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GR 12 PHYSICAL SCIENCES

EXAM QUESTION PAPERS & MEMOS

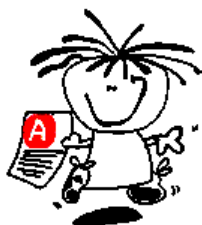
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We trust that working through these exam papers and following our suggested answers and comments will help you prepare thoroughly for your final exam.

The Answer Series Physical Sciences study guides offer a key to exam success.



EXAM QUESTION PAPERS

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1

PAPER 1

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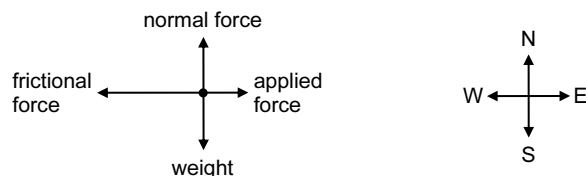
Question 1

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A - D) next to the question numbers (1.1 - 1.10).

- 1.1 Which ONE of the following physical quantities is equal to the product of force and constant velocity?
A work **B** power
C energy **D** acceleration (2)

- 1.2 A 30 kg iron sphere and a 10 kg aluminium sphere with the same diameter fall freely from the roof of a tall building. Ignore the effects of friction. When the spheres are 5 m above the ground, they have the same . . .
A momentum **B** acceleration
C kinetic energy **D** potential energy (2)

- 1.3 The free-body diagram below shows the relative magnitudes and directions of all the forces acting on an object moving horizontally in an easterly direction.



The kinetic energy of the object . . .

- A** is zero **B** increases
C decreases **D** remains constant (2)

- 1.4 The hooter of a vehicle travelling at constant speed towards a stationary observer, produces sound waves of frequency 400 Hz. Ignore the effects of wind.

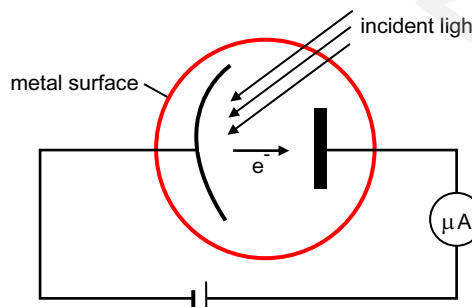
Which ONE of the following frequencies, in hertz, is most likely to be heard by the observer?

- A** 400 **B** 350
C 380 **D** 480 (2)

- 1.5 An astronomer, viewing light from distant galaxies, observes a shift of spectral lines toward the red end of the visible spectrum. This shift provides evidence that . . .

- A** the universe is expanding.
B the galaxies are moving closer towards Earth.
C Earth is moving towards the distant galaxies.
D the temperature of Earth's atmosphere is increasing. (2)

- 1.6 When light of a certain frequency is incident on the cathode of a photocell, the ammeter in the circuit registers a reading.



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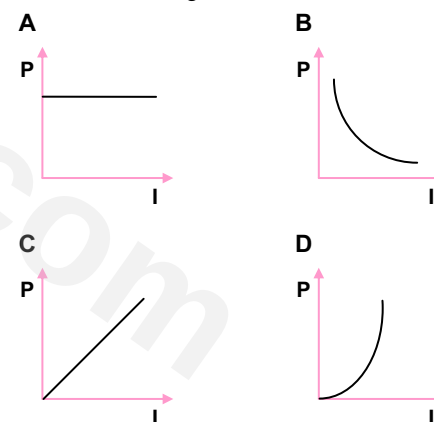
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The frequency of the incident light is now increased while keeping the intensity constant. Which ONE of the following correctly describes the reading on the ammeter and the reason for this reading?

	Ammeter reading	Reason
A	increases	More photoelectrons are emitted per second.
B	increases	The speed of the photoelectrons increases.
C	remains the same	The number of photoelectrons remains the same.
D	remains the same	The speed of the photoelectrons remains the same.

- 1.7 Which ONE of the following graphs best represents the relationship between the electrical power and the current in a given ohmic conductor?



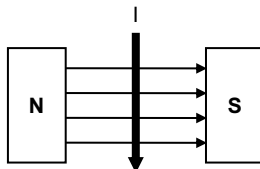
- 1.8 In a vacuum, all electromagnetic waves have the same . . .

- A** energy **B** speed
C frequency **D** wavelength (2)



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- 1.9 In the sketch alongside, a conductor carrying conventional current, I , is placed in a magnetic field.



Which ONE of the following best describes the direction of the magnetic force experienced by the conductor?

- A parallel to the direction of the magnetic field
- B opposite to the direction of the magnetic field
- C into the page perpendicular to the direction of the magnetic field
- D out of the page perpendicular to the direction of the magnetic field

(2)

- 1.10 An atom in its ground state absorbs energy E and is excited to a higher energy state. When the atom returns to the ground state, a photon with energy . . .

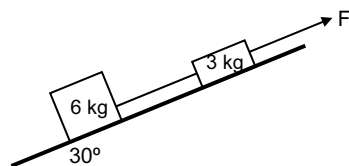
- A E is absorbed.
- B E is released.
- C less than E is released.
- D less than E is absorbed.

(2)

[20]

Question 2

A light inelastic string connects two objects of mass 6 kg and 3 kg respectively. They are pulled up an inclined plane that makes an angle of 30° with the horizontal, with an applied force of magnitude F . Ignore the mass of the string.



The coefficient of kinetic friction for the 3 kg object and the 6 kg object is 0,1 and 0,2 respectively.

- 2.1 State Newton's Second Law of Motion in words. (2)
- 2.2 How will the coefficient of kinetic friction be affected if the angle between the incline and the horizontal increases? Write down only **increases, decreases** or **remains the same**. (1)

(1)

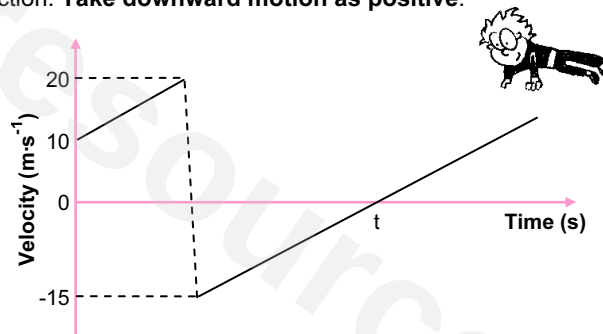
- 2.3 Draw a labelled free-body diagram indicating all the forces acting on the 6 kg object as it moves up the inclined plane. (2)

- 2.4 Calculate the tension in the string if the system accelerates up the inclined plane at 4 m.s^{-2} . (5)

[10]

Question 3

A ball of mass 0,15 kg is thrown vertically downwards from the top of a building to a concrete floor below. The ball bounces off the floor. The velocity-time graph below shows the motion of the ball. Ignore the effects of air friction. **Take downward motion as positive.**



- 3.1 From the graph, write down the magnitude of the velocity at which the ball bounces off the floor. (1)

- 3.2 Is the collision of the ball with the floor **elastic** or **inelastic**? Refer to the data on the graph to explain the answer. (3)

- 3.3 Calculate the:

- 3.3.1 height from which the ball is thrown (4)
- 3.3.2 magnitude of the impulse imparted by the floor on the ball (3)
- 3.3.3 magnitude of the displacement of the ball from the moment it is thrown until time t (4)

- 3.4 Sketch a position-time graph for the motion of the ball from the moment it is thrown until it reaches its maximum height after the bounce. **Use the floor as the zero position.**

Indicate the following on the graph:

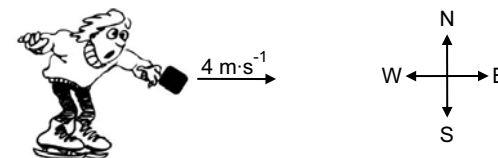
- The height from which the ball is thrown
- Time t

(4)

[19]

Question 4

A boy on ice skates is stationary on a frozen lake (no friction). He throws a package of mass 5 kg at 4 m.s^{-1} horizontally east as shown below. The mass of the boy is 60 kg.



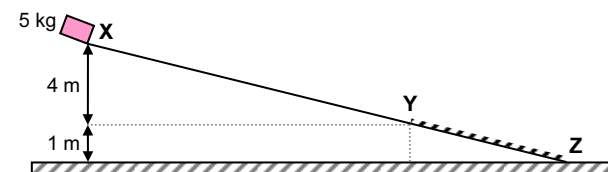
At the instant the package leaves the boy's hand, the boy starts moving.

- 4.1 In which direction does the boy move? Write down only **east** or **west**. (1)
- 4.2 Which ONE of Newton's laws of motion explains the direction in which the boy experiences a force when he throws the package? Name and state this law in words. (3)
- 4.3 Calculate the magnitude of the velocity of the boy immediately after the package leaves his hand. Ignore the effects of friction. (5)
- 4.4 How will the answer to Question 4.3 be affected if: (Write down **increases, decreases** or **remains the same**.)
 - 4.4.1 the boy throws the same package at a higher velocity in the same direction. (1)
 - 4.4.2 the boy throws a package of double the mass at the same velocity as in Question 4.3. Explain the answer. (3)

[13]

Question 5

A 5 kg rigid crate moves from rest down path XYZ as shown below (diagram not drawn to scale). Section XY of the path is frictionless. Assume that the crate moves in a straight line down the path.



- 5.1 State, in words, the *principle of the conservation of mechanical energy*. (2)

- 5.2 Use the principle of the conservation of mechanical energy to calculate the speed of the crate when it reaches point **Y**. (4)

On reaching point **Y**, the crate continues to move down section **YZ** of the path. It experiences an average frictional force of 10 N and reaches point **Z** at a speed of $4 \text{ m}\cdot\text{s}^{-1}$.

- 5.3 Apart from friction, write down the names of TWO other forces that act on the crate while it moves down section **YZ**. (2)

- 5.4 In which direction does the net force act on the crate as it moves down section **YZ**? Write down only from '**Y** to **Z**' or from '**Z** to **Y**'. (1)

- 5.5 Use the work-energy theorem to calculate the length of section **YZ**. (5)

Another crate of mass 10 kg now moves from point **X** down path **XYZ**.

- 5.6 How will the velocity of this 10 kg crate at point **Y** compare to that of the 5 kg crate at **Y**? Write down only **greater than**, **smaller than** or **equal to**. (1)

[15]

Question 6

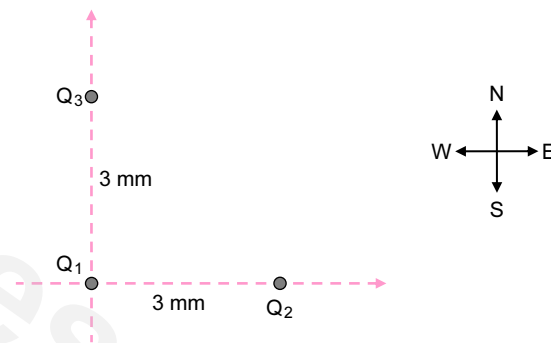
An ambulance approaches a stationary observer at a constant speed of $10,6 \text{ m}\cdot\text{s}^{-1}$, while its siren produces sound at a constant frequency of 954,3 Hz. The stationary observer measures the frequency of the sound as 985 Hz.

- 6.1 Name the medical instrument that makes use of the Doppler effect. (1)
- 6.2 Calculate the velocity of sound. (5)
- 6.3 How would the wavelength of the sound wave produced by the siren of the ambulance change if the frequency of the wave were higher than 954,3 Hz? Write down only **increases**, **decreases** or **stays the same**. (1)
- 6.4 Give a reason for the answer to Question 6.3. (2)
- 6.5 State, in words, a definition for the Doppler effect. (2)

[11]

Question 7

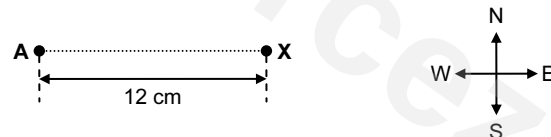
Three small, identical metal spheres, Q_1 , Q_2 and Q_3 , are placed in a vacuum. Each sphere carries a charge of $-4 \mu\text{C}$. The spheres are arranged such that Q_2 and Q_3 are each 3 mm from Q_1 as shown in the diagram below.



Calculate the net force exerted on Q_1 by Q_2 and Q_3 . [7]

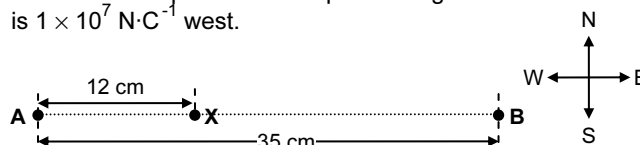
Question 8

In the diagram below, point charge **A** has a charge of $+16 \mu\text{C}$. **X** is a point 12 cm from point charge **A**.



- 8.1 Draw the electric field pattern produced by point charge **A**. (2)
- 8.2 Is the electric field in Question 8.1 **uniform** or **non-uniform**? (1)
- 8.3 Calculate the magnitude and direction of the electric field at point **X** due to point charge **A**. (5)

Another point charge **B** is now placed at a distance of 35 cm from point charge **A** as shown below. The **net** electric field at point **X** due to point charges **A** and **B** is $1 \times 10^7 \text{ N}\cdot\text{C}^{-1}$ west.



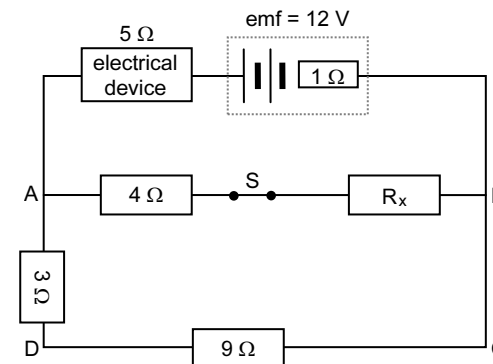
- 8.4 Is point charge **B** positive or negative? (1)
- 8.5 Calculate the magnitude of point charge **B**. (5)

[14]

Question 9

A learner wants to use a 12 V battery with an internal resistance of 1Ω to operate an electrical device. He uses the circuit below to obtain the desired potential difference for the device to function. The resistance of the device is 5Ω .

When switch **S** is **closed** as shown, the device functions at its maximum power of 5 W.

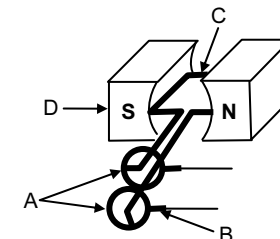


- 9.1 Explain, in words, the meaning of an *emf* of 12 V. (2)
- 9.2 Calculate the current strength that passes through the electrical device. (3)
- 9.3 Calculate the resistance of resistor R_x . (7)
- 9.4 Switch **S** is now **opened**. Will the device still function at maximum power? Write down **yes** or **no**. Explain the answer without doing any calculations. (4)

[16]

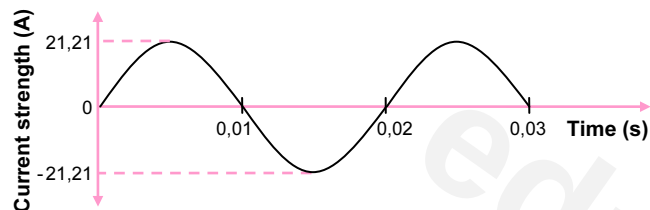
Question 10

The simplified sketch represents an AC generator. The main components are labelled **A**, **B**, **C** and **D**.



- 10.1 Write down the names of components:
10.1.1 **A** 10.1.2 **B** (1)(1)
- 10.2 Write down the function of component **B**. (1)
- 10.3 State the energy conversion which takes place in an AC generator. (1)

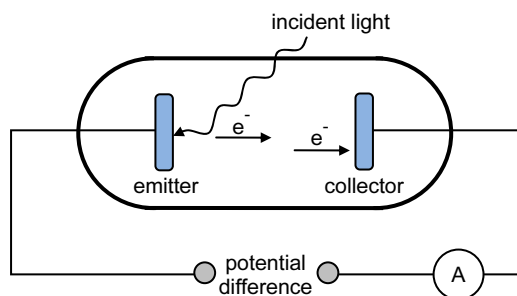
A similar coil is rotated in a magnetic field. The graph below shows how the alternating current produced by the AC generator varies with time.



- 10.4 How many rotations are made by the coil in 0,03 seconds? (1)
- 10.5 Calculate the frequency of the alternating current. (3)
- 10.6 Will the plane of the coil be **perpendicular to** or **parallel to** the magnetic field at $t = 0,015$ s? (1)
- 10.7 If the generator produces a maximum potential difference of 311 V, calculate its average power output. (5)
- [14]

Question 11

- 11.1 In the simplified diagram below, light is incident on the emitter of a photocell. The emitted photoelectrons move towards the collector and the ammeter registers a reading.



- 11.1.1 Name the phenomenon illustrated above. (1)
- 11.1.2 The work function of the metal used as emitter is $8,0 \times 10^{-19}$ J. The incident light has a wavelength of 200 nm.
Calculate the maximum speed at which an electron can be emitted. (5)

- 11.1.3 Incident light of a higher frequency is now used.
How will this change affect the maximum kinetic energy of the electron emitted in Question 11.1.2? Write down only **increases, decreases** or **remains the same**. (1)
- 11.1.4 The intensity of the incident light is now increased.
How will this change affect the speed of the electron calculated in Question 11.1.2? Write down **increases, decreases** or **remains the same**. (1)
- 11.2 A metal worker places two iron rods, **A** and **B**, in a furnace. After a while he observes that **A** glows deep red while **B** glows orange.
Which ONE of the rods (**A** or **B**) radiates more energy? Give a reason for the answer. (2)
- 11.3 Neon signs illuminate many buildings. What type of spectrum is produced by neon signs? (1)
- [11]

TOTAL: 150

PAPER 2

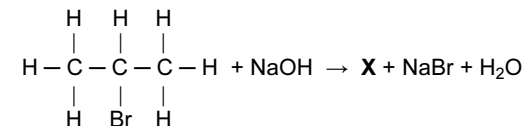
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Question 1

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (**A - D**) next to the question number (1.1 - 1.10).

- 1.1 Which ONE of the following is the functional group of aldehydes?
A — COO — **B** — COOH
C — CHO **D** — OH (2)
- 1.2 Which ONE of the following hydrocarbons always gives a product with the same IUPAC name when any one of its hydrogen atoms is replaced with a chlorine atom?
A propane **B** prop-1-ene
C 2,2-dibromopropane **D** 1-bromoethane (2)

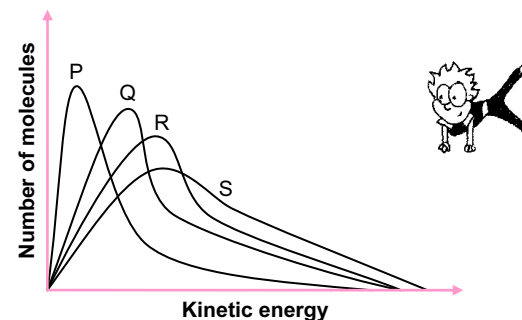
- 1.3 The equation below represents the reaction that takes place when an organic compound and concentrated sodium hydroxide are strongly heated. **X** represents the major organic product formed.



Which ONE of the following is the correct IUPAC name for compound **X**?

- A** prop-1-ene **B** prop-2-ene
C propan-1-ol **D** propan-2-ol (2)

- 1.4 The graphs below represent the molecular distribution for a reaction at different temperatures.



Which ONE of the graphs above represents the reaction at the highest temperature?

- A** P **B** Q
C R **D** S (2)

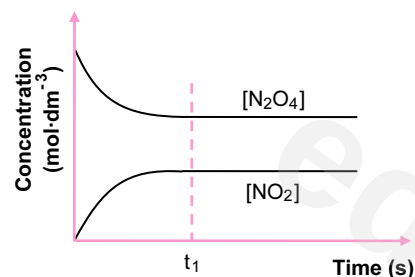
- 1.5 The reaction represented below reaches equilibrium in a closed container:



Which ONE of the following changes will increase the yield of products?

- A** Increase temperature.
B Decrease temperature.
C Increase pressure by decreasing the volume.
D Decrease pressure by increasing the volume. (2)

- 1.6 The graph below represents the decomposition of $\text{N}_2\text{O}_4(\text{g})$ in a closed container according to the following equation: $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$



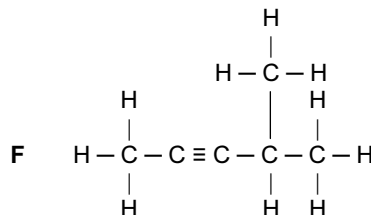
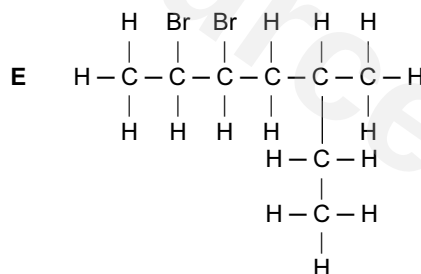
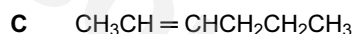
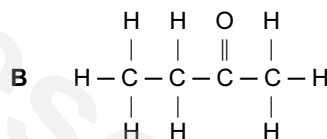
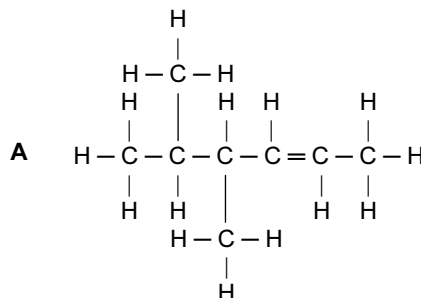
Which ONE of the following correctly describes the situation at t_1 ?

- A** The N_2O_4 gas is used up.
B The NO_2 gas is used up.
C The rate of the forward reaction equals the rate of the reverse reaction.
D The concentrations of the reactant and the product are equal. (2)
- 1.7 Which ONE of the following is the strongest oxidising agent?
A $\text{F}_2(\text{g})$ **B** $\text{F}^-(\text{aq})$
C $\text{Li}(\text{s})$ **D** $\text{Li}^+(\text{aq})$ (2)
- 1.8 Which ONE of the following statements about a galvanic cell in operation is correct?
A ΔH for the cell reaction is positive.
B The overall cell reaction is non-spontaneous.
C The emf is negative.
D ΔH for the cell reaction is negative. (2)
- 1.9 The function of the salt bridge in a galvanic cell in operation is to . . .
A allow anions to travel to the cathode.
B maintain electrical neutrality in the half-cells.
C allow electrons to flow through it.
D provide ions to react at the anode and cathode. (2)
- 1.10 The major product formed at the anode in a membrane cell is . . .
A hydrogen. **B** oxygen.
C chlorine. **D** hydroxide ions. (2)

[20]

Question 2

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



- 2.1 Write down the letter(s) that represent(s) the following:

- 2.1.1 alkenes (2)
 2.1.2 a ketone (1)
 2.1.3 a compound with the general formula $\text{C}_n\text{H}_{2n-2}$ (1)
 2.1.4 a structural isomer of octanoic acid (2)

- 2.2 Write down the IUPAC name of compound:

2.2.1 **A** 2.2.2 **E** 2.2.3 **F** (2)(2)(2)

- 2.3 Compound **D** is prepared by reacting two organic compounds in the presence of an acid as catalyst.

Write down the:

- 2.3.1 homologous series to which compound **D** belongs (1)
 2.3.2 structural formula of compound **D** (2)
 2.3.3 IUPAC name of the organic acid used to prepare compound **D** (1)
 2.3.4 name or formula of the catalyst used (1)

[17]

Question 3

A laboratory technician is supplied with three unlabelled bottles containing an alcohol, an aldehyde and an alkane respectively of comparable molecular mass. She takes a sample from each bottle and labels them **P**, **Q** and **R**.

In order to identify each sample, she determines the boiling point of each under the same conditions. The results are shown in the table below.

Sample	Boiling point (°C)
P	76
Q	36
R	118

- 3.1 For this investigation, write down the:
 3.1.1 independent variable (1)
 3.1.2 dependent variable (1)
- 3.2 From the passage above, write down a phrase that shows that this investigation is a fair test. (1)
- 3.3 Which sample (**P**, **Q** or **R**) is the:
 3.3.1 alkane (1)
 3.3.2 alcohol (1)
- 3.4 Refer to boiling point and the type of inter-molecular forces present between alcohol molecules to give a reason for the answer in Question 3.3.2. (2)

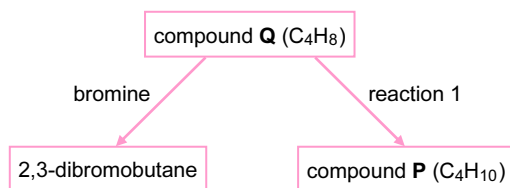
- 3.5 The alkane is identified as pentane. Will the boiling point of hexane be **higher than** or **lower than** that of pentane? Refer to **molecular structure, intermolecular forces** and **energy** needed to explain the answer. (4) [11]

Question 4

Two straight chain compounds, **P** and **Q**, each have the following molecular formula:



- 4.1 Write down the name of the homologous series to which compound **Q** belongs. (1)
- 4.2 Compound **P** reacts with chlorine to form 2-chlorobutane.
Write down:
- 4.2.1 a balanced chemical equation, using molecular formulae, for the reaction that takes place (3)
- 4.2.2 the type of reaction that takes place (1)
- 4.2.3 one reaction condition (other than the solvent needed) (1)
- 4.3 Compound **Q** takes part in reactions as shown in the flow diagram below.



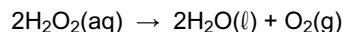
Write down the:

- 4.3.1 structural formula for 2,3-dibromobutane (2)
- 4.3.2 IUPAC name of compound **Q** (2)
- 4.3.3 balanced equation, using structural formulae, for **reaction 1** (4)
- 4.3.4 type of reaction that occurs in **reaction 1** (1) [15]

Note: You are required by CAPS to identify different types of addition and elimination reactions.

Question 5

A hydrogen peroxide solution decomposes slowly at room temperature according to the following equation:

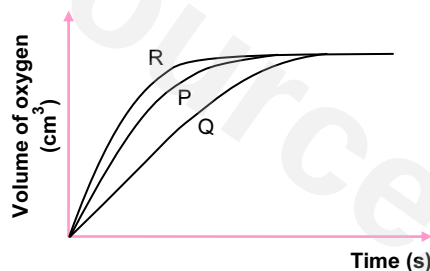


During an investigation, learners compare the effectiveness of three different catalysts on the rate of decomposition of hydrogen peroxide. They place equal amounts of sufficient hydrogen peroxide into three separate containers. They then add equal amounts of the three catalysts, **P**, **Q** and **R**, to the hydrogen peroxide in the three containers respectively and measure the rate at which oxygen gas is produced.

- 5.1 For this investigation, write down the:

- 5.1.1 independent variable (1)
- 5.1.2 dependent variable (1)

The results obtained are shown in the graph below.



- 5.2 Which catalyst is the most effective? Give a reason for the answer. (2)
- 5.3 Fully explain, by referring to the collision theory, how a catalyst increases the rate of a reaction. (3)

In another experiment, the learners obtain the following results for the decomposition of hydrogen peroxide:

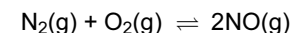
Time (s)	H ₂ O ₂ concentration (mol·dm ⁻³)
0	0,0200
200	0,0160
400	0,0131
600	0,0106
800	0,0086

- 5.4 Calculate the average rate of decomposition (in mol·dm⁻³·s⁻¹) of H₂O₂(aq) in the first 400 s. (3)

- 5.5 Will the rate of decomposition at 600 s be **greater than**, **less than** or **equal to** the rate calculated in Question 5.4? Give a reason for the answer. (2)
- 5.6 Calculate the mass of oxygen produced in the first 600 s if 50 cm³ of hydrogen peroxide decomposes in this time interval. (5) [17]

Question 6

A chemical engineer studies the reaction of nitrogen and oxygen in a laboratory. The reaction reaches equilibrium in a closed container at a certain temperature, **T**, according to the following balanced equation:

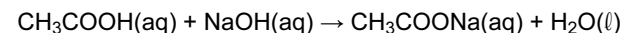


Initially, 2 mol of nitrogen and 2 mol of oxygen are mixed in a 5 dm³ sealed container. The equilibrium constant (K_c) for the reaction at this temperature is $1,2 \times 10^{-4}$.

- 6.1 Is the yield of NO(g) at temperature **T** **high** or **low**? Give a reason for the answer. (2)
- 6.2 Calculate the equilibrium concentration of NO(g) at this temperature. (8)
- 6.3 How will each of the following changes affect the yield of NO(g)? Write down only **increases**, **decreases** or **remains the same**.
- 6.3.1 The volume of the reaction vessel is decreased at constant temperature. (1)
- 6.3.2 An inert gas such as argon is added to the mixture. (1)
- 6.4 It is found that K_c of the reaction increases with an increase in temperature. Is this reaction **exothermic** or **endothermic**? Explain the answer. (3) [15]

Question 7

A Grade 12 class wants to determine the percentage of ethanoic acid in a certain bottle of vinegar. They titrate a sample taken from the bottle of vinegar with a standard solution of sodium hydroxide. The equation for the reaction is:

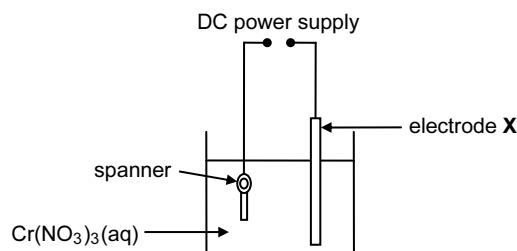


- 7.1 Define an *acid* in terms of the Arrhenius theory. (1)
- 7.2 Give a reason why ethanoic acid is classified as a weak acid. (1)

- 7.3 Explain the meaning of *standard solution*. (1)
- 7.4 Write down the names of TWO items of apparatus needed to measure accurate volumes of the acid and the base in this titration. (1)
- 7.5 It is found that 40 ml of a 0,5 mol·dm⁻³ sodium hydroxide solution is needed to neutralise 20 ml of the vinegar.
Calculate the:
- 7.5.1 pH of the sodium hydroxide solution (3)
- 7.5.2 percentage of ethanoic acid by mass present in the vinegar (assume that 1 ml of vinegar has a mass of 1 g) (6)
- 7.6 The sodium ethanoate (CH₃COONa) formed during the above neutralisation reaction undergoes hydrolysis to form an alkaline solution. Write down an equation for this hydrolysis reaction. (2) [15]

Question 8

The diagram below represents a simplified electrolytic cell used to electroplate a spanner with chromium. The spanner is continuously rotated during the process of electroplating.



A constant current passes through the solution and the concentration of Cr(NO₃)₃(aq) remains constant during the process. In the process, a total of 0,03 moles of electrons is transferred in the electrolytic cell.

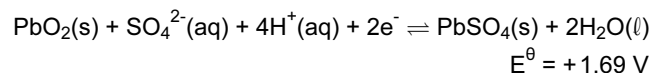
- 8.1 Define the term *electrolysis*. (2)
- 8.2 Write down the:
- 8.2.1 half-reaction that occurs at the spanner (2)
- 8.2.2 **name** or **formula** of the metal of which electrode X is made (1)
- 8.2.3 **name** or **formula** of the oxidising agent (1)
- 8.3 Calculate the gain in mass of the spanner. (4) [10]

Question 9 (Optional)

Batteries are examples of galvanic cells. Lead-acid batteries consist of several cells. A sulphuric acid solution is used as electrolyte in these batteries.

- 9.1 Define the term *electrolyte*. (2)

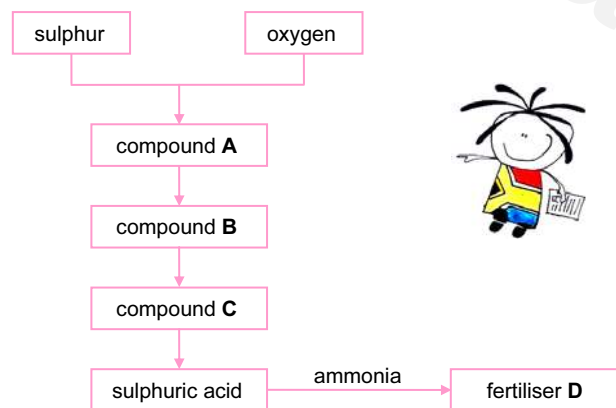
The standard reduction potentials for the half-reactions that take place in a cell of a lead-acid battery are as follows:



- 9.2 Write down the half-reaction that takes place at the anode of this cell. (2)
- 9.3 Write down the overall cell reaction when the cell delivers current. (3)
- 9.4 A number of the cells above are connected in series to form a 300 V battery which operates at standard conditions.
Calculate the minimum number of cells in this battery. (5) [12]

Question 10

Sulphuric acid is used, amongst others, in the manufacturing of fertilisers. The flow diagram below shows how fertiliser **D** can be prepared using sulphuric acid as one of the reagents.



- 10.1 Write down the **name** of the industrial process for the preparation of sulphuric acid. (1)

- 10.2 Compound **A** is formed when sulphur burns in oxygen. Write down the **name** or **formula** of compound **A**. (1)
- 10.3 Compound **B** is formed when compound **A** reacts with oxygen in the presence of a catalyst. Write down the:
- 10.3.1 **name** or **formula** of the catalyst (1)
- 10.3.2 balanced equation for the reaction which takes place (3)
- 10.4 Compound **B** is dissolved in concentrated sulphuric acid to form compound **C**. Write down the **name** or **formula** of compound **C**. (1) [7]

Question 11

- 11.1 A farmer wants to produce the following fruit and vegetables for the market:
spinach; potatoes; apples
Write down the **name** of the most important primary nutrient required to enhance:
- 11.1.1 root growth of potato plants (1)
- 11.1.2 leaf growth of spinach (1)
- 11.1.3 flower and fruit production of apple trees (1)
- 11.2 Ammonia must be produced in large quantities to produce nitrogen-based fertilisers.
- 11.2.1 Write down the **name** of the process used in the industrial preparation of ammonia. (1)
- 11.2.2 Write down a balanced chemical equation for the reaction that takes place in the process named in Question 11.2.1. (3)
- 11.3 Ammonium hydrogen phosphate, (NH₄)₂HPO₄, is a type of fertiliser used in agriculture.
Refer to the type of elements of which this fertiliser is composed to give a reason why it will be advantageous for a farmer to use this fertiliser instead of a fertiliser such as ammonium nitrate, NH₄NO₃. (2)
- 11.4 Describe ONE negative impact on humans when fertiliser runs off into dams and rivers as a result of rain. (2) [11]

TOTAL: 150

EXAM MEMOS

EXAM MEMO 1

National Nov 2013 - Adapted for CAPS

Question 1

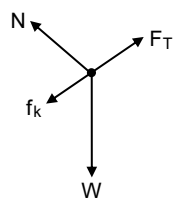
- 1 B 1.2 B 1.3 C 1.4 D
 5 A 1.6 B 1.7 D 1.8 B
 9 D 1.10 B

[20]

Question 2

- 1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the force and inversely proportional to the mass of the object. (2)

- 2 remains the same (1)



Accepted labels	
W	F_g / F_w / weight / mg / gravitational force
f_k	F_{friction} / F_f / friction
N	F_N / F_{normal} / normal force
F_T	F_t / T / tension

(2)

- 4 Take up the incline as positive:

$$\begin{aligned} \therefore F_{\text{net}} &= ma \\ \therefore F_T + f_k + w_{\parallel} &= ma \\ \therefore F_T + \mu_k N + w \sin 30^\circ &= ma \\ \therefore F_T + \mu_k mg \cos 30^\circ + mg \sin 30^\circ &= ma \\ \therefore F_T - (0,2)(6)(9,8) \cos 30^\circ - (6)(9,8) \sin 30^\circ &= (6)(4) \\ \therefore F_T &= 63,58 \text{ N up the inclined plane} \end{aligned}$$

(5)
[10]

$$N = w_{\perp} = mg \cos 30^\circ$$



Question 3

- 3.1 $15 \text{ m} \cdot \text{s}^{-1}$ (1)

- 3.2 inelastic

The magnitude of the speed at which the ball leaves the floor ($15 \text{ m} \cdot \text{s}^{-1}$) is less than that at which it strikes the floor ($20 \text{ m} \cdot \text{s}^{-1}$).

(3)



Note: Use words and refer explicitly to values read off the graph.

- 3.3.1 Option 1

$$\begin{aligned} v_f^2 &= v_i^2 + 2a\Delta y \\ \therefore (20)^2 &= (10)^2 + 2(9,8)\Delta y \\ \therefore \Delta y &= 15,31 \text{ m} \end{aligned}$$

Take $\downarrow +$
 $v_i = 10 \text{ m} \cdot \text{s}^{-1}$
 $v_f = 20 \text{ m} \cdot \text{s}^{-1}$
 $g = 9,8 \text{ m} \cdot \text{s}^{-2}$

- Option 2

$$\begin{aligned} (E_p + E_k)_{\text{top}} &= (E_p + E_k)_{\text{bottom}} \\ \left(mgh + \frac{1}{2}mv^2 \right)_{\text{top}} &= \left(mgh + \frac{1}{2}mv^2 \right)_{\text{bottom}} \\ m(9,8)h + \frac{1}{2}m(10)^2 &= m(9,8)(0) + \frac{1}{2}m(20)^2 \\ 9,8h + 50 &= 200 \\ \therefore h &= 15,31 \text{ m} \end{aligned}$$

- Option 3

$$\begin{aligned} v_f &= v_i + a\Delta t \\ \therefore 20 &= 10 + (9,8)(\Delta t) \\ \therefore \Delta t &= 1,02 \text{ s} \end{aligned}$$

$$\begin{aligned} \Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \\ &= (10)(1,02) + \frac{1}{2}(9,8)(1,02)^2 \\ \therefore \Delta y &= 15,31 \text{ m} \end{aligned}$$

- 3.3.2 $F_{\text{net}}\Delta t = \Delta p$

$$\begin{aligned} F_{\text{net}}\Delta t &= mv_f - mv_i \\ &= m(v_f - v_i) \\ &= 0,15(-15 - 20) \\ &= -5,25 \text{ N} \cdot \text{s} \text{ (or } -5,25 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}) \end{aligned}$$

$$\text{Impulse} = 5,25 \text{ N} \cdot \text{s} \text{ or } 5,25 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1} \quad (3)$$

- 3.3.3 Option 1

Displacement from floor to maximum height:

$$\begin{aligned} v_f^2 &= v_i^2 + 2a\Delta y \\ \therefore (0)^2 &= (-15)^2 + 2(9,8)\Delta y \\ \therefore \Delta y &= -11,48 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Total displacement} &= -11,48 + 15,31 \\ &= 3,83 \text{ m} \end{aligned}$$

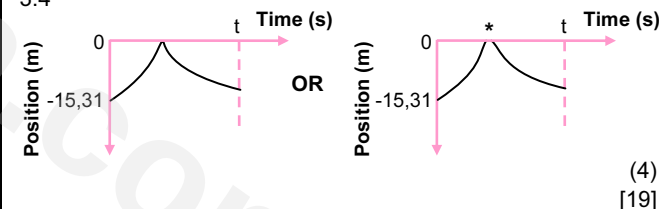
- Option 2

$$\begin{aligned} v_f &= v_i + a\Delta t \\ \therefore 0 &= -15 + (9,8)\Delta t \\ \therefore \Delta t &= 1,53 \text{ s} \\ \Delta y &= v_i\Delta t + \frac{1}{2}a\Delta t^2 \\ &= (-15)(1,53) + \frac{1}{2}(9,8)(1,53)^2 \\ &= -11,48 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Total displacement} &= -11,48 + 15,31 \\ &= 3,83 \text{ m} \end{aligned} \quad (4)$$



- 3.4



Note: The small time interval * when $y = 0$ is the time interval of the impulse ($F\Delta t$) of the ground on the ball.

(4)
[19]

Question 4

- 4.1 west (1)

- 4.2 (Newton's) Third Law (of Motion)
 When object A exerts a force on object B, object B exerts a force equal in magnitude on object A, but opposite in direction. (3)

4.3 Option 1

east as positive :

$$\Sigma p_i = \Sigma p_f$$

$$\therefore 0 = (60)v_f + (5)(4)$$

$$\therefore v_f = -0,33$$

$$\therefore v_f = 0,33 \text{ m}\cdot\text{s}^{-1}$$

west as positive :

$$\Sigma p_i = \Sigma p_f$$

$$\therefore 0 = (60)v_f + (5)(-4)$$

$$\therefore v_f = 0,33 \text{ m}\cdot\text{s}^{-1}$$

Option 2

east as positive :

$$\Delta p_A = -\Delta p_B$$

$$\therefore (60)v_f - 0 = -[(5)(4) - 0]$$

$$\therefore v_f = -0,33$$

$$\therefore v_f = 0,33 \text{ m}\cdot\text{s}^{-1}$$

west as positive :

$$\Delta p_A = -\Delta p_B$$

$$\therefore (60)v_f - 0 = -[(5)(-4) - 0]$$

$$\therefore v_f = 0,33 \text{ m}\cdot\text{s}^{-1}$$

(5)

4.4.1 increases (1)

4.4.2 increases

- ▷ Δp package increases, thus Δp boy increases.
- ▷ for the same mass (m) of the boy, the velocity (v) will be greater.

(3)

[13]



Note: According to Newton III, the boy and the package exert equal but opposite forces on each other.

Question 5

5.1 The total mechanical energy remains constant in an isolated system. (2)

Note: We refer to an isolated system when no net external forces are acting on it.

We refer to a closed system when no material or energy can enter or leave the system.

5.2 Option 1

$$E_{\text{mechanical at X}} = E_{\text{mechanical at Y}}$$

$$\therefore (E_p + E_k)_X = (E_p + E_k)_Y$$

$$\therefore \left(mgh + \frac{1}{2}mv^2 \right)_X = \left(mgh + \frac{1}{2}mv^2 \right)_Y$$

$$\therefore 5(9,8)(5) + \frac{1}{2}(5)(0^2) = (5)(9,8)(1) + \frac{1}{2}(5)v_Y^2$$

$$v_Y^2 = 78,4$$

$$\therefore v_Y = 8,85 \text{ m}\cdot\text{s}^{-1}$$



m	= 5 kg
at X: h	= 5 m
v	= 0 m·s ⁻¹
at Y: h	= 1 m
v	= ?

Option 2

$$E_{\text{mechanical at X}} = E_{\text{mechanical at Y}}$$

$$\therefore (E_p + E_k)_X = (E_p + E_k)_Y$$

$$\therefore \left(mgh + \frac{1}{2}mv^2 \right)_X = \left(mgh + \frac{1}{2}mv^2 \right)_Y$$

$$\therefore 5(9,8)(4) + \frac{1}{2}(5)(0^2) = (5)(9,8)(0) + \frac{1}{2}(5)v_Y^2$$

$$\therefore v_Y = 8,85 \text{ m}\cdot\text{s}^{-1}$$

(4)

5.3 1) weight / gravitational force / force of gravity
and 2) normal force (2)

5.4 Z to Y (1)

5.5 Option 1: for the part YZ

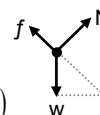
$$W_{\text{net}} = \Delta K / \Delta E_k$$

$$\therefore W_w + W_f = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$\therefore mg\Delta y \cos 0^\circ + f\Delta x \cos 180^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$\therefore (5)(9,8)(1)(1) + (10)\Delta x(-1) = \frac{1}{2}(5)(4^2 - 8,85^2)$$

$$\therefore \Delta x = 20,48 \text{ m}$$



Option 2: for the part YZ:

$$W_{\text{net}} = \Delta K / \Delta E_k$$

$$\therefore W_w + W_f = \Delta E_k$$

$$\therefore -\Delta E_p + W_f = \Delta E_k$$

$$\therefore -(0 - mgh) + f\Delta x \cos 180^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$\therefore (5)(9,8)(1) + (10)\Delta x(-1) = \frac{1}{2}(5)(4^2 - 8,85^2)$$

$$\therefore \Delta x = 20,48 \text{ m}$$

Option 3: for the part XY:

$$W_{\text{net}} = \Delta K / \Delta E_k$$

$$\therefore W_w + W_f = \Delta E_k$$

$$\therefore -\Delta E_p + W_f = \Delta E_k$$

$$\therefore -(0 - mgh) + f\Delta x \cos 180^\circ = \frac{1}{2}m(v_f^2 - v_i^2)$$

$$\therefore (5)(9,8)(5) + (10)\Delta x(-1) = \frac{1}{2}(5)(4^2 - 0^2)$$

$$\therefore \Delta x = 20,48 \text{ m}$$

Option 4 (followed from option 2)



Frictional force is the only non-conservative force that acts on the cart over the YZ part.

$$\therefore W_{\text{nc}} = \Delta E_p + \Delta E_k$$

$$\therefore f\Delta x \cos \theta = (mgh_f - mgh_i) + \left(\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \right)$$

$$\therefore (10)\Delta x \cos 180^\circ = [0 - (5)(9,8)(1)] + \left[\frac{1}{2}(5)(4)^2 - \frac{1}{2}(5)(8,85)^2 \right]$$

$$\therefore \Delta x = 20,48 \text{ m}$$

(5)

5.6 equal to (1)

[15]

Question 6

6.1 Doppler flow meter (1)

$$6.2 \quad f_L = \frac{v \pm v_L}{v \pm v_s} f_s$$

$$\therefore 985 = \frac{v}{(v - 10,6)}(954,3)$$

$$\therefore v = 340,1 \text{ m}\cdot\text{s}^{-1}$$

(5)

6.3 decreases (1)

6.4 For a constant speed of sound if the frequency increases, wavelength decreases.

OR $\lambda \propto \frac{1}{f}$ or $f \propto \frac{1}{\lambda}$ for a constant speed (2)

- 6.5
- ▷ The Doppler effect is the apparent/observed change in frequency of a wave
 - ▷ when the source of the wave and an observer move relative to each other (and to the medium through which the wave is propagated)



NB: The general definition, and not one specific for sound, is asked.

(2)

[11]

Question 7

$$F = k \frac{Q_1 Q_2}{r^2}$$

$$F(Q_2 \text{ on } Q_1) = (9 \times 10^9) \frac{(4 \times 10^{-6})(4 \times 10^{-6})}{(3 \times 10^{-3})^2}$$

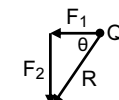
$$= 1,6 \times 10^4 \text{ N to the left}$$

$$F(Q_3 \text{ on } Q_1) = (9 \times 10^9) \frac{(4 \times 10^{-6})(4 \times 10^{-6})}{(3 \times 10^{-3})^2}$$

$$= 1,6 \times 10^4 \text{ N downwards}$$

$$F_{\text{net}} = \sqrt{(F_{Q_2 \text{ on } Q_1})^2 + (F_{Q_3 \text{ on } Q_1})^2}$$

$$= \sqrt{(1,6 \times 10^4)^2 + (1,6 \times 10^4)^2} = 2,26 \times 10^4 \text{ N}$$



$$\tan \theta = \frac{F_2}{F_1}$$

$$= \frac{1,6 \times 10^4}{1,6 \times 10^4}$$

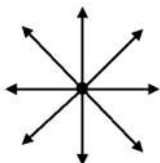
$$= 1$$

$$\therefore \theta = 45^\circ$$

$$F_{\text{net}} = 2,26 \times 10^4 \text{ N SW} / 225^\circ / 45^\circ \text{ south of west} / \text{S}45^\circ\text{W} \quad [7]$$

Question 8

8.1



- field lines radially around charge
- direction of field lines away from the positive charge

(2)

8.2 non-uniform (1)

$$E = \frac{kQ}{r^2}$$

$$= \frac{(9 \times 10^9)(16 \times 10^{-6})}{(0,12)^2}$$

$$= 1 \times 10^7 \text{ N} \cdot \text{C}^{-1} \text{ east} \quad (5)$$

8.4 positive (1)

E-field at X due to A is east, thus the E-field due to B must be west. (E_{net} is west) $\therefore$ B is positive.

8.5 take west: positive

$$E_A + E_B = E_{\text{net}}$$

$$\therefore -1 \times 10^7 + E_B = 1 \times 10^7$$

$$\therefore E_B = 2 \times 10^7 \text{ N} \cdot \text{C}^{-1} \text{ west}$$

OR take west: negative

$$E_A + E_B = E_{\text{net}}$$

$$\therefore 1 \times 10^7 + E_B = -1 \times 10^7$$

$$\therefore E_B = -2 \times 10^7 \text{ N} \cdot \text{C}^{-1}$$

$$= 2 \times 10^7 \text{ N} \cdot \text{C}^{-1} \text{ west}$$

$$\therefore E_B = \frac{kQ_B}{r^2}$$

$$\therefore 2 \times 10^7 = \frac{(9 \times 10^9)Q_B}{(0,23)^2}$$

$$\therefore Q_B = 1,18 \times 10^{-4} \text{ C}$$

Use distance X_B here for r .

Note: When substituting the values for the E-field in this equation, the correct sign must be used, like for vector addition.

Note: Only use magnitudes of E_B and Q_B in this equation.

(5) [14]

Question 9

9.1 12 J of energy are transferred to each coulomb (of charge) delivered by the battery. (2)

9.2 Option 1

$$P = I^2 R$$

$$\therefore 5 = I^2 (5)$$

$$\therefore I = 1 \text{ A}$$



Note: Mark allocation indicates preference for Option 1.

Option 2

$$P = \frac{V^2}{R}$$

$$\therefore 5 = \frac{V^2}{5}$$

$$\therefore V = 5 \text{ V}$$

$$P = VI$$

$$\therefore 5 = (5)I$$

$$\therefore I = 1 \text{ A}$$

Option 3

$$P = \frac{V^2}{R}$$

$$\therefore 5 = \frac{V^2}{5}$$

$$\therefore V = 5 \text{ V}$$

$$V = IR$$

$$\therefore 5 = I(5)$$

$$\therefore I = 1 \text{ A} \quad (3)$$

9.3 Option 1

$$\text{emf} = I(R_{\text{ext}} + r)$$

$$\therefore 12 = (1)(R_{\text{ext}} + 1)$$

$$\therefore R_{\text{ext}} = 11 \Omega$$

$$R_p = 11 - 5$$

$$= 6 \Omega$$

Option 3

$$V = IR_T$$

$$\therefore 12 = (1)R_T$$

$$\therefore R_T = 12 \Omega$$

$$R_p = R_T - (5 + 1)$$

$$= 12 - 6$$

$$= 6 \Omega$$

Note: $R_T = R_{\text{ext}} + r$
 $= R_p + R_5 + r$

For Options 1, 2 and 3

$$\frac{1}{R_p} = \frac{1}{R_{12}} + \frac{1}{R}$$

$$\therefore \frac{1}{6} = \frac{1}{12} + \frac{1}{4 + R_X}$$

$$\therefore \frac{1}{12} = \frac{1}{4 + R_X}$$

$$\therefore 12 = 4 + R_X$$

$$\therefore R_X = 8 \Omega$$

OR

$$R_p = \frac{(4 + R_X)(12)}{4 + R_X + 12}$$

$$\therefore 6 = \frac{(4 + R_X)(12)}{4 + R_X + 12}$$

$$\therefore 6 = \frac{48 + 12R_X}{16 + R_X}$$

$$\therefore 96 + 6R_X = 48 + 12R_X$$

$$\therefore R_X = 8 \Omega$$

Option 4

$$V_{5\Omega} = IR$$

$$= (1)(5)$$

$$= 5 \text{ V}$$

$$V_{\text{internal}} = Ir$$

$$= (1)(1)$$

$$= 1 \text{ V}$$

$$V_{\text{parallel}} = 12 - (1 + 5)$$

$$= 6 \text{ V}$$

$$V_{\text{parallel}} = IR$$

$$\therefore 6 = I(12)$$

$$\therefore I = 0,5 \text{ A}$$

$$I_{R_X} = 1 - 0,5$$

$$= 0,5 \text{ A}$$

$$V = IR$$

$$\therefore 6 = (0,5)(4 + R_X)$$

$$\therefore R_X = 8 \Omega \quad (7)$$

9.4 no

If S is opened, the $\parallel$ branch falls away and the total resistance (R) increases. The current (I) decreases and the power ($P = I^2 R$) decreases (for constant R). (4) [16]

Question 10

10.1.1 slip rings

10.1.2 (carbon) brush(es) (1)(1)

10.2 Maintains electrical contact with the slip rings.

OR To take current from the coil to the external circuit and back. (1)

10.3 mechanical kinetic energy to electrical potential energy (1)

10.4 $\frac{1}{2}$ (1)

10.5 Option 1

$$f = \frac{1}{T}$$

$$= \frac{1}{0,02}$$

$$= 50 \text{ Hz}$$

Option 2

$$f = \frac{\text{number of cycles}}{\text{time}}$$

$$= \frac{1,5}{0,03} \text{ OR } \frac{1}{0,02} \text{ OR } \frac{0,5}{0,01}$$

$$= 50 \text{ Hz} \quad (3)$$

10.6 parallel to (1)

10.7 Option 1

$$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}}$$

$$= \left(\frac{V_{\text{max}}}{\sqrt{2}} \right) \left(\frac{I_{\text{max}}}{\sqrt{2}} \right)$$

$$= \left(\frac{311}{\sqrt{2}} \right) \left(\frac{21,21}{\sqrt{2}} \right)$$

$$= 3\,298,16 \text{ W}$$

Option 2

$$P_{\text{ave}} = \frac{V_{\text{max}} I_{\text{max}}}{2}$$

$$= \frac{(311)(21,21)}{2}$$

$$= 3\,298,16 \text{ W}$$

Option 3

$$V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}} \quad I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}}$$

$$= \frac{311}{\sqrt{2}} \quad = \frac{21,21}{\sqrt{2}}$$

$$= 219,91... \text{ V} \quad = 14,9977... \text{ A}$$

$$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}}$$

$$= (219,91...)(14,9977...)$$

$$= 3\,298,21 \text{ W}$$

Option 4

$$R = \frac{V_{\text{max}}}{I_{\text{max}}}$$

$$= \frac{311}{21,21}$$

$$= 14,66... \Omega$$

$$V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$$

$$= \frac{311}{\sqrt{2}}$$

$$= 219,91... \text{ V}$$

$$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R}$$

$$= \frac{(219,91...)^2}{14,66...}$$

$$= 3\,298,16 \text{ W}$$

Option 5

$$R = \frac{V_{\text{max}}}{I_{\text{max}}}$$

$$= \frac{311}{21,21}$$

$$= 14,66... \Omega$$

$$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}}$$

$$= \frac{21,21}{\sqrt{2}}$$

$$= 14,9977... \text{ A}$$

$$P_{\text{ave}} = I_{\text{rms}}^2 R$$

$$= (14,997...)^2 (14,66...)$$

$$= 3\,298,16 \text{ W} \quad (5)$$

Note: In Options 3, 4 and 5 the unrounded values from previous steps must be used for calculating P_{ave} . The final answer is then rounded off to 2 decimal figures.

Question 11

11.1.1 photo-electric effect (1)

11.1.2 **Option 1**
Any 1

$$\lambda = 200 \text{ nm} = 200 \times 10^{-9} \text{ m}$$

$$W_0 = 8 \times 10^{-19} \text{ J}$$

$$E = W_0 + E_k \quad \text{OR} \quad hf = hf_0 + E_k \quad \text{OR} \quad \frac{hc}{\lambda} = W_0 + \frac{1}{2}mv^2$$

$$\therefore \frac{(6,63 \times 10^{-34})(3 \times 10^8)}{200 \times 10^{-9}} = 8 \times 10^{-19} + \frac{1}{2}(9,11 \times 10^{-31})v^2$$

$$\therefore v = 6,53 \times 10^5 \text{ m}\cdot\text{s}^{-1}$$

$$(653\,454,89 \text{ m}\cdot\text{s}^{-1})$$

Option 2

$$c = f\lambda$$

$$\therefore 3 \times 10^8 = f(200 \times 10^{-9})$$

$$\therefore f = 1,5 \times 10^{15} \text{ Hz}$$

$$hf = hf_0 + E_k$$

$$\therefore (6,63 \times 10^{-34})(1,5 \times 10^{15}) = 8 \times 10^{-19} + \frac{1}{2}(9,11 \times 10^{-31})v^2$$

$$\therefore v = 6,53 \times 10^5 \text{ m}\cdot\text{s}^{-1} \quad (5)$$

11.1.3 increases (1)

11.1.4 remains the same (1)

11.2 B
Orange light has a higher frequency than red light.
OR
Orange light has a shorter wavelength than red light. (2)

11.3 line emission (spectra) (1)
[11]

TOTAL: 150

EXAM MEMO 2

National Nov 2013 - Adapted for CAPS

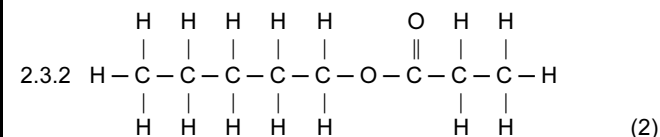
Question 1

- | | | | |
|-------|--------|-------|-------|
| 1.1 C | 1.2 C | 1.3 A | 1.4 D |
| 1.5 B | 1.6 C | 1.7 A | 1.8 D |
| 1.9 B | 1.10 C | | |
- [20]

Question 2

- 2.1.1 A / C 2.1.2 B 2.1.3 F (2)(1)(1)
- 2.1.4 D Both have the molecular formula $C_8H_{16}O_2$. (2)
- 2.2.1 4,5-dimethyl hex-2-ene (2)
- 2.2.2 2,3-dibromo-5-methyl heptane (2)
- 2.2.3 4-methyl pent-2-yne (2)

2.3.1 esters (1)



2.3.3 propanoic acid (1)

2.3.4 sulphuric acid / H_2SO_4 (1)
[17]

Question 3

3.1.1 samples / contents of bottle / (type of) compound / functional group / homologous series (1)

3.1.2 boiling point (1)

3.2 ... comparable molecular masses **OR**
... under the same conditions (1)

3.3.1 Q 3.3.2 R (1)(1)

3.4 Alkanes and aldehydes have weaker Van der Waals forces between their molecules, while alcohol has additional strong hydrogen bonds, so more energy is needed to break bonds between alcohol molecules, so higher boiling point. (2)

3.5 higher than

▷ **Molecular structure:**

longer chain length / more C atoms in chain / greater molecular size / greater molecular mass / larger surface area

▷ **Intermolecular forces:**

stronger intermolecular forces / Van der Waals forces / dispersion forces / London forces

▷ **Energy:**

more energy needed to overcome or break intermolecular forces / Van der Waals forces / dispersion forces / London forces (4)
[11]

Our solutions are set out in such a way as to promote thorough understanding and logic!

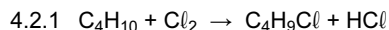


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Question 4

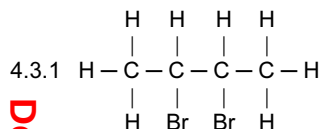
4.1 alkenes (1)



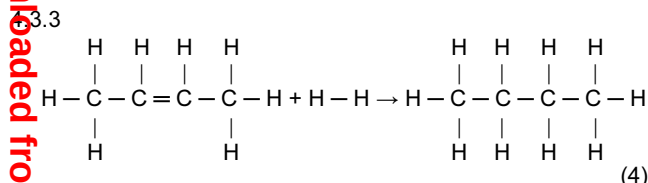
NB: Asked for molecular formulae.

4.2.2 substitution (halogenation/chlorination) (1)

4.2.3 gentle heat **OR** (sun)light (UV) / hf (1)



4.3.2 but-2-ene (2)



4.3.4 addition (hydrogenation) (1)

[15]

Question 5

5.1.1 (type of) catalyst (1)

5.1.2 rate (of reaction) (1)

5.2 R
fastest rate / steepest (initial) gradient or slope/
reaction is completed in the shortest time (2)

- 5.3
- ▶ A catalyst provides an alternative pathway of lower activation energy.
 - ▶ More molecules have sufficient/enough kinetic energy. / More molecules have kinetic energy equal to or greater than the activation energy.
 - ▶ More effective collisions per unit time. / Rate of effective collisions increases.

(3)

5.4 Average rate = $\frac{\Delta[H_2O_2]}{\Delta t}$
 $= \frac{0,0131 - 0,020}{400 - (0)}$
 $= -1,73 \times 10^{-5} \text{ mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$
OR $1,73 \times 10^{-5} \text{ mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$ (3)



5.5 less than

The concentration of hydrogen peroxide decreases as the reaction proceeds; fewer molecules per unit of volume, thus fewer effective collisions per time unit. (2)

5.6 Option 1

$$c = \frac{n}{V}$$

$$\therefore (0,0200 - 0,0106) = \frac{n}{5 \times 10^{-3}}$$

$$\therefore n = 4,7 \times 10^{-4} \text{ mol}$$

$n(O_2 : H_2O_2)$

= 1 : 2

$$\therefore n(O_2) = \frac{1}{2}n(H_2O_2)$$

$$= \frac{1}{2}(4,7 \times 10^{-4})$$

$$= 2,35 \times 10^{-4} \text{ mol}$$

$$n(O_2) = \frac{m}{M}$$

$$\therefore 2,35 \times 10^{-4} = \frac{m}{32}$$

$$\therefore m(O_2) = 7,52 \times 10^{-3} \text{ g } O_2$$

Option 2

$$\Delta c(H_2O_2) = 0,0200 - 0,0106$$

$$= 0,0094$$

$$\Delta c(O_2) = \frac{1}{2}\Delta c(H_2O_2)$$

$$= \frac{1}{2}(0,0094) = 0,0047$$

$$c = \frac{m}{MV}$$

$$\therefore m(O_2) = cMV$$

$$= (0,0047)(32)(50 \times 10^{-3})$$

$$= 7,52 \times 10^{-3} \text{ g } O_2$$

Option 3

$$\text{At } t = 0, n(H_2O_2) = cV$$

$$= 0,02 \times 0,05$$

$$= 0,001 \text{ mol}$$

$$\text{At } t = 600, n(H_2O_2) = cV$$

$$= 0,0106 \times 0,05$$

$$= 5,3 \times 10^{-4} \text{ mol}$$

$$\text{Change in } n(H_2O_2) = 5,3 \times 10^{-4} - 0,001$$

$$= -4,7 \times 10^{-4} \text{ mol}$$

Note: Use mole ratio from balanced equation.



$n(O_2 : H_2O_2)$

= 1 : 2

$$\therefore n(O_2) \text{ formed} = \frac{1}{2}n(H_2O_2) \text{ reacted}$$

$$= \frac{1}{2}(4,7 \times 10^{-4}) = 2,35 \times 10^{-4} \text{ mol } O_2$$

$m = nM$

$$= 2,35 \times 10^{-4} \times 32$$

$$= 7,52 \times 10^{-3} \text{ g } O_2$$

(5)

[17]

Question 6

6.1 low

▶ small K_c value

▶ K_c is smaller than 1 (2)

6.2

$V = 5 \text{ dm}^3$		N_2	O_2	NO
I (initial)	initial (mol)	2	2	0
C (change)	change in (mol)	-x	-x	+2x
E (equilibrium)	equilibrium (mol)	2 - x	2 - x	2x
	(concentration) (mol·dm ⁻³)	$\frac{2-x}{5}$	$\frac{2-x}{5}$	$\frac{2x}{5}$

$$K_c = \frac{[NO]^2}{[N_2][O_2]}$$

$$\therefore 1,2 \times 10^{-4} = \frac{\left(\frac{2x}{5}\right)^2}{\left(\frac{2-x}{5}\right)\left(\frac{2-x}{5}\right)}$$

$$= \frac{4x^2}{25} \times \frac{25}{(2-x)^2}$$

$$\therefore \sqrt{1,2 \times 10^{-4}} = \frac{2x}{2-x}$$

$$\therefore 0,01095 = \frac{2x}{2-x}$$

$$\therefore 0,0219 - 0,01095x = 2x$$

$$\therefore x = 0,0109 \text{ mol}$$

$$\therefore [NO] = \frac{2(0,0109)}{5}$$

$$= 4,36 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}$$

(8)

It is best to keep answers like this in scientific notation, with at least two decimal places.



6.3.1 remains the same

The number of mol on both sides is the same, i.e. 2 mol, thus an increase in pressure doesn't favour either reaction.

6.3.2 remains the same

6.4 endothermic

- (An increase in K_c implies) an increase in concentration of products.

OR (An increase in K_c implies) that the forward reaction is favoured

OR (An increase in K_c implies) the equilibrium position shifts to the right.

- An increase in temperature favours an endothermic reaction.

Question 7

7.1 An acid forms hydronium ions/ H_3O^+ ions when it dissolves in water.

7.2 incompletely / partially ionised during a reaction with water

7.3 solution of known concentration

7.4 burette; pipette

7.5.1 **Option 1**

$$K_w = [H_3O^+][OH^-]$$

$$\therefore 1 \times 10^{-14} = [H_3O^+](0,5)$$

$$\therefore [H_3O^+] = 2 \times 10^{-14} \text{ mol}\cdot\text{dm}^{-3}$$

$$\begin{aligned} \text{pH} &= -\log[H_3O^+] \\ &= -\log(2 \times 10^{-14}) \\ &= 13,7 \end{aligned}$$

Option 2

$$\begin{aligned} \text{pOH} &= -\log[OH^-] \\ &= -\log(0,5) \\ &= 0,3 \end{aligned}$$

$$\begin{aligned} \text{pH} &= 14 - \text{pOH} \\ &= 14 - 0,3 \\ &= 13,7 \end{aligned}$$



(1) 7.5.2

$$\begin{aligned} V_b &= 40 \text{ ml} = 40 \text{ cm}^3 = 0,04 \text{ dm}^3 \\ c_b &= 0,5 \text{ mol}\cdot\text{dm}^{-3} \\ V_a &= 20 \text{ ml} \\ \therefore m_a &= 20 \text{ g} \end{aligned}$$

$$n(\text{NaOH}) = cV = (0,5)(0,04) = 0,02 \text{ mol}$$

$$\therefore n(\text{CH}_3\text{COOH}) = n(\text{NaOH}) = 0,02 \text{ mol}$$

From equation:
 $n(\text{CH}_3\text{COOH} : \text{NaOH})$
 $= 1 : 1$

$$\begin{aligned} M(\text{CH}_3\text{COOH}) &= (12 \times 2) + (1 \times 4) + (16 \times 2) \\ &= 60 \text{ g}\cdot\text{mol}^{-1} \end{aligned}$$

$$m(\text{CH}_3\text{COOH}) = nM = (0,02)(60) = 1,2 \text{ g}$$

$$\% \text{ mass of CH}_3\text{COOH} = \frac{1,2}{20} \times 100 = 6\% \quad (6)$$

(1) 7.6 $\text{CH}_3\text{COO}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{CH}_3\text{COOH}(\text{aq}) + \text{OH}^-(\text{aq})$ (2)
[15]

Question 8

8.1 The chemical process in which electrical energy is converted to chemical energy.

OR The use of electrical energy to produce chemical change. (2)

8.2.1 $\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Cr}(\text{s})$ (2)

8.2.2 Cr / chromium (1)

8.2.3 chromium(III) ions / Cr^{3+} (1)

$$\begin{aligned} 8.3 \quad n &= \frac{m}{M} \\ \therefore \left(\frac{0,03}{3}\right) &= \frac{m}{52} \quad \text{OR} \quad 0,01 = \frac{m}{52} \\ \therefore m &= 0,52 \text{ g} \end{aligned}$$

OR

$$\begin{aligned} 3 \text{ mol e}^- &\dots\dots\dots 52 \text{ g Cr} \\ 0,03 \text{ mol e}^- &\dots\dots\dots \left(\frac{0,03}{3}\right) (52) = 0,52 \text{ g} \end{aligned} \quad (4)$$

(3)

Question 9

9.1 A solution which conducts electricity through the movement of ions. (2)

9.2 $\text{Pb}(\text{s}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{PbSO}_4(\text{s}) + 2\text{e}^-$ (2)

9.3 $\text{PbO}_2(\text{s}) + \text{Pb}(\text{s}) + 2\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) \rightarrow 2\text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l})$

OR

$\text{PbO}_2(\text{s}) + \text{Pb}(\text{s}) + 2\text{H}_2\text{SO}_4(\text{aq}) \rightarrow 2\text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l})$ (3)

$$\begin{aligned} 9.4 \quad E_{\text{cell}}^{\ominus} &= E_{\text{cathode}}^{\ominus} - E_{\text{anode}}^{\ominus} \\ &= +1,69 - (-0,36) \\ &= +2,05 \text{ V} \end{aligned}$$

$$\begin{aligned} \text{No. cells} &= \frac{300}{2,05} \\ &= 146,34 \text{ cells} \end{aligned}$$

$\therefore$ 147 cells

**Question 10**

10.1 Contact process (1)

10.2 sulphur dioxide / SO_2 (1)

10.3.1 vanadium pentoxide / vanadium(V) oxide / V_2O_5 (1)

10.3.2 $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ (3)

10.4 oleum / pyrosulphuric acid / $\text{H}_2\text{S}_2\text{O}_7$ (1)
[7]

Question 11

11.1.1 phosphorus (1)

11.1.2 nitrogen (1)

11.1.3 potassium (1)

11.2.1 Haber (process) (1)

11.2.2 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ (3)

11.3 The fertiliser contains two primary nutrients N/nitrogen and P/phosphorus, whereas the ammonium nitrate contains only N/nitrogen. (2)

11.4 Any one

- Fertilisers in water leads to eutrophication which can result in less drinking water/starvation due to dying of fish/less water recreation areas.

- Fertilisers in water leads to excess of nitrates in water resulting in blue baby syndrome/cancer. (2)

[11]

TOTAL: 150

PHYSICAL CONSTANTS AND FORMULAE

Physical constants

	Constants	Symbol	Value and unit
Physics	Acceleration due to gravity	g	9,8 m.s ⁻²
	Universal gravitational constant	G	6,67 × 10 ⁻¹¹ N.m ² .kg ⁻²
	Speed of light in a vacuum	c	3,0 × 10 ⁸ m.s ⁻¹
	Planck's constant	h	6,63 × 10 ⁻³⁴ J.s
	Coulomb's constant	k	9,0 × 10 ⁹ N.m ² .C ⁻²
	Charge on electron	e	-1,6 × 10 ⁻¹⁹ C
	Electron mass	m _e	9,11 × 10 ⁻³¹ kg
Chemistry	Standard pressure	p ^θ	1,013 × 10 ⁵ Pa
	Molar gas volume at STP	V _m	22,4 dm ³ .mol ⁻¹
	Standard temperature	T ^θ	273 K
	Charge on electron	e	-1,6 × 10 ⁻¹⁹ C

Formulae

Chemistry

$$n = \frac{m}{M}; n = \frac{N}{N_A}; n = \frac{V}{V_m} \quad c = \frac{n}{V} \text{ or } c = \frac{m}{MV} \quad \frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at } 298 \text{ K}$$

$$E_{\text{cell}}^{\theta} = E_{\text{cathode}}^{\theta} - E_{\text{anode}}^{\theta} = E_{\text{reduction}}^{\theta} - E_{\text{oxidation}}^{\theta} = E_{\text{oxidising agent}}^{\theta} - E_{\text{reducing agent}}^{\theta}$$

Waves, Sound and Light

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

$$E = W_0 + K_{\text{max}} \text{ or } E = W_0 + E_{k(\text{max})} \text{ where}$$

$$E = hf \text{ and } W_0 = hf_0 \text{ and } K_{\text{max}} = \frac{1}{2}mv_{\text{max}}^2 \text{ or } E_{k(\text{max})} = \frac{1}{2}mv_{\text{max}}^2$$

Electricity and Magnetism

Electrostatics

$$F = \frac{kQ_1Q_2}{r^2} \quad E = \frac{F}{q} \quad E = \frac{kQ}{r^2}$$

$$V = \frac{W}{q} \quad n = \frac{Q}{e} \text{ or } n = \frac{Q}{q_e}$$

Alternating Current

$$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}} \quad V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$$

$$P_{\text{ave}} = V_{\text{rms}}I_{\text{rms}} = I_{\text{rms}}^2R = \frac{V_{\text{rms}}^2}{R}$$

Electric Circuits

$$R = \frac{V}{I} \quad \text{emf } (E) = I(R + r) \quad q = I\Delta t$$

$$W = Vq = VI\Delta t = I^2R\Delta t = \frac{V^2\Delta t}{R} \quad P = \frac{W}{\Delta t} = VI = I^2R = \frac{V^2}{R}$$

Resistors - in series: $R_s = R_1 + R_2 + R_3 \dots$

in parallel: $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \dots$

Mechanics

Motion

$$v_f = v_i + a\Delta t \quad v_f^2 = v_i^2 + 2a\Delta x \text{ or } v_f^2 = v_i^2 + 2a\Delta y$$

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



Work, energy and power

$$W = F\Delta x \cos \theta$$

$$E_p/U = mgh \quad E_k/K = \frac{1}{2}mv^2$$

$$W_{\text{net}} = \Delta K = K_f - K_i \text{ or } W_{\text{net}} = \Delta E_k = E_{kf} - E_{ki}$$

$$W_{\text{nc}} = \Delta K + \Delta U \text{ or } W_{\text{nc}} = \Delta E_k + \Delta E_p$$

$$P_{\text{ave}} = Fv_{\text{ave}} \quad P = \frac{W}{\Delta t}$$

Force

$$F_{\text{net}} = ma \quad p = mv$$

$$F_{\text{net}}\Delta t = \Delta p = mv_f - mv_i$$

$$F = \frac{Gm_1m_2}{r^2}$$

$$g = \frac{G.m}{r^2}$$

$$w = mg$$

STANDARD REDUCTION POTENTIALS

Increasing oxidising ability

TABLE 4A	
Half-reactions	E° (V)
$\text{F}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	+2,87
$\text{Co}^{3+} + \text{e}^- \rightleftharpoons \text{Co}^{2+}$	+1,81
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,77
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1,36
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{Pt}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pt}$	+1,20
$\text{Br}_2(\text{l}) + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+1,07
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Hg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Hg}(\text{l})$	+0,85
$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+0,80
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+0,77
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+0,68
$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+0,54
$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+0,52
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+0,45
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0,40
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0,34
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+0,16
$\text{Sn}^{4+} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{S} + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0,14
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{Fe}^{3+} + 3\text{e}^- \rightleftharpoons \text{Fe}$	-0,06
$\text{Pb}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pb}$	-0,13
$\text{Sn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sn}$	-0,14
$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	-0,27
$\text{Co}^{2+} + 2\text{e}^- \rightleftharpoons \text{Co}$	-0,28
$\text{Cd}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cd}$	-0,40
$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	-0,41
$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	-0,44
$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	-0,74
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0,76
$2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Cr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cr}$	-0,91
$\text{Mn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mn}$	-1,18
$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	-1,66
$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	-2,36
$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	-2,71
$\text{Ca}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ca}$	-2,87
$\text{Sr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sr}$	-2,89
$\text{Ba}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ba}$	-2,90
$\text{Cs}^+ + \text{e}^- \rightleftharpoons \text{Cs}$	-2,92
$\text{K}^+ + \text{e}^- \rightleftharpoons \text{K}$	-2,93
$\text{Li}^+ + \text{e}^- \rightleftharpoons \text{Li}$	-3,05

Increasing reducing ability

Increasing oxidising ability

TABLE 4B	
Half-reactions	E° (V)
$\text{Li}^+ + \text{e}^- \rightleftharpoons \text{Li}$	-3,05
$\text{K}^+ + \text{e}^- \rightleftharpoons \text{K}$	-2,93
$\text{Cs}^+ + \text{e}^- \rightleftharpoons \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ca}$	-2,87
$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	-2,71
$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	-2,36
$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	-1,66
$\text{Mn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mn}$	-1,18
$\text{Cr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	-0,44
$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	-0,41
$\text{Cd}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cd}$	-0,40
$\text{Co}^{2+} + 2\text{e}^- \rightleftharpoons \text{Co}$	-0,28
$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	-0,27
$\text{Sn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3\text{e}^- \rightleftharpoons \text{Fe}$	-0,06
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+0,52
$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+0,77
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+0,80
$\text{Hg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Hg}(\text{l})$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\text{l}) + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+1,07
$\text{Pt}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + \text{e}^- \rightleftharpoons \text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	+2,87

Increasing reducing ability

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