.5 Concentration of the acid decreases√/Surface area of $CaCO_3$ decreases.√
Konsentrasie van die suur neem af/Oppervlakarea van $CaCO_3$ neem af. (2)

5.6 Calcium carbonate√/$CaCO_3$
Kalsiumkarbonaat/$CaCO_3$ (1)

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5.7 $m(CO_2) = 192,4 - 186,7 = 5,7\ g$√

$n = m/M = 5,7 / 44$ √ $= 0,13$ mol (0,1295.. mol)

$n(CaCO_3) = n(CO_2) = 0,13$ mol√ (0,1295.. mol)

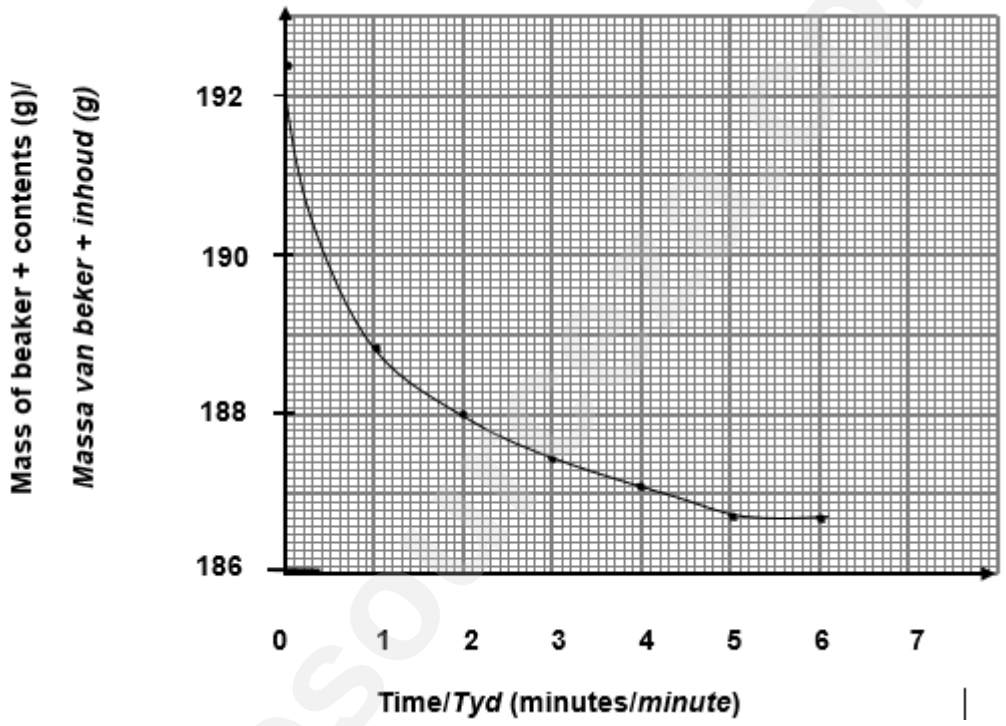
$m(CaCO_3) = n.M = 0,13 \times 100$ √ $= 13$ g (12,95 g) (5)

Accept Range/*Aanvaar* reikwydte 12,95 g to/*tot* 13 g

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5.8

Graph of mass of beaker and contents vs time
Grafiek van massa van beker en inhoud teenoor tyd.



(4)

5.9 Reaction rate increases√
Average kinetic energy of particles increases √ (as temperature increases)
More particles have enough kinetic energy to react√
More effective collisions per unit time√
Reaksietempo neem toe.
Gemiddelde kinetiese energie van partikels neem toe (soos temperatuur toeneem.)
Meer partikels het genoegsame kinetiese energie om te reageer.
Meer effektiewe botsings per eenheidstyd. (4)

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QUESTION / *VRAAG* 6

6.1 Stage reached by a reversible chemical reaction in a closed container where the rate of forward reaction is equal to rate of reverse reaction√√ (2)
'n Stadium bereik deur die omkeerbare chemiese reaksie in 'n geslote houer waar die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie.

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Notes/Aantekeninge
2 marks or 0/ *2 punte of 0*

6.2.1 4 √ (minutes/*minute*) (1)

6.2.2 0,5 √ (mol) (1)

6.3 + Positive marking from 6.2.2/*Positiewe nasien vanaf 6.2.2*

Marking criteria/*Nasien riglyne*

- division all n by V√/*verdeel alle 'n deur V.*
- K_c expression√/ *K_c uitdrukking*
- substitution for Kc√/*substitusie van K_c*
- substitution of equilibrium concentrations√√/*substitusie van ewewig.*
- final answer√/*finale antwoord*

Concentration at equilibrium/*Konsentrasie by ewewig*

$c(AX_3) = n/V = 0,5/V$
$c(AX_2) = n/V = 0,6/V$
$c(X_2) = n/V = 0,2/V$
} √ (division by V/ *Verdeel deur V*)

$K_c = [AX_2]^2.[X_2] / [AX_3]^2$√

$2,5 \times 10^{-2}$√ $= (0,6/V)^2 . (0,2/V)$ √ $/ (0,5/V)^2$√

$V = 11,52\ dm^3$√ (6)

6.4 Low√ K_c is less than 1 (or K_c is low)
Lae K_c is kleiner as 1 (of K_c is laag) (2)

6.5 Endothermic√/*Endotermies*
As temperature decreases $[AX_3]$ increases√
Reverse reaction is favoured by decrease in temperature√
Reverse reaction is exothermic√
Soos temperatuur afneem, neem $[AX_3]$ toe.
Omkeerbare reaksie word bevoordeel deur afname in temperatuur.
Omkeerbare reaksie is eksotermies. (4)

6.6 Remains constant√/*Bly konstant.* (1)
[17]

QUESTION / *VRAAG* 7

7.1.1 Ionisation constant√ (for an acid)/*Ionisasie konstante (vir 'n suur)* (1)

7.1.2 K_a depends on temperature.√/ *K_a changes as temperature changes.*
K_a is afhanklik van temperatuur. √/ *K_a verander as temperatuur verander.* (1)

7.1.3 $H(COO)_2^-$ √ (1)

7.1.4 $(COOH)_2(s) + 2H_2O(\ell)$ √ ⇌ $(COO)_2^{2-}(aq) + 2H_3O^+(aq)$ √
√ Balancing/*Balansering* (3)

Notes/*Aantekeninge*
Ignore phases/*Ignoreer fases*
Ignore type of arrow./*Ignoreer tipe pyltjie*

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7.2.1 $n = cV$ √= 1 × 40/1000√ = 0,04 mol

$m = n.M$= 0,04 × 40√ = 1,6 g√ (4)

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7.2.2 $n = c.V$√ = 0,06 × 50/1000√ = 0,003 mol√ (3)

7.2.3 + Positive marking from 7.2.1 and 7.2.2/
Positiewe nasien vanaf 7.2.1 en 7.2.2

Marking criteria/Nasienriglyne

- use of ratio $n(H_2SO_4):n(NaOH)$√/*gebruik die verhouding* $n(H_2SO_4):n(NaOH)$
- n(NaOH) in excess $n_{initial} - n_{reacting}$√/ n(NaOH) in oormaat $n_{initial} - n_{reacting}$/
- substituting (90/100) into c = n/V√/ vervang (90/100) in c = n/V/
- $[OH^-].[H_3O^+] = 10^{-14}$√
- substitution for/*vervanging vir* $[OH^-]$√
- $pH = -\log[H_3O^+]$√
- substitution for/*vervanging vir* $[H_3O^+]$√
- final answer/*finale antwoord* √

n(NaOH) initial = 0,04 mol therefore $n(H_2SO_4)$ required = ½ × 0,04 = 0,02 mol
$n(H_2SO_4)$ initial = 0,003 mol

therefore/*dus* n(NaOH)reacting/*reagerend* = 2 × 0,003 = 0,006 mol√

n(NaOH) in excess/*oormaat* = 0,04 - 0,006 = 0,034 mol√

c = n/V = 0,034 / (90/1000) √ = 0,378 mol·dm^{-3}
$[OH^-].[H_3O^+] = 10^{-14}$√
0,378√ × $[H_3O^+] = 10^{-14}$
$[H_3O^+] = 2,65 \times 10^{-14}$
$pH = -\log[H_3O^+]$√
$= -\log 2,65 \times 10^{-14}$√
= 13,58√ (8)

7.3.1 Endpoint√/*Endpunt* (1)
7.3.2 Burette√/*Buret* (1)
7.3.3 To see endpoint clearly.√ *Om die eindpunt duidelik te sien.* (1)

7.3.4 $CH_3COO^- + H_2O$ √ ⇌ $CH_3COOH + OH^-$√ √ balancing/*balansering*
Ethanoate ion reacts with water to form (an excess of) OH^-ions√
Etanoaat-ioon reageer met water om OH^--ione (in oormaat) te vorm. (4)

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QUESTION / *VRAAG* 8

8.1 Activation√ /*Aktiverings*(energy/*energie*) (1)

8.2.1 Exothermic√/*Eksotermies* $\Delta H < 0$ √ / Δ H negative/*negatief* (2)
8.2.2 Increase pressure.√ / Decrease temperature√ / Add more NO or O_2 √
Toename in druk./Afname in temperatuur./Voeg meer NO of O_2 by.
(any 2/*enige 2*) (2)
8.2.3 ΔH = -74,55 √ (1)

8.3.1 Neutralisation√ /Protolysis/Protolytic
Neutralisasie / Protoliese/Protolities (1)
8.3.2 Proton √ (1)
8.3.3 $n(NaOH) = n(NH_4NO_3) = 2,4 \times 10^{-3}$ mol√
$m(NH_4NO_3) = n.M = 2,4 \times 10^{-3} \times 80$√ = 0,192 g
% Purity = 0,192 / 0,204 × 100√ = 94,12 %√ (4)

[12]

TOTAL / TOTAAL: 150

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