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WOODRIDGE COLLEGE

SEPTEMBER 2021

3 HOURS

PHYSICAL SCIENCES: PAPER 1

EXAMINER: Mr P. Maartens

TOTAL = 200 marks

MODERATOR: Dr C. Logie

GRADE 12

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

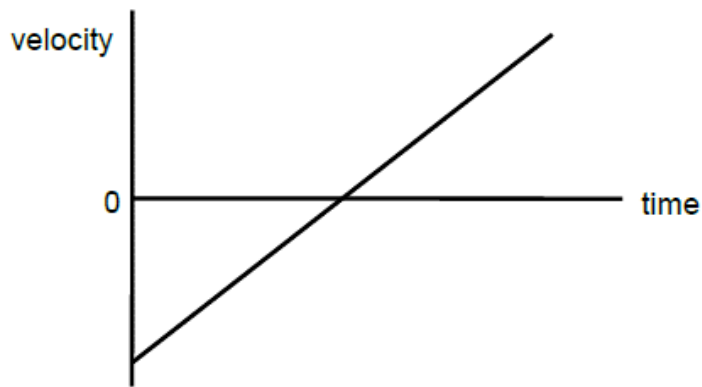
1. This question paper consists of 16 pages, an Answer Sheet of 3 pages and a Data sheet of 2 pages. Please make sure that your question paper is complete.
 2. Answer ALL the questions.
 3. Start each question on a new page.
 4. Use the data and formulae whenever necessary.
 5. Show your working in all calculations.
 6. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
 7. Where appropriate express answers to TWO decimal places.
 8. It is in your own interest to write legibly and present your work neatly.
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QUESTION 1 MULTIPLE CHOICE

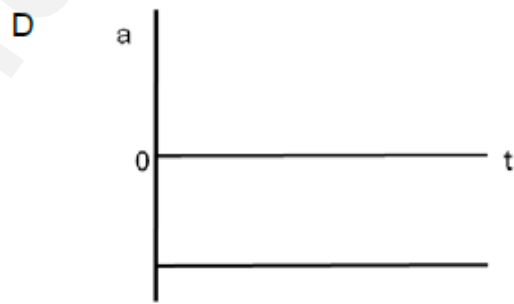
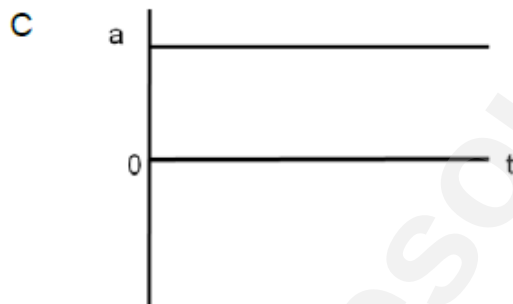
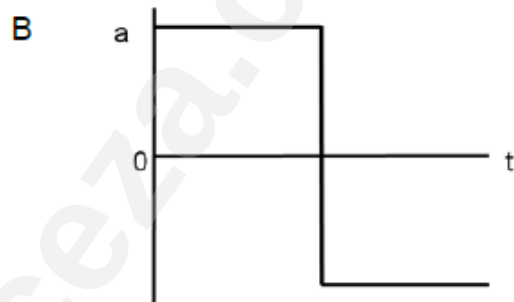
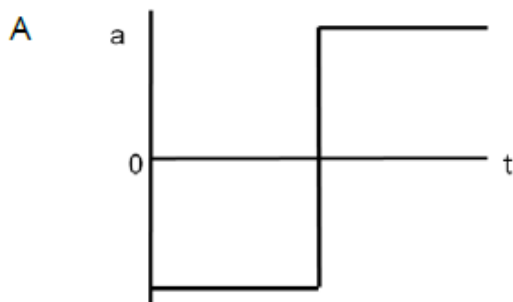
Answer these questions on the Answer Sheet. Make a cross (X) in the box corresponding to the letter that you consider to be most correct.

- 1.1 A person stands on a scale in an elevator (a lift). He notices that the scale reading is lower than his usual weight. Which of the following could possibly describe the motion of the elevator (the lift)?
- A. It is stationary.
 - B. It is moving down at a constant speed.
 - C. It is moving down and speeding up.
 - D. It is moving up and speeding up.
- (2)

1.2 The graph shows how the velocity of an object changes with time.



Which one of the following graphs correctly shows how the acceleration of the object changes with time?



(2)

1.3 An object initially at rest travels a distance d in a time t at a constant acceleration. What is the time taken for the object to travel $16d$ from rest at the same acceleration?

- A. $2t$
- B. $4t$
- C. $8t$
- D. $16t$

(2)

1.4 An apple is at rest on the ground. **Downloaded from eduresourceza.com**

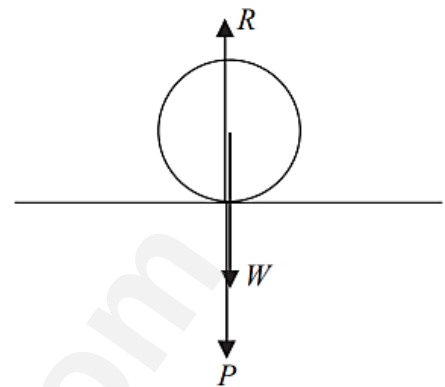
The diagram below shows three forces of equal magnitude.

W = weight of apple

P = force of apple on ground

R = normal contact force of ground on apple

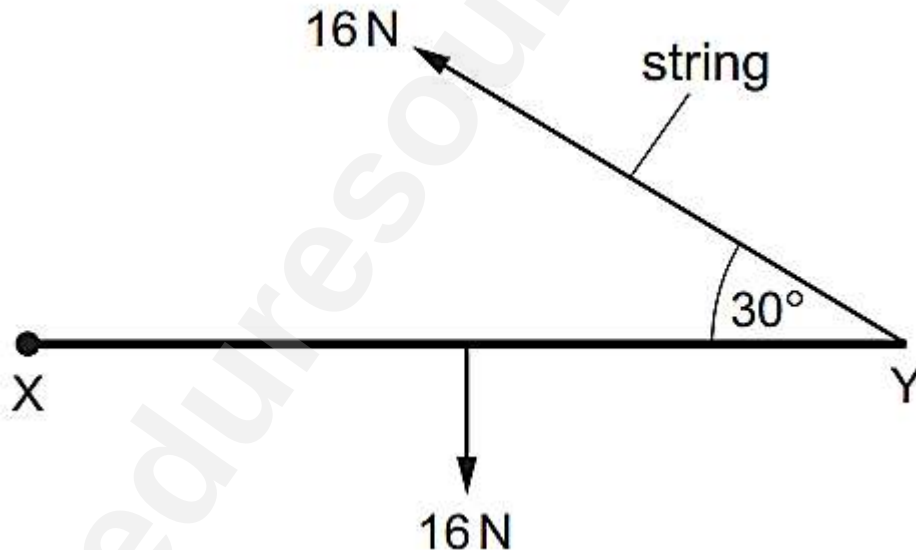
Which row in the table shows Newton's first and third laws being applied correctly.



	Newton's first law	Newton's third law
A	$P = W$	$R = P$
B	$R = P$	$P = W$
C	$W = R$	$P = W$
D	$W = R$	$R = P$

(2)

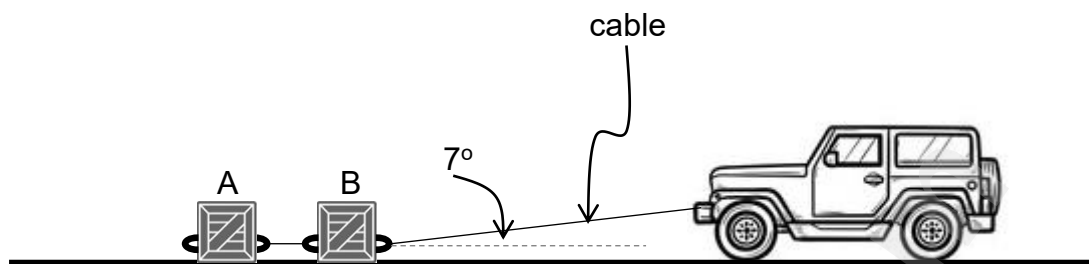
1.5 A rod XY of weight 16 N is hinged at X and supported by a string at Y. The string is at an angle of 30° . The tension in the string is 16 N. What is the horizontal component of the force acting at X?



- A. 16 N
- B. 14 N
- C. 9 N
- D. 8 N

(2)

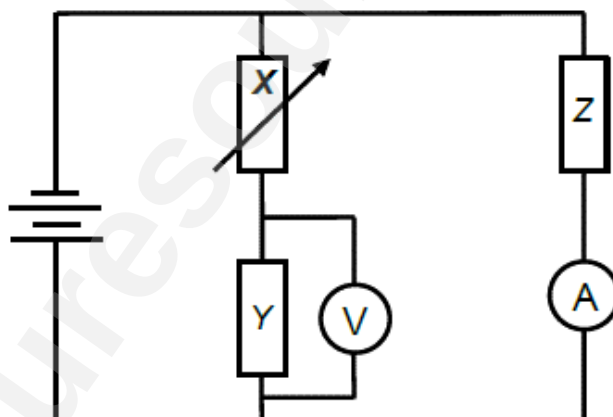
- 1.6 A Jeep uses a cable attached to the vehicle to drag two heavy wooden crates across a rough concrete surface to the right. The Jeep reverses and as a result, a force of 1300 N is exerted on crate B by the cable at an angle of 7° to the horizontal. The Jeep and the crates accelerate to the right. Crates A and B each have a mass of 100 kg and they are identical in all respects.



During the motion

- A. Crate B experiences a lesser kinetic frictional force than Crate A.
 - B. Crate B experiences a greater kinetic frictional force than Crate A.
 - C. Crate A and B experiences the same kinetic frictional force.
 - D. Neither experiences a kinetic frictional force.
- (2)

- 1.7 An electrical circuit with three different resistors is connected as shown across a battery of negligible internal resistance.



How do the readings on the ammeter and voltmeter change as the resistance of the variable resistor **X** is increased?

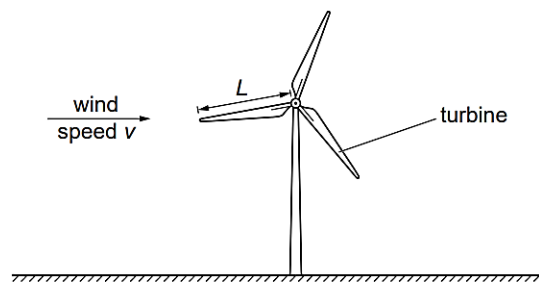
	Voltmeter	Ammeter
A.	Increases	Decreases
B.	Decreases	Increases
C.	Decreases	No change
D.	Increases	No change

(2)

1.8 The power available from the wind for a turbine is given by the formula:

$$P = CL^2\rho v^3$$

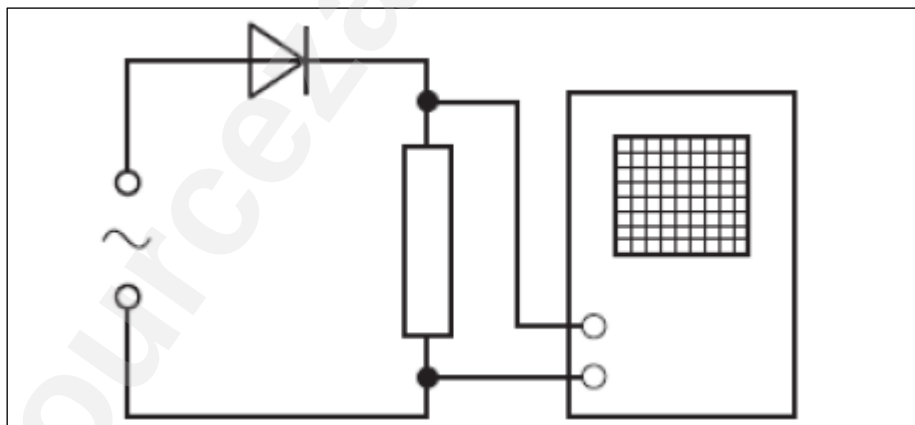
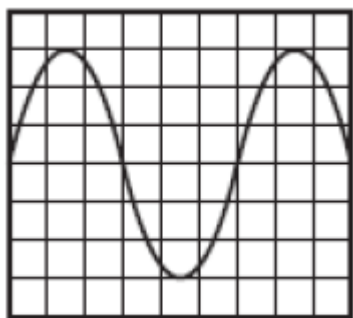
Where: C is a constant
L = length of each blade in metres
 ρ = density in kg/m^3
v = speed in m/s



If the base units for the watt is $\text{kg}\cdot\text{m}^2\cdot\text{s}^{-3}$, the units for constant C

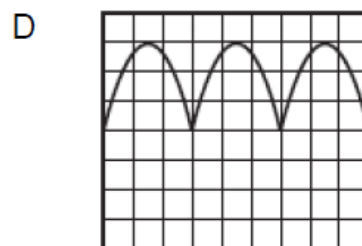
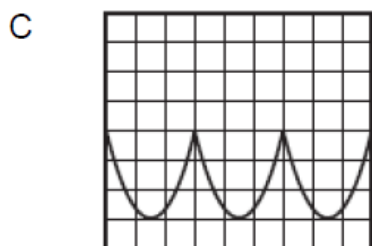
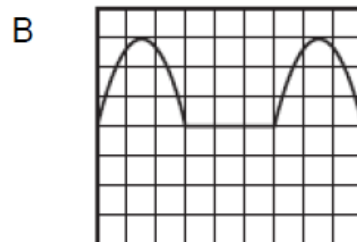
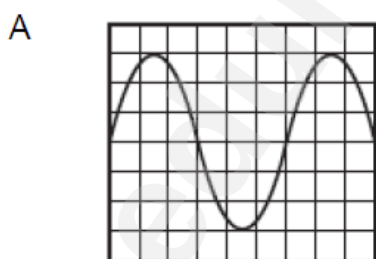
- | | |
|----------|--------------------------------------|
| A. is W | B. is $\text{m}^3\cdot\text{s}^{-6}$ |
| C. is kg | D. has no units. |
- (2)

1.9 An AC source is connected to an oscilloscope and produces the trace as shown below on the left.



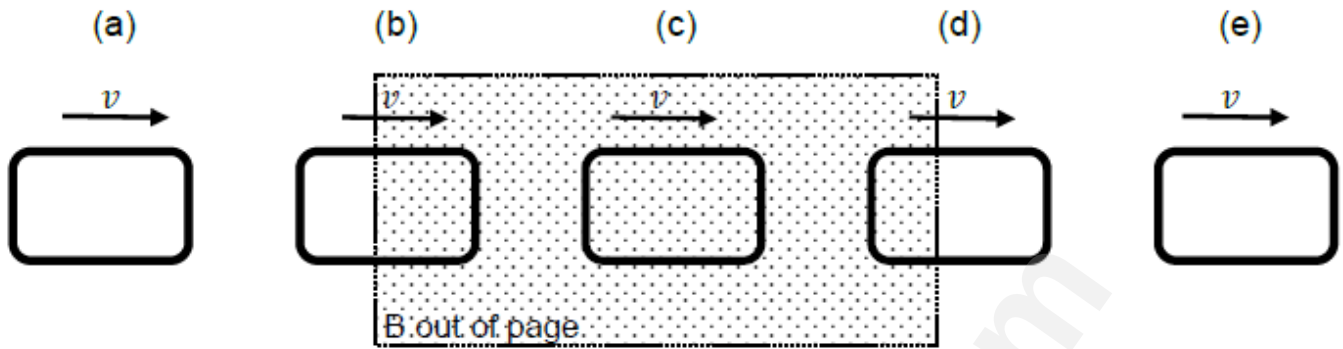
A diode is now connected in series to the circuit above.

Which of the following diagrams shows the new trace on the screen?



(2)

- 1.10 A single rectangular conducting loop travels from left to right at a constant velocity, v , through a uniform magnetic field directed out of the page as shown in the diagrams (a)–(e).



At what positions (a)–(e) is a current induced in the loop?

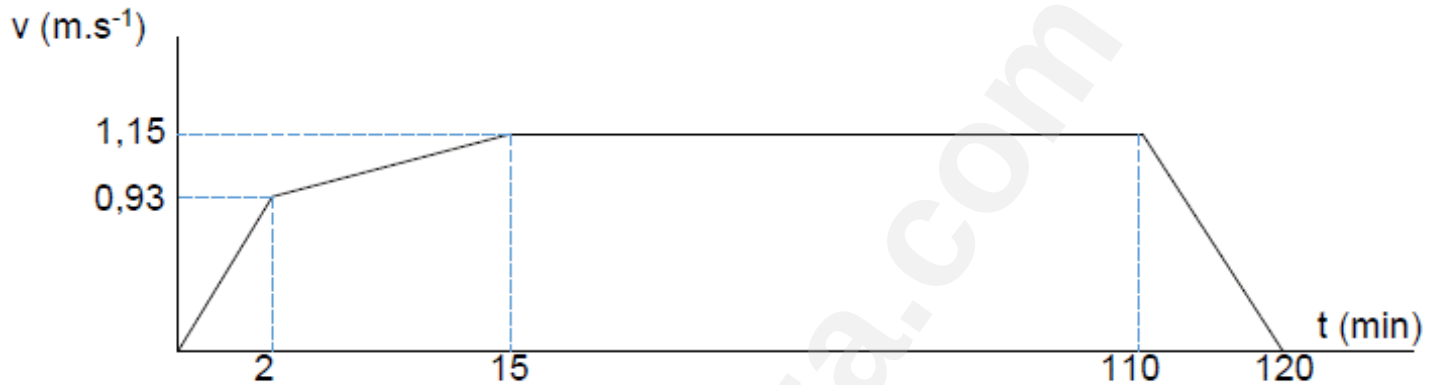
- A. (a) and (e) only
- B. (b) and (d) only
- C. only (c)
- D. (a), (b), (c), (d) and (e)

(2)
[20]

According to Guinness world records, the longest distance ever swum without fins in the open sea is 225 km by Veljko Rogosic.

2.1 Distinguish between *speed* and *velocity*. (3)

2.2 The graph (not to scale) below shows the velocity vs time of Veljko for the first 2 hours until he stopped at a rubber duck to get some refreshments.



2.2.1 Use the graph to determine the displacement (in meters) during the first 15 minutes. (3)

2.2.2 Determine the magnitude of the average velocity for Veljko during the first 15 minutes. (3)

2.2.3 Define *acceleration*. (2)

2.2.4 Determine the magnitude of the acceleration of Veljko during the first 2 minutes. (3)

2.2.5 Use features of the graph to describe the difference in his acceleration during the first 2 minutes and the next 13 minutes. (No calculation necessary) (2)

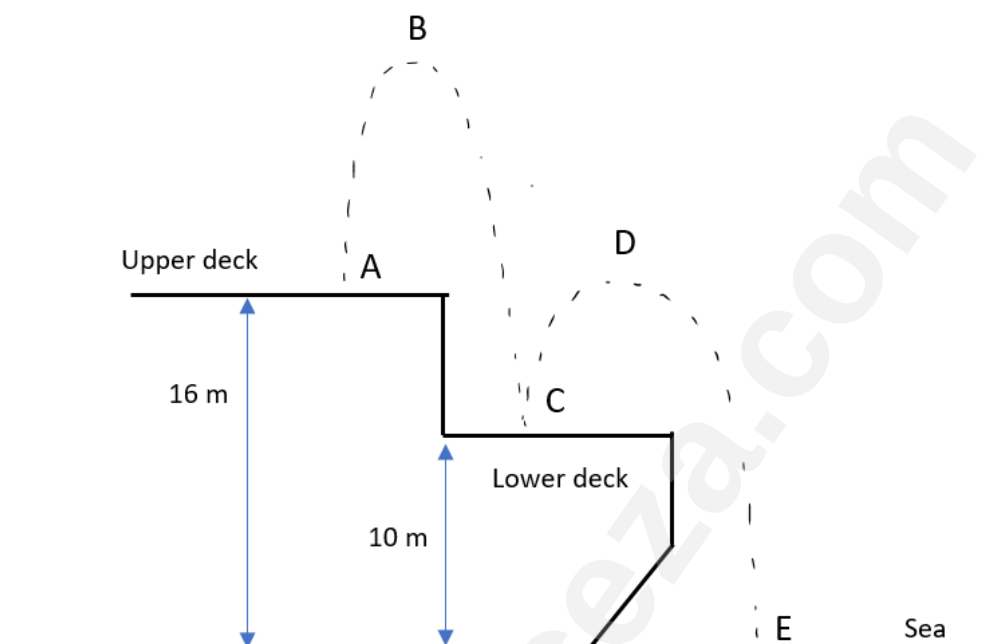
2.2.6 Draw a sketch graph of the displacement vs time for Veljko's swim during the first 2 hours. Only the time intervals need to be shown. (5)

[21]

QUESTION 3

KINEMATICS

A boy is playing with a tennis ball on the upper deck of a boat. He hits the ball upwards with a velocity of 9 m.s^{-1} . The ball hits the lower deck and bounces off into the sea as shown in the diagram. The lower deck is 10 m above the ocean level and the upper deck is 16 m above the sea level. Ignore the effects of friction. Assume ball bounces straight up and down.



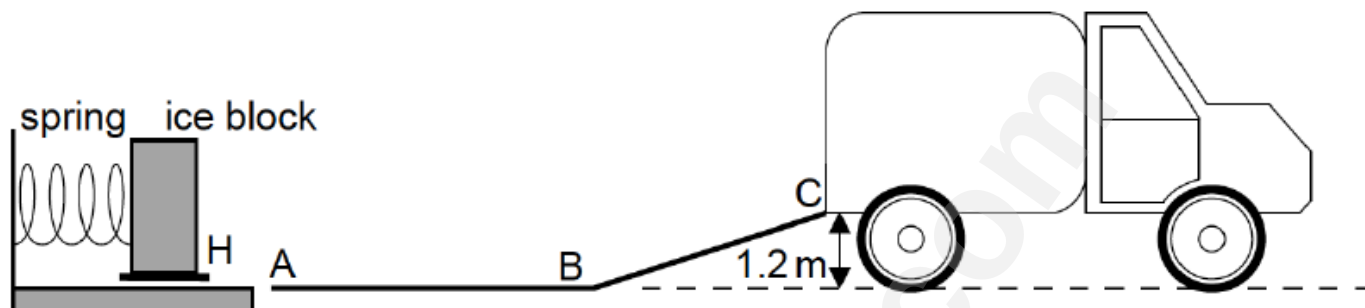
- 3.1 Define *velocity*. (2)
- 3.2 State the magnitude of the velocity and acceleration of the ball when it reaches its maximum height at B. (2)
- 3.3 Calculate the magnitude of the velocity of the tennis ball when it hits the lower deck. (4)
- 3.4 Show that the time taken for the ball to reach the lower deck is **$t = 2,36 \text{ s}$** . (2)
- 3.5 If the total time taken from the moment the boy hits the ball upward to the time he hears it splash into the sea is **$5,64 \text{ s}$** , calculate the velocity with which the ball leaves the lower deck. (5)
- 3.6 Sketch a velocity time graph for the ball from the moment the boy hits it until it splashes into the sea. Include all known (calculated) values on your axes. (7)

[22]

QUESTION 4

NEWTON'S LAWS

A company designs a spring system for loading ice blocks onto a truck. The ice block is placed in a holder H in front of a compressed spring. When the compressed spring is released, the ice block is accelerated from rest towards point A. When the spring is fully decompressed, the ice block loses contact with the spring at A. The ice block moves along ramp ABC. The mass of the ice block is 55 kg.



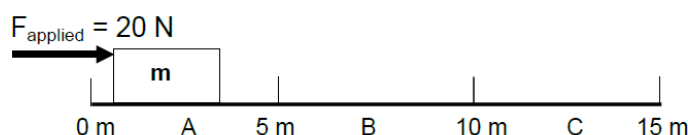
The surface of the ramp ABC is frictionless.

- 4.1 The ice block arrives at C with a speed of $0,9 \text{ m.s}^{-1}$.
Use energy principles to calculate the speed of the ice block at A. (4)
- 4.2 State *Newton's first law*. (2)
- 4.3 Describe and briefly explain the motion of the ice block
 - 4.3.1 from A to B with reference to Newton's first law. (2)
 - 4.3.2 from B to C with reference to Newton's second law. (3)
- 4.4 Define impulse. (2)
- 4.5 The spring is in contact with the ice block for 0,42 s. Ignore friction and determine the magnitude of the average force that the spring exerts on the block. (3)
- 4.6 Define *frictional force due to a surface*. (2)
- 4.7 On a particular day, the ice blocks experience a frictional force because the section of the ramp from **B to C** is not cleaned properly. The coefficient of kinetic friction between the ice blocks and the ramp **BC** is 0,03. The ramp BC makes an angle of 14° to the horizontal.
 - 4.7.1 Draw a labelled free body diagram showing all the forces acting on the **ice block**. (3)
 - 4.7.2 Determine whether the ice block will reach C. (6)

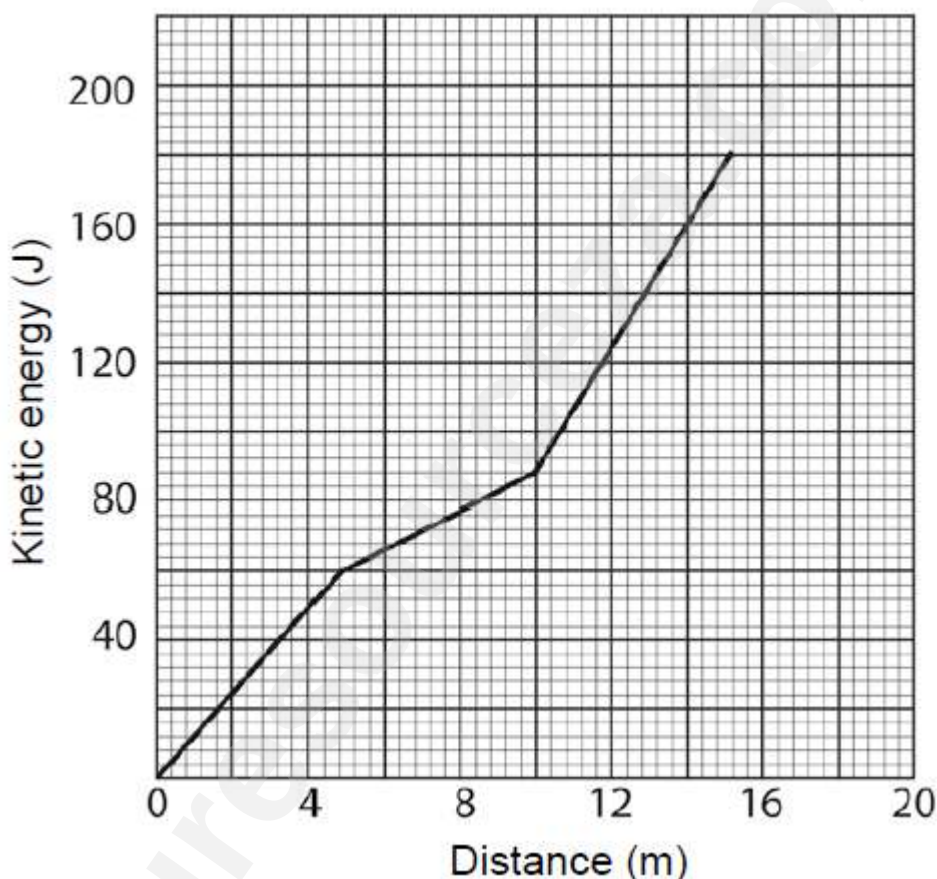
[27]

QUESTION 5

- 5.1 A box of mass m is pushed, from rest, with a constant applied force of 20 N over a horizontal surface which has three different regions, A, B and C. Each region is 5 m long and exerts a different frictional force on the box as it moves through. The regions are A, B and C as illustrated in the diagram below.



The graph below shows the kinetic energy of the object as a function of the distance from the starting position as the object experiences the constant applied force of 20 N.



- 5.1.1 State the *work-energy theorem*. (2)
- 5.1.2 Use the work-energy theorem to show that the gradient (slope) of the graph represents the net force experienced by the object. (3)
- 5.1.3 Calculate the net force experienced by the object in region C. (3)
- 5.1.4 Hence determine the work done by the net force on the object in region C. (3)
- 5.1.5 Which region, A, B or C offers the largest friction force? (1)
- 5.1.6 Justify your answer in Question 5.1.5. (2)
- 5.1.7 Assuming that the box starts from rest and accelerates at $1 \text{ m} \cdot \text{s}^{-2}$ while moving over region A, calculate the mass of the box. (4)

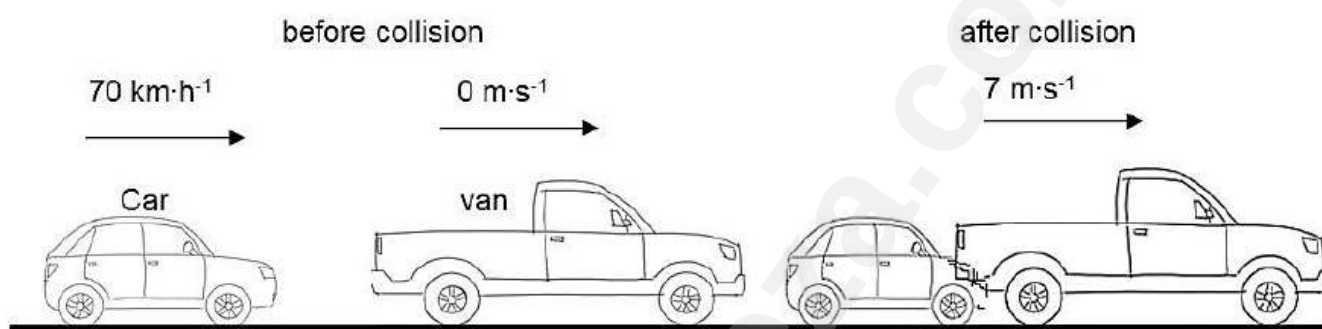
- 5.2 A car engine dissipates a power of 60 000 W while the car is travelling at a constant velocity of $60 \text{ km}\cdot\text{h}^{-1}$.

5.2.1 Define *power*. (2)

5.2.2 Convert $60 \text{ km}\cdot\text{h}^{-1}$ to $\text{m}\cdot\text{s}^{-1}$. (1)

5.2.3 Calculate the force applied by the engine under these conditions. (3)

- 5.3 The car of mass 1 500 kg travelling to the right at $70 \text{ km}\cdot\text{h}^{-1}$ runs into the back of a stationary van of unknown mass. The two vehicles lock together and move to the right at $7 \text{ m}\cdot\text{s}^{-1}$. Calculate the mass of the van. (4)



[Source: <www.juniorcardesigner.com>]

[28]

QUESTION 6

FIELDS

In 1968, the race was on between the USA and the Soviet Union to get a man on the Moon. The Russians launched the Zond 5 spaceship with a capsule carrying samples of soil and seeds, some worms and two steppe tortoises. These tortoises were the first living creatures able to survive this journey to the Moon but they lost 5 % of their body mass during this trip due to muscle and bone degeneration.

6.1.1 The Zond 5 had a total mass of 5 375 kg.

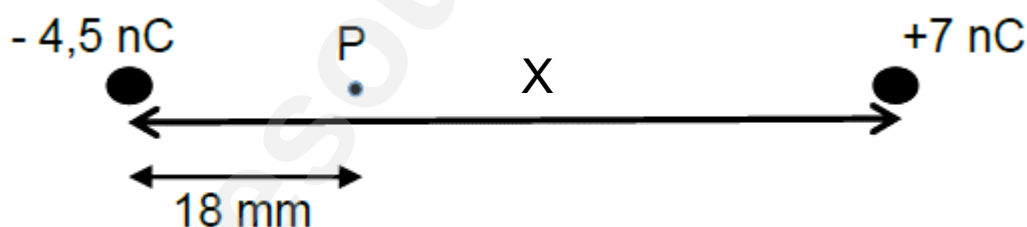
- a) State Newton's *Law of Universal Gravitation*. (2)
- b) Determine the magnitude of the gravitational force acting on the Zond 5 when it was 953 km above the Earth's surface. (The radius of the Earth is 6 371 km and the mass of the Earth is $6,0 \times 10^{24}$ kg.) (4)

6.1.2 The smallest tortoise had a mass of 340 g when leaving the Earth and lost 5% of this mass by the time she reached the Moon.

The Earth has a mass of 81 times that of the Moon and is 4 times larger than the Moon.

- a) What would the gravitational field strength of the Moon be? (3)
- b) What would the mass of the small tortoise be on the surface of the Moon? (1)

6.2 Two small conducting spheres which carry charges of $-4,5$ nC and $+7$ nC are placed a distance X mm apart as shown in the diagram below.

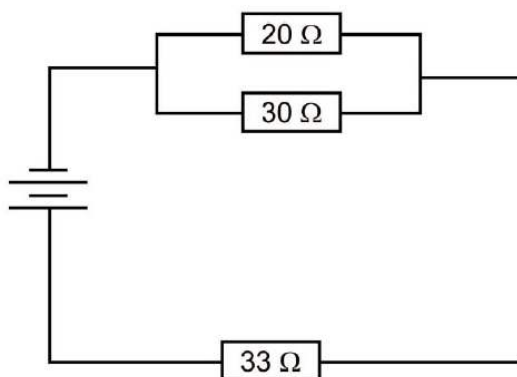


- 6.2.1 Define *the magnitude of an electric field at a point*. (2)
- 6.2.2 Draw the electric field between the two spheres. (2)
- 6.2.3 Along the straight line joining the two small spheres, there is a point P as indicated on the diagram. This point is 18 mm from the $-4,5$ nC charge.
 - a) If the resultant electric field strength at P is $255165,29$ N.C $^{-1}$ to the left, calculate the value of X . (7)

[21]

QUESTION 7

- 7.1 A battery with an **emf of 28 V** and an **internal resistance of 7 Ω** is connected in a circuit as shown.



- 7.1.1 Define *emf*. (2)
- 7.1.2 Calculate the total resistance of the external circuit. (3)
- 7.1.3 Calculate the total current drawn from the battery. (3)
- 7.1.4 Determine the potential difference across the terminals of the battery. (3)
- 7.1.5 On the circuit diagram **on the answer sheet**, draw a voltmeter symbol and an ammeter symbol that would enable the potential difference across the 20 Ω and the current through the 20 Ω to be measured. (2)
- 7.2 Students realise that the potential difference across the terminals of a battery and the current drawn from the battery change as the resistance in a circuit changes. The students decided to experiment and changed the external resistance of a circuit and recorded the following set of data.

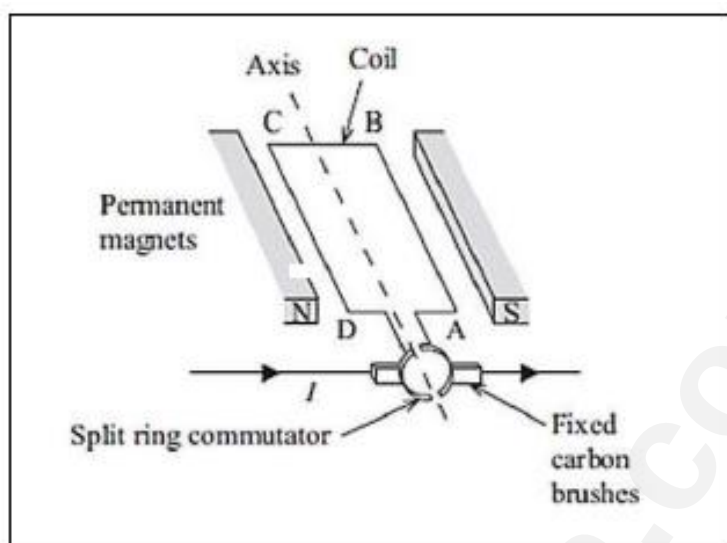
Current (A)	Terminal potential difference (V)
0,15	11,75
0,35	11,10
0,55	10,52
0,75	10,23
0,95	9,64
1,15	9,15

- 7.2.1 Define *potential difference*. (2)
- 7.2.2 Plot a graph of the terminal potential difference (on the y-axis) vs current (on the x-axis) on the graph paper provided **on the answer sheet**. (6)
- 7.2.3 If the gradient of the graph is **-2,52** determine the internal resistance of the battery. (2)
- 7.2.4 What quantity does the y-intercept represent? (1)

[24]

QUESTION 8

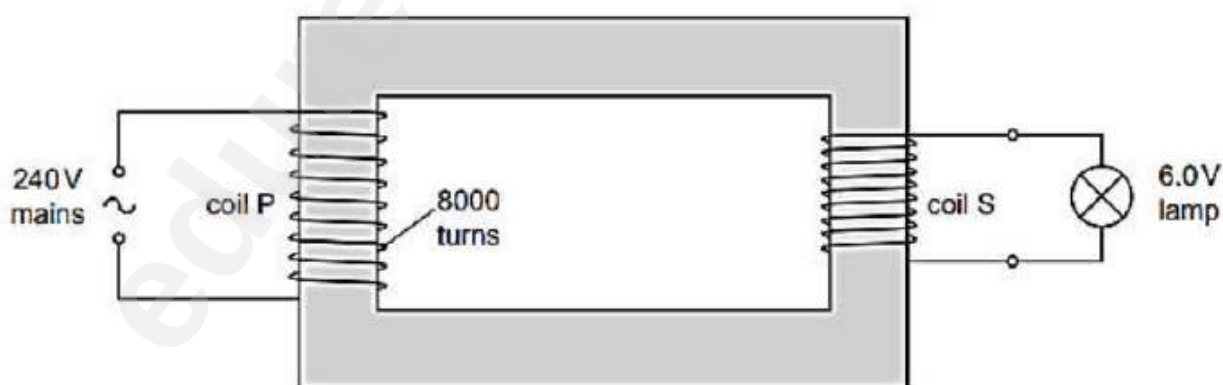
8.1 The simplified diagram below illustrates a DC electric motor.



The arrows show the direction of current as it enters and exits the coil through the carbon brushes and the split ring commutator.

- 8.1.1 State whether the coil turns clockwise or anti-clockwise when viewed from the split-ring commutator. (1)
- 8.1.2 State the function of the split-ring commutator. (2)
- 8.1.3 Refer to an appropriate formulae to explain three ways in which the turning force that the coil experiences can be increased. (3)

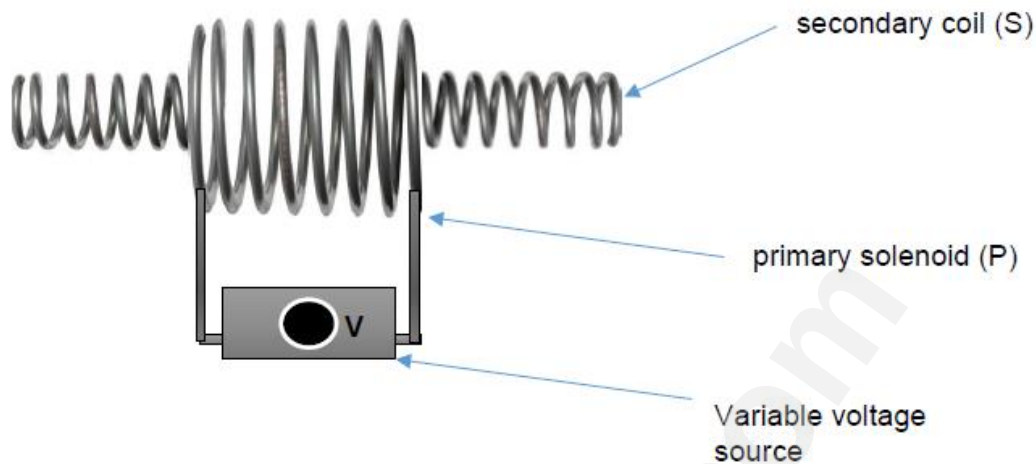
8.2 The diagram below shows a transformer.



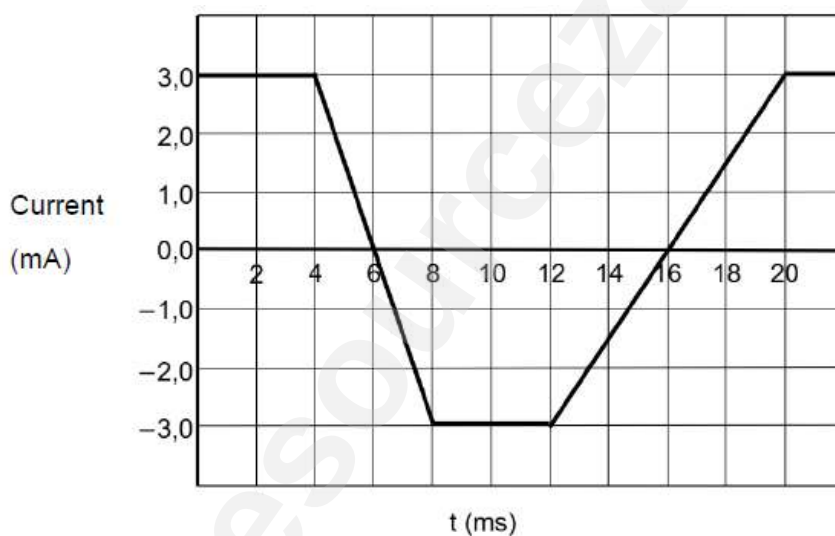
The primary coil P, connected to the 240 V mains supply, has 8000 turns. The secondary coil S supplies 6 V to a lamp.

- 8.2.1 Calculate the number of turns in the secondary coil. (3)
- 8.2.2 The current in the primary coil is 0,05 A. Calculate the power input to the transformer. (3)

- 8.3 A secondary coil (S) has a primary solenoid (P) wound around the middle as shown in the diagram.



The current in the **primary solenoid** is changed with time as shown on the graph below.



8.3.1 State *Faraday's law of electromagnetic induction*. (2)

8.3.2 Explain why an emf is induced in the secondary coil. (3)

The **maximum emf** induced in the secondary solenoid is **200 mV**.

8.3.3 On the graph provided **on the answer sheet**, draw the corresponding induced emf vs time graph for the **secondary coil**. The relative sizes of the emf must be included on the graph.

(4)
[21]

QUESTION 9

- 9.1 Ultraviolet light of frequency $9,1 \times 10^{14}$ Hz is shone onto a metal surface. The work function of the metal if Electrons are ejected from the metal is $3,5 \times 10^{-19}$ J.
- 9.1.1 Calculate the energy of a photon of ultraviolet light. (3)
- 9.1.2 Define *work function*. (2)
- 9.1.3 Calculate the maximum velocity of the ejected electrons. (4)
- 9.2 Light of wavelength 524 nm is emitted from a certain element when an electron transition occurs between the fifth and second energy level.
- 9.2.1 Describe a photon. (1)
- 9.2.2 Calculate the energy of the photon of light that is emitted. (3)
- The second energy level has an energy of 2,81 eV.
- 9.2.3 Calculate the energy of an electron in the fifth orbital. (3)
- [16]**

TOTAL: 200 MARKS