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TRINITYHOUSE HIGH SCHOOL LITTLE FALLS

PHYSICAL SCIENCE: PAPER 1

GRADE 12

PRELIMINARY EXAMINATION

3 SEPTEMBER 2018

Time: 3 hours**Total:** 200 marks**Examiner:** Mr D Du Toit**Moderator:** Mr D Brown**Name:** _____

Acknowledgements: Kearsney's College 2015, St John's College 2016, DOE 2018 SUPP

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

- This paper consists of:
 - a question paper of 16 pages
 - a data sheet of 2 pages
 - an ANSWER BOOKLET
 - a separate ANSWER SHEET
- Answer ALL the questions in the ANSWER BOOKLET. Answer **Question 2.7** and **Question 7.1.3** of the separate ANSWER SHEET.
- Read questions carefully.
- Question 1 consists of 10 multiple choice questions. There is only one correct answer to each question. The questions are answered on the **cover sheet** of your ANSWER BOOKLET. The letter that corresponds with your choice of the correct answer must be marked with a cross as shown in the example below:

A	B	C	D
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Here the answer C has been marked

- Use the data and formulae sheet whenever necessary.
- Start each question on a new page.
- Show your working in all calculations.
- Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
- Where appropriate, express answers to TWO decimal places.
- It is in your own interest to write legibly and set out your work neatly.

QUESTION 1 MULTIPLE-CHOICE QUESTIONS

Answer the following multiple-choice questions on your separate ANSWER SHEET. Make a cross (X) in the box corresponding to the letter which you consider to be the most correct.

1.1 Which one of the following is NOT a unit of force?

- A. N
- B. $\text{J}\cdot\text{s}^{-1}$
- C. $\text{kg}\cdot\text{m}\cdot\text{s}^{-2}$
- D. $\text{J}\cdot\text{m}^{-1}$

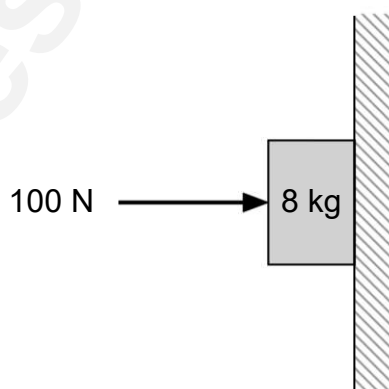
(2)

1.2 A net force pushes an object horizontally in a straight line from rest. The distance moved by the object in time t is x metres. What distance will the same object move from rest under the action of the same net force in time $2t$?

- A. $2x$
- B. $4x$
- C. x^2
- D. $\frac{1}{2}x^2$

(2)

1.3 A block with a mass of 8 kg is pushed into a wall with a horizontal force of 100 N as shown in the diagram below. The coefficient of static friction between the wall and the block is 0,8.



Which of the following describes the motion of the block?

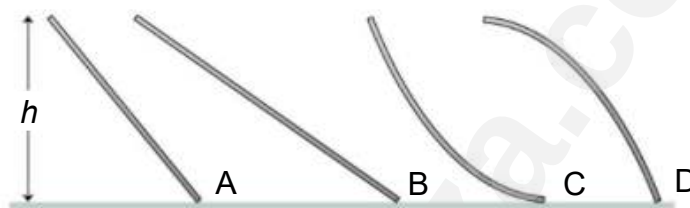
- A. It remains stationary against the wall
- B. It accelerates up the wall
- C. It travels down the wall at a constant velocity
- D. It accelerates down the wall

(2)

- 1.4 If the momentum of an object, of constant mass, is doubled, then its kinetic energy of the same mass will be:

A. halved
 B. doubled
 C. three times greater
 D. four times greater (2)

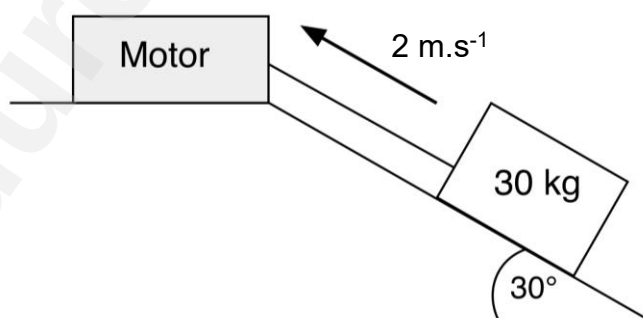
- 1.5 A small child slides down the four **frictionless** slides (A–D). Each has the same height h .



Which of the following correctly describes her velocities (v_A to v_D) at the bottom of each slide.

A. $v_D > v_A > v_B > v_C$
 B. $v_D > v_A = v_B > v_C$
 C. $v_A = v_B = v_C = v_D$
 D. $v_C = v_D > v_A = v_B$ (2)

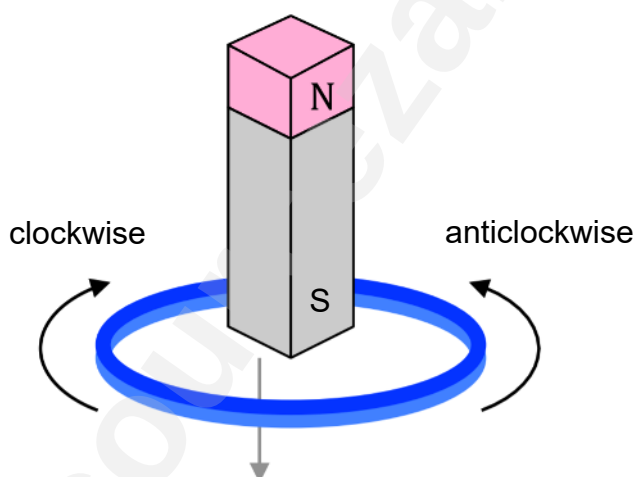
- 1.6 A motor pulls a crate with a mass of 30 kg at a constant speed of 2 m.s^{-1} up a frictionless incline angled at 30° to the horizontal as shown in the image below.



Which of the following is the expression for the power of the motor?

A. $294 \sin 30^\circ$
 B. $294 \cos 30^\circ$
 C. $2 \times 294 \sin 30^\circ$
 D. $2 \times 294 \cos 30^\circ$ (2)

- 1.7 Which of the following is true concerning Newton's law of universal gravitation?
- A. The force between masses can be attractive or repulsive
 - B. The magnitude of the force between masses is directly proportional to the sum of the masses
 - C. The magnitude of the force between the masses is inversely proportional to the square of the distance between the mass centres
 - D. $G = 6,67 \times 10^{-11} \text{ N.m}^2.\text{kg}^{-2}$ only on earth (2)
- 1.8 A permanent magnet is dropped, south pole down, through a conducting loop as shown. The magnet falls towards the loop and then away from the loop once it has fallen through.

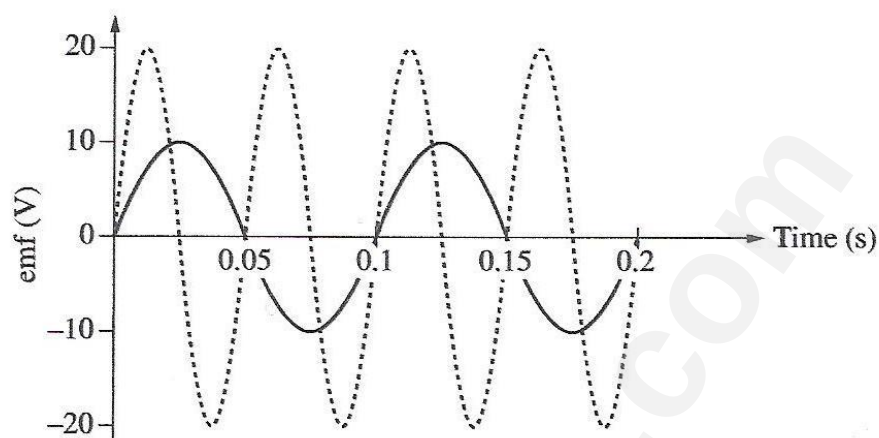


Which of the following correctly describes the direction of the current flowing in the loop when the magnet is falling towards the loop and then when falling away from the loop?

	When falling towards	When falling away
A.	clockwise	anticlockwise
B.	clockwise	clockwise
C.	anticlockwise	clockwise
D.	anticlockwise	anticlockwise

(2)

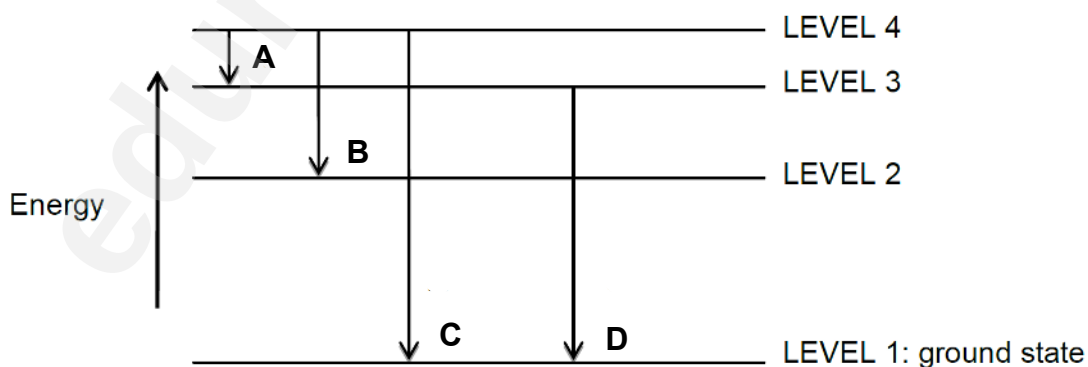
- 1.9 In the graph shown, the solid curve shows how the emf produced by a simple generator varies with time. The dashed curve is the output from the same generator after a modification has been made to the generator.



Which modification was made to produce the result shown?

- A. The area of the coil was doubled.
 - B. A split-ring commutator was added.
 - C. The speed of rotation of the coil was doubled.
 - D. The number of turns in the coil was quadrupled.
- (2)
- 1.10 The possible atomic transitions in an excited atom of an element are shown below.

Which transition (**A**, **B**, **C** or **D**) will produce the spectral line with the longest wavelength?



(2)

[20]

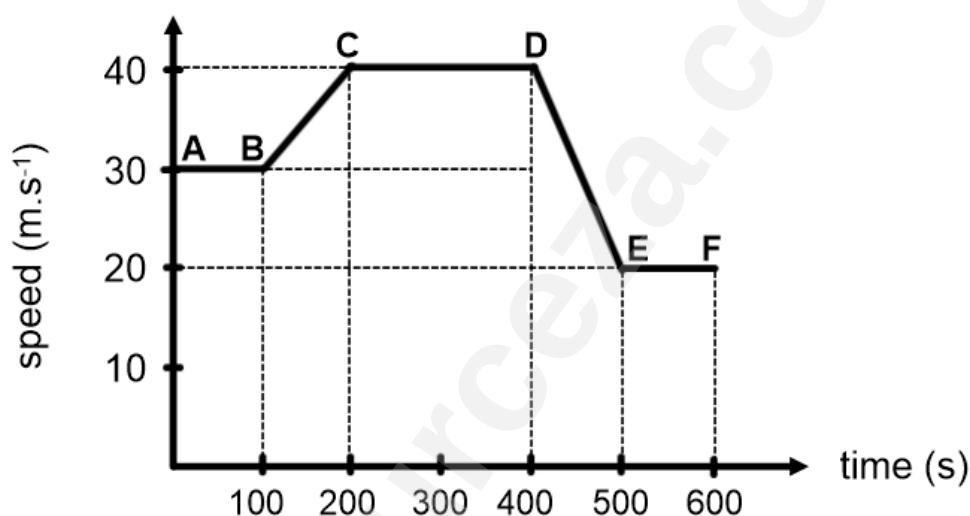
QUESTION 2 AVERAGE SPEED TRAPPING

Motorists on the N3 highway between Gauteng and KwaZulu-Natal are often fined because their average speed exceeds the speed limit of 120 km.h^{-1} .

2.1 Define *speed*. (2)

2.2 Convert 120 km.h^{-1} into m.s^{-1} . (1)

The following speed vs time graph shows the motion of a car travelling for 10 minutes in a **south easterly** direction.



2.3 During which interval(s) was the car travelling with a constant speed? (3)

2.4 During which interval was the car slowing down? (1)

2.5 Calculate the acceleration of the car between D and E (4)

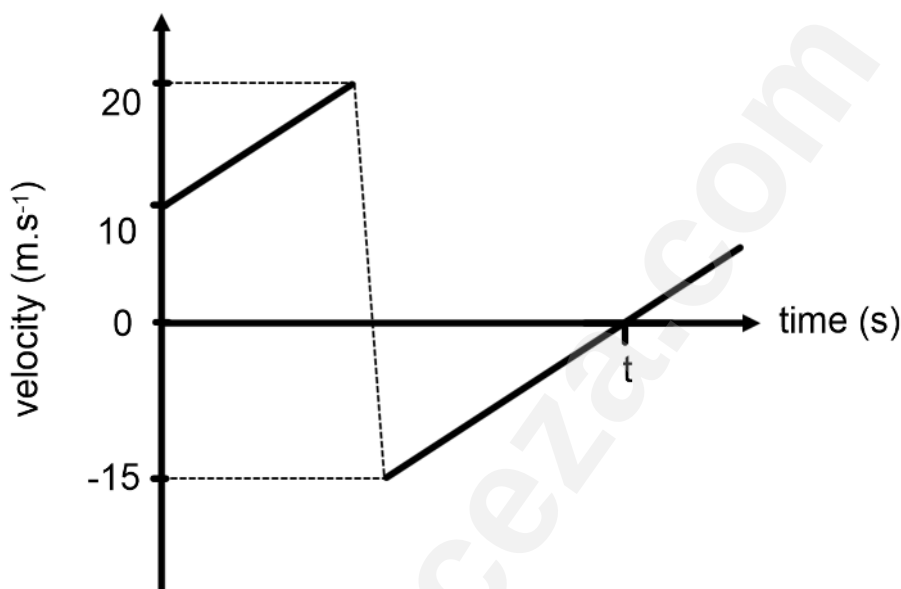
2.6 Is the driver guilty of speeding? Determine his average speed during the full 600 s. (7)

2.7 Sketch a position vs time graph for 100 s to 600 s on the graph provided on the ANSWER SHEET. (4)

[22]

QUESTION 3 BOUNCING BALL

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 vs time graph below shows the motion of the ball. Ignore air friction and **take down as positive**.



- 3.1 Define *vector*. (2)
- 3.2 From the graph, state the velocity with which the ball:
 - 3.2.1 strikes the floor. (2)
 - 3.2.2 bounces off the floor. (2)
- 3.3 Refer to data from the graph to explain whether the collision of the ball with the floor was elastic or inelastic. (3)
- 3.4 Show that the ball is thrown from an original height of 15,3 m. (3)
- 3.5 Calculate the impulse experienced by the ball on striking the floor. (4)
- 3.6 The ball bounces to a height of 11,5 m. Calculate the displacement of the ball from the moment it is thrown until it reaches this maximum bounce height (2)

[18]

QUESTION 4 WINTER OLYMPICS (1) – SNOWBOARDING HALF PIPE

A snowboarder (mass 80 kg) made a high jump in the half pipe event at the Winter Olympics in PyeongChang in 2018.

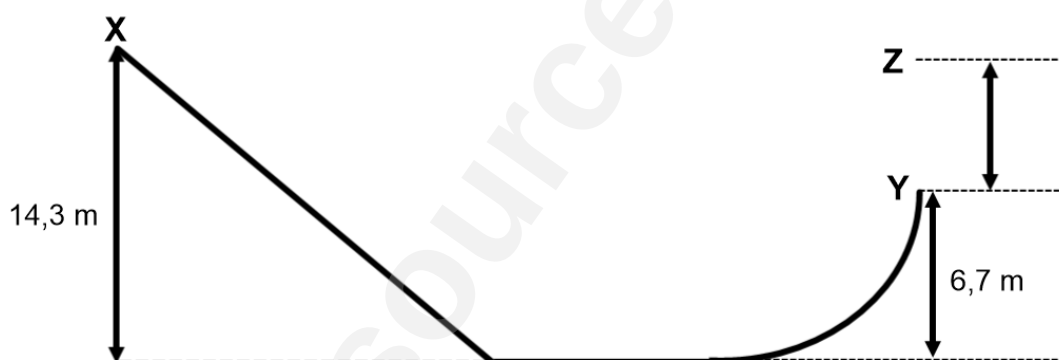


Picture taken from thehackernews.com accessed 10 August 2018



Picture taken from onboardmag.com accessed 10 August 2018

He started at position X, left the pipe at Y and reached a height at Z. **Ignore all forms of friction for the entire journey.**



- 4.1 State the *principle of conservation of mechanical energy*. (2)
- 4.2 Calculate snowboarder's gravitational potential energy at position X taking the ground as the reference point. (3)
- 4.3 Determine his speed at point Y assuming that he starts at rest at point X. (4)
- 4.4 Prove, using energy formulae, that the mass of the snow boarder does not affect the velocity with which he leaves the ramp. (3)
- 4.5 When the snow boarder lands he bends his knees. Explain why he does this by making use of a suitable formula in your explanation. (4)

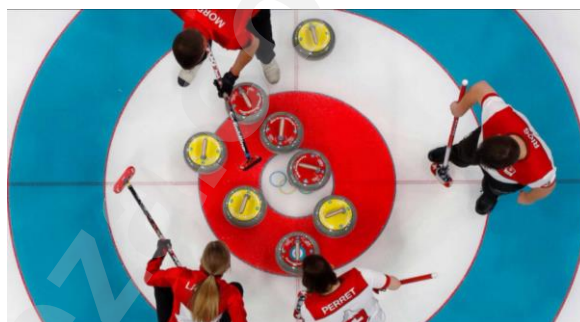
[16]

QUESTION 5 WINTER OLYMPICS (2) – CURLING

Curling is a sport played on an ice surface where two teams slide a curling stone towards a target and they see who can get their stone closest to the centre of the target. They alternate turns and slide multiple curling stones which sometimes collide in an attempt to bump the opposition stone away and place their stone closer to the centre of the target. While the stone slides, the team mates are allowed to brush the ice with brooms to increase the temperature of the ice and thus reduce the friction and make the ice more slick. This is one of the strategies the team employs to win the game.



Picture taken from www.inverse.com accessed 10 August 2018



Picture taken from www.abcnews.go.com accessed 10 August 2018

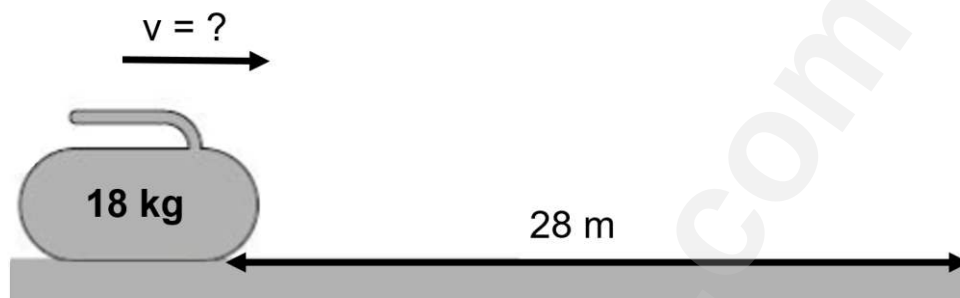
During the pushing phase: A curling stone of mass 18 kg lies on a horizontal ice surface. It is pushed by a force of magnitude 12 N at an angle of 20° to the horizontal, which causes the stone to accelerate along the ice. The coefficient of kinetic friction of the ice is 0,04.



- 5.1 Draw a fully labelled free-body diagram to represent all the forces acting on the stone while it is accelerating. (4)
- 5.2 Calculate the magnitude of the horizontal component of the 12 N force acting on the curling stone. (3)
- 5.3 Determine the kinetic friction force acting on the curling stone. (5)
- 5.4 State *Newton's second law of motion*. (2)
- 5.5 Calculate the acceleration of the curling stone. (3)

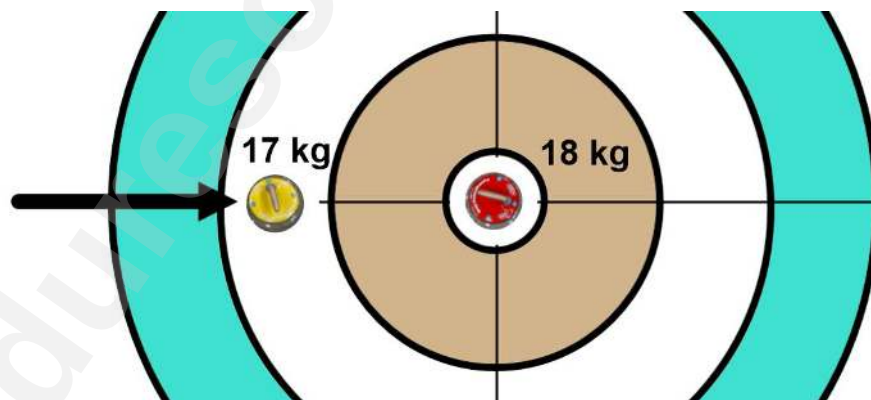
The curling stone is released at the “hog line” (starting line) and slides 28 m until it comes to rest.

During this gliding phase: the curling teammates use special brushes to brush the ice in front of the stone. This brushing action raises the temperature of the ice slightly which makes the ice temporarily more slick. The kinetic coefficient of the ice now drops to 0,02. Assume they brush consistently for the whole 28 m journey as the stone glides.



- 5.6 Calculate the new kinetic friction force acting on the curling stone during this gliding phase. (2)
- 5.7 State the *work-energy theorem*. (2)
- 5.8 Determine the initial velocity of the curling stone upon release 28 m from its target. (4)

The curling stone stops on the centre of the target. The opposition team now slides their curling stone of mass 17 kg. It hits the first curling stone straight on with a velocity of 0.3 m.s^{-1} to the right.



- 5.9 State the *law of conservation of linear momentum*. (2)
- 5.10 Calculate the magnitude of the initial momentum of the 17 kg curling stone **immediately before** it hits the 18 kg stone. (3)
- 5.11 Calculate the speed of the 18 kg stone **immediately after** the collision if the 17 kg stone rebounds with a velocity of $0,01 \text{ m.s}^{-1}$ to the left. (4)

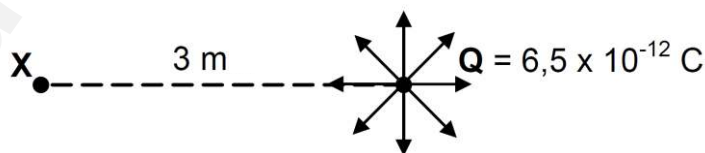
[34]

QUESTION 6 FIELDS

- 6.1 Two small charged polystyrene spheres, **X** and **Y**, are in equilibrium as shown in the diagram below. Sphere **X** stands on an insulated pole. Sphere **Y**, which has a charge of $+60 \text{ nC}$, is suspended by means of a light inextensible thread. The tension (F_T) in the thread is $0,06 \text{ N}$. The angle between the thread and the vertical is 35° . The distance between the centre of sphere **X** and the centre of sphere **Y** is 24 mm .



- 6.1.1 The free body diagram represents the forces acting on sphere **Y**. Provide labels (names) for forces **P** and **Q**. (2)
- 6.1.2 Calculate the magnitude of the horizontal component of the tension in the thread. (round your answer off to 3 decimal places) (2)
- 6.1.3 What is the magnitude of force **P**? (1)
- 6.1.4 State *Coulomb's Law*. (2)
- 6.1.5 Calculate the charge on sphere **X**. (5)
- 6.1.6 Calculate the mass of sphere **Y** in grams. (3)
- 6.2 An isolated point charge **Q** is located in space as shown in the diagram below. Point charge **Q** contributes to an electric field as shown. Point **X** is located 3 m away from point charge **Q**.

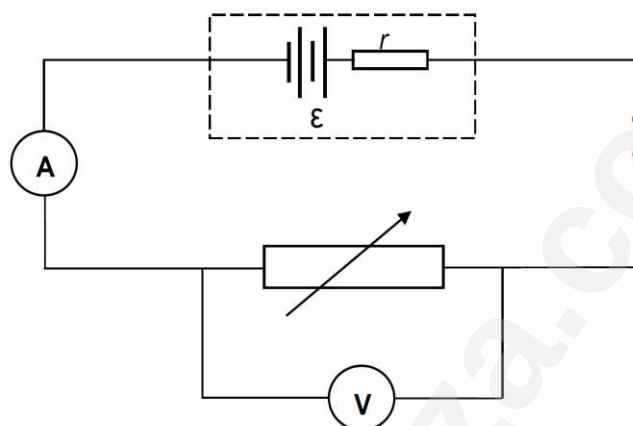


- 6.2.1 How many electrons does charge **Q** have? (2)
- 6.2.2 Calculate the magnitude of the electric field at point **X**. (3)
- 6.2.3 Would an electron placed at point **X** move towards **Q** or away from **Q**. Explain your answer. (3)

[23]

QUESTION 7 ELECTRIC CIRCUITS

- 7.1 A group of grade 12 learners conduct an investigation to determine the emf (ϵ) and internal resistance (r) of a battery. They connect a battery to a rheostat (a variable resistor), an ammeter and a voltmeter as shown below. Assume that the resistance of the ammeter and connecting wires is negligible.

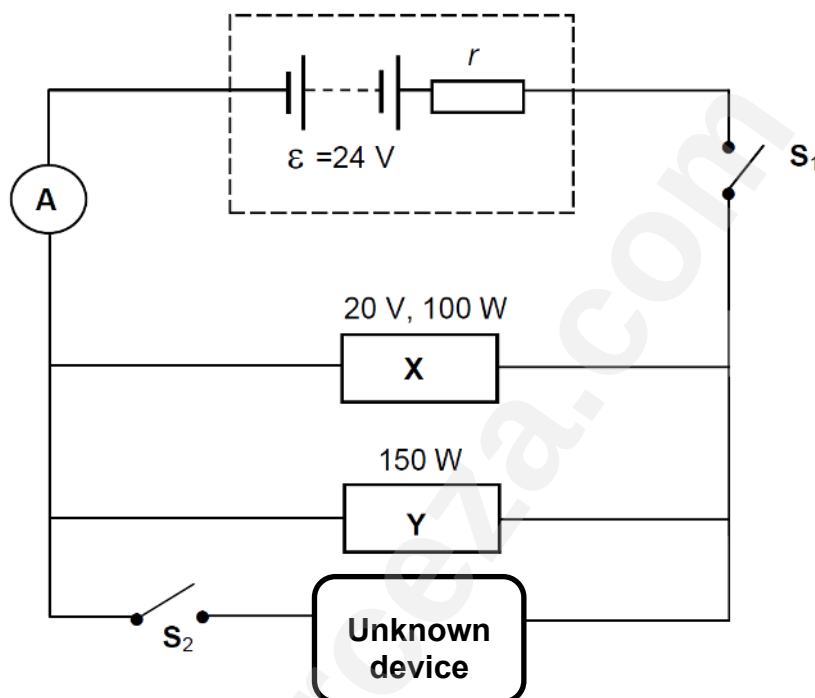


In this investigation the resistance of the rheostat is changed and the readings on the voltmeter and the ammeter are recorded in the table below:

Reading on voltmeter (V)	Reading on ammeter (A)
2	0,58
3	0,46
4	0,36
5	0,24
6	0,14

- 7.1.1 Define *emf*. (2)
- 7.1.2 Name ONE factor that must be kept constant during this investigation. (1)
- 7.1.3 Using the information in the table above, plot the points and draw the line of best fit on graph paper on your separate ANSWER SHEET. (5)
- 7.1.4 Rearrange the formula $\text{emf} = V_{\text{load}} + Ir$ to match the quantities plotted on each axis of your graph in QUESTION 7.1.3. (1)
- 7.1.5 Hence, use the graph drawn in QUESTION 7.1.3 to determine the following:
- 7.1.5.1 the emf (ϵ) of the battery (1)
- 7.1.5.2 internal resistance (r) of the battery. (4)

- 7.2 Three electrical devices, **X**, **Y** and **Z** are connected to a 24 V battery with an internal resistance r as shown in the circuit diagram below. The power rating of each of the devices **X** and **Y** are indicated in the diagram. There is also an unknown electrical device connected in the circuit as shown.



With switch S_1 closed and S_2 open, the devices function as rated.

Calculate:

- 7.2.1 current in X (3)
- 7.2.2 resistance of Y (3)
- 7.2.3 internal resistance of the battery (5)

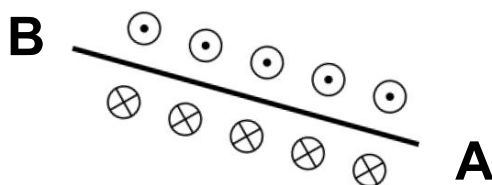
Now switch S_2 is also closed:

- 7.2.4 Identify the **unknown device** which, when placed in the positions shown, can still enable X and Y to operate as rated. Assume the resistances of X and Y remain unchanged. (1)
- 7.2.5 Explain how you arrived at your answer in QUESTION 7.2.4. (2)

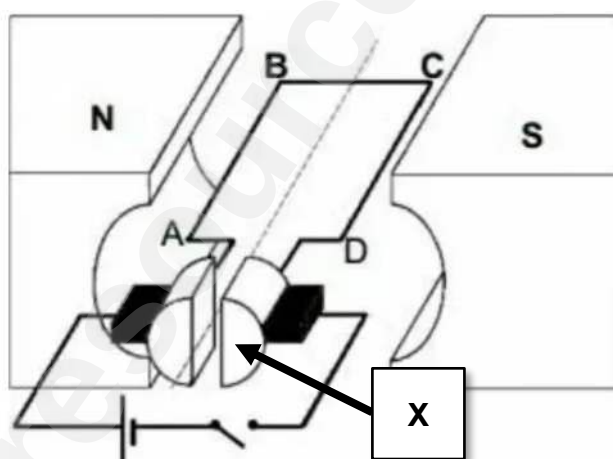
[28]

QUESTION 8 ELECTRODYNAMICS

- 8.1 The magnetic field lines created by a current in a conductor are shown in the diagram.

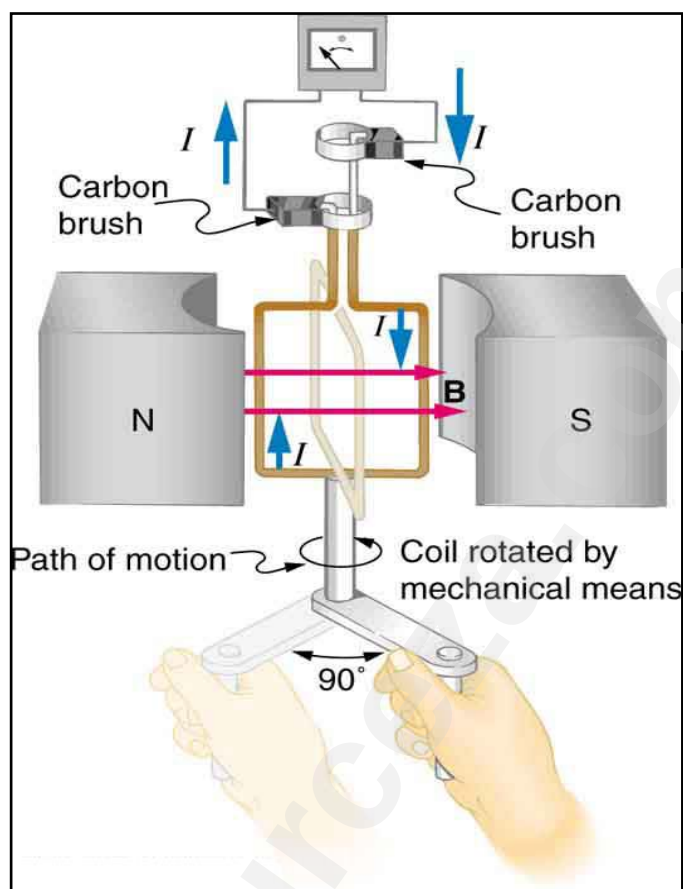


- 8.1.1 Is the direction of conventional current from **A to B** or **B to A**? (1)
- 8.1.2 If this current-carrying conductor is placed between permanent magnets it will experience a force. Briefly explain the origin of the force. (2)
- 8.2 Consider the following diagram of a simple dc motor. Assume that the switch is closed when answering the following questions.



- 8.2.1 Describe the energy conversion which takes place in a motor. (1)
- 8.2.2 Is the direction of the conventional current in the coil **ABCD** or **DCBA**? (1)
- 8.2.3 Name component labelled **X** in the above diagram **and** explain its function. (3)
- 8.2.4 In what direction (clockwise or anticlockwise) would the coil in this motor rotate when looking down the side of the brushes. (1)
- 8.2.5 Why does length BC not experience a force when it is in the position shown in diagram? Refer to a relevant physics formula to explain your answer. (3)

8.3 Consider the following diagram showing a type of generator.



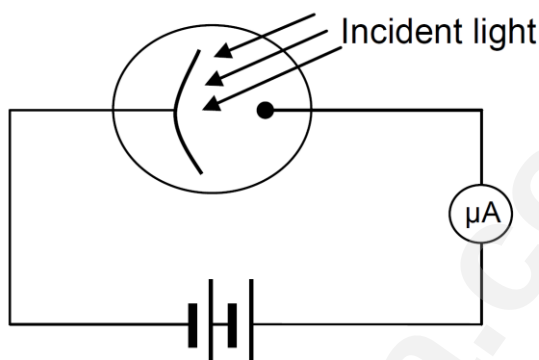
- 8.3.1 State *Faraday's law of electromagnetic induction* (2)
- 8.3.2 What type of current (ac or dc) is generated by the device illustrated above? Explain your answer. (2)
- 8.3.3 Describe ONE way in which the emf induced by a generator could be increased (1)
- 8.3.4 Explain why NO emf is induced in the coil unless the coil is rotated in the magnetic field. (2)
- 8.3.5 Sketch the induced emf vs time graph for a single rotation of this coil, beginning with the coil in the position shown in bold on this diagram. (4)

[23]

PLEASE TURN OVER

QUESTION 9 PHOTONS AND ELECTRONS

A learner uses photocells to determine the maximum kinetic energy of ejected photoelectrons. One photocell has a caesium cathode and the other has a sodium cathode. Each photocell is radiated by ultraviolet light from the same source as shown below:



The incomplete results obtained are shown in the table below:

Name of the metal	W_0 ($\times 10^{-19}\text{J}$)	E_k^{max} ($\times 10^{-19}\text{J}$)
Caesium	3,36	2,32
Sodium	3,65	?

- 9.1 Define *work function*. (2)
- 9.2 Use the information in the table to calculate the wavelength of the ultraviolet light used in the experiment. (5)
- 9.3 Hence, calculate the maximum kinetic energy, E_k^{max} , of an electron ejected from the sodium metal. Give your answer in electron volts. (4)
- 9.4 The intensity of the incident ultraviolet light was then increased.
 - 9.4.1 Explain why this change does NOT affect the maximum kinetic energy of the ejected photoelectrons. (2)
 - 9.4.2 How does the increased intensity affect the reading on the ammeter? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
 - 9.4.3 Explain your answer in QUESTION 9.4.2. (2)

[16]**TOTAL: 200 marks**