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ST. MARY'S DSG KLOOF



PHYSICAL SCIENCES
TRIALS PAPER 1: PHYSICS

GRADE 12

AUGUST 2016

Examiner: Mrs K. Bolton

Moderator: Mrs T. Kirsten and Mrs G. Main

TIME: 3 hours

MARKS: 200

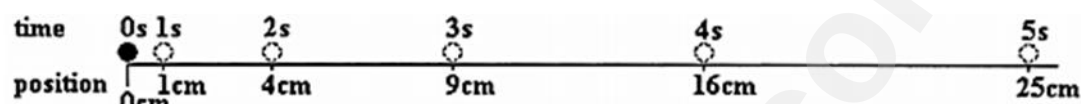
Read the Following Instructions Carefully:

1. This paper consists of:
A question paper of 17 pages
Data sheet
2. Read the questions carefully.
3. Answer **ALL** questions.
4. Number your answers exactly as the questions are numbered.
5. Write legibly and present your work neatly.
6. All working should be shown and units **MUST** be given with answers. Work to two significant figures. **Make sure your calculator is in the correct mode.**
7. Consult the data sheet where necessary.
8. Answers are to be collated in three separate parts:
 1. Question 1 - 4
 2. Question 5
 3. Question 6-8

Acknowledgements: Certain questions have been sourced and adapted from the following papers: NSC Feb/Mar 2015, 2016; GCE 2012; A2GCE Physics A June 2014; GCSE Physics June 2009; June 2015; EC 2014; 2016; AS Physics B.

QUESTION 1 - MULTIPLE CHOICE

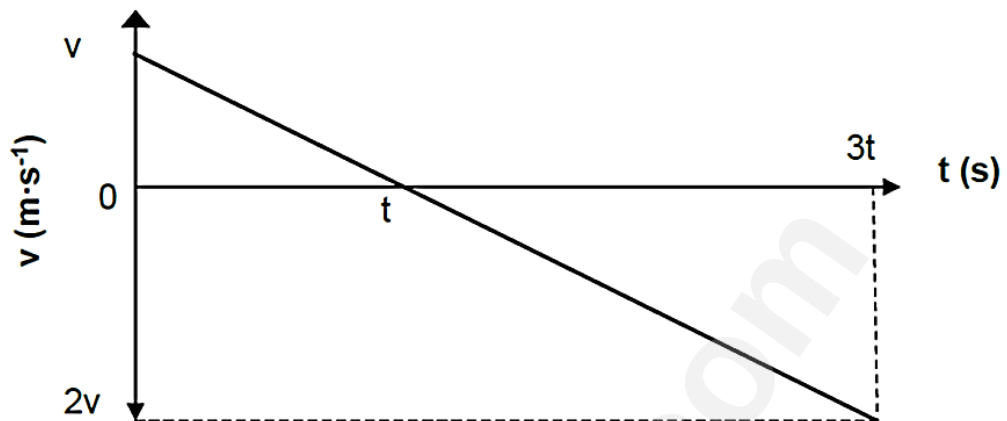
- 1.1 When an object falls freely in a vacuum near the surface of the earth
- A the terminal velocity will be greater than when dropped in air
 - B the velocity will increase but the acceleration will be zero
 - C the acceleration will constantly increase
 - D the acceleration will remain constant
- 1.2 The diagram shows a uniformly accelerating ball. Use this diagram for Q 1.2 and Q 1.3. The position of the ball each second is indicated.



What is the average speed of the ball between 3 and 4 seconds?

- A 3 cm.s^{-1}
 - B 7 cm.s^{-1}
 - C $3,5 \text{ cm.s}^{-1}$
 - D $12,5 \text{ cm.s}^{-1}$
- 1.3 Which of the following is closest to the acceleration of the ball?
- A 1 cm.s^{-2}
 - B 4 cm.s^{-2}
 - C 2 cm.s^{-2}
 - D 5 cm.s^{-2}
- 1.4 A ball is dropped from height h above the ground and reaches the ground with kinetic energy E . From which height h must the ball be dropped to reach the ground with kinetic energy $2E$? (Ignore all effects of friction.)
- A $2h$
 - B $3h$
 - C $4h$
 - D $8h$

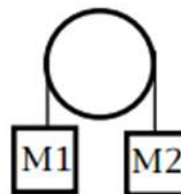
- 1.5 The velocity versus time graph below represents the movement of an object under the influence of gravitational force ONLY.



The displacement of the object in time $3t$ is ...

- A $\frac{5}{2} vt$
 - B $7 vt$
 - C $\frac{7}{2} vt$
 - D $-\frac{3}{2} vt$
- 1.6 A person stands on a scale in an elevator. He notices that the scale reading is lower than his usual weight. Which of the following could possibly describe the motion of the elevator?
- A It is moving down at constant speed.
 - B It is moving down and slowing down.
 - C It is moving up and slowing down.
 - D It is moving up and speeding up.
- 1.7 Solve for the mass of block M_2 below. The pulley is frictionless. $M_1 = 6 \text{ kg}$, and M_2 accelerates upward at $2,9 \text{ m}\cdot\text{s}^{-2}$.

- A $3,2 \text{ kg}$
- B $4,8 \text{ kg}$
- C $6,6 \text{ kg}$
- D $9,8 \text{ kg}$



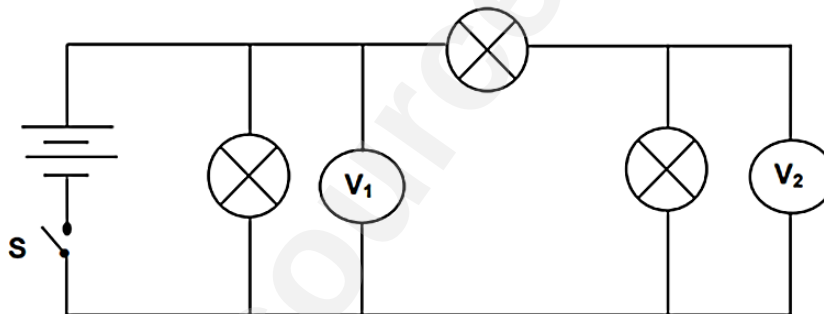
1.8 A net force acts on each of the isolated objects, R and S, as shown below.



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

- A $\frac{1}{9} X$
- B $\frac{1}{3} X$
- C X
- D $3 X$

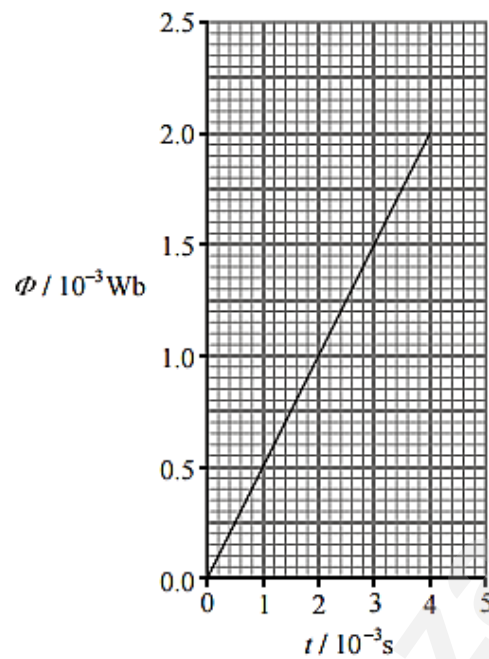
1.9 Three identical light bulbs are connected in a circuit as shown below.



The resistances of the battery and connecting wires can be ignored. Which ONE of the following statements is CORRECT when switch S is closed? The reading on V_1 is ...

- A half that on V_2 .
- B equal to that on V_2 .
- C twice that on V_2 .
- D three times that on V_2 .

1.10 The magnetic flux Φ through a coil having 500 turns varies with time t as shown below.



The magnitude of the emf induced in the coil is:

- A 0,25 V
- B 0,50 V
- C 250 V
- D 1 000 V

[2x10=20]

QUESTION 2 - KINEMATICS (VECTORS)

In still air an aircraft flies at 200 m.s^{-1} . The aircraft is heading due north in still air when it flies into a steady wind of 50 m.s^{-1} blowing from the west.

2.1 Define the term *resultant vector*. (2)

2.2.1 Sketch a vector diagram to show the new resultant velocity of the aircraft. (3)

Label the resultant velocity clearly. (3)

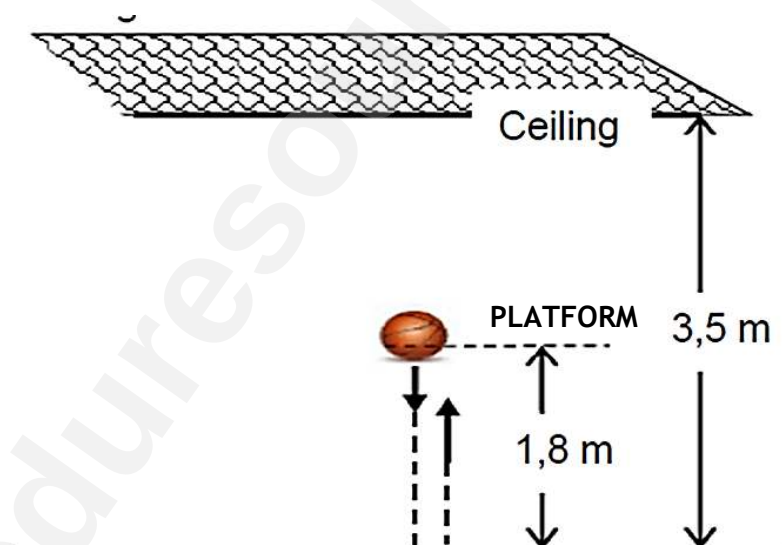
2.2.2 Calculate the magnitude and direction of the resultant velocity. (3)

2.3 The pilot now heads slightly to the west of north with the same speed setting of 200 m.s^{-1} in order to regain his original northerly direction. Calculate the magnitude of his new northerly velocity. (3)

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QUESTION 3 - KINEMATICS (MOTION)

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



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

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

3.3 Calculate the magnitude of the velocity with which the ball hits the floor. (3)

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

The ball bounces **INELASTICALLY** on the floor where the velocity of the ball **DECREASES** by 20%.

- 3.5 Determine by means of calculations, whether the ball will reach the ceiling after its first bounce on the floor. (5)
- 3.6 Sketch a velocity-time graph for the motion of the ball, from the time the ball is thrown until it reaches the maximum height after the bounce.
Clearly show the following on the graph:
- The initial velocity of the ball
 - The velocity and time when the ball hits the floor

(4)

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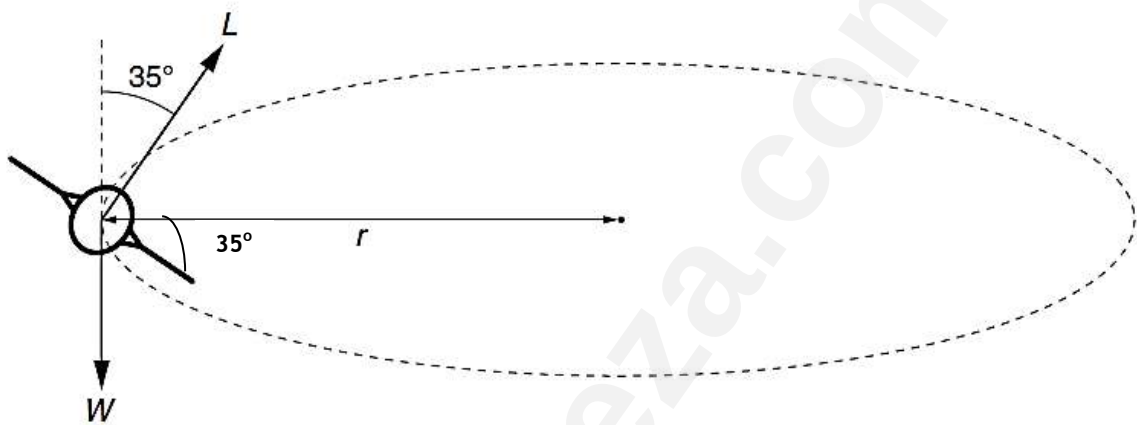
QUESTION 4 - NEWTON'S LAWS

The figure below shows a jet aircraft preparing for take-off along a horizontal runway. The engine of the jet is running but the brakes are applied. The jet is not yet moving.



- 4.1 Draw a labelled free body diagram showing all the forces acting on the jet. (4)
- 4.2 State Newton's *Second Law of Motion*. (3)
- 4.3 The brakes are released. The maximum force produced by the engine is 28 000 N. The take-off speed of the jet is 56 m.s^{-1} . The mass of the jet is 6200 kg. Calculate the minimum distance the jet travels from rest to the point where it takes off. (6)

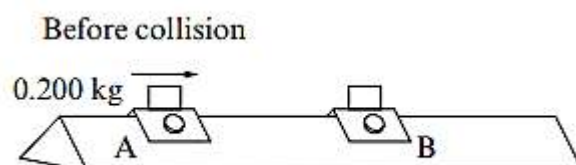
- 4.4 The jet is to be used in a flying display in which the pilot will be required to fly the jet in a horizontal circle at a **constant** speed of 86 m.s^{-1} . This is achieved by flying the jet with its wings at 35° to the horizontal. With the jet flying in this way, the two forces acting on the jet are the lift L and the weight W as shown in the figure below. Air resistance has a negligible effect on the motion of the jet during this manoeuvre.



- 4.4.1 State Newton's *First Law of Motion*. (2)
- 4.4.2 Explain the significance of the jet flying at **constant** speed during this manoeuvre in terms of the forces acting on the jet. (2)
- 4.4.3 Show that the magnitude of the force L is about 74 kN. (3)
- [20]

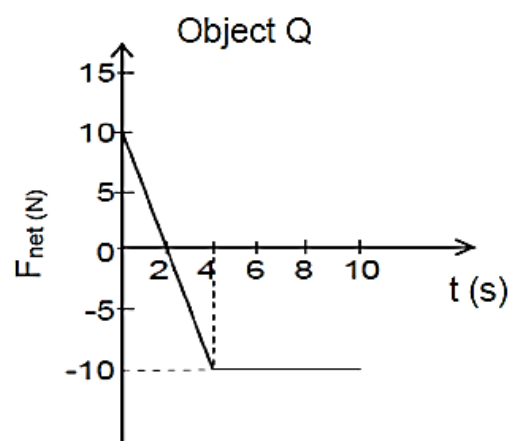
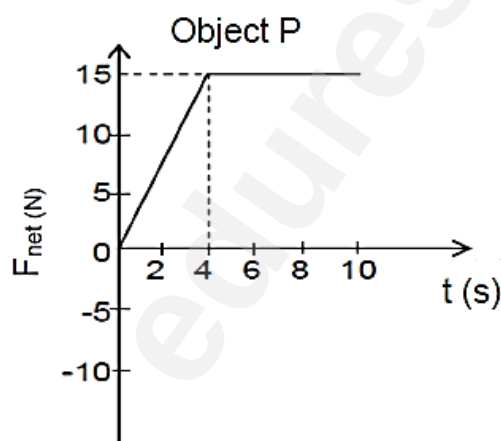
START THIS QUESTION ON A NEW PAGEQUESTION 5 - MOMENTUM, ENERGY AND POWER

In a laboratory experiment two gliders A and B lie on a linear air track (friction-free). The gliders float on a cushion of air emerging from the holes in the track.



Glider A, of mass 0,2 kg, is accelerated from rest by a force of 3 N acting for 0,15 s.

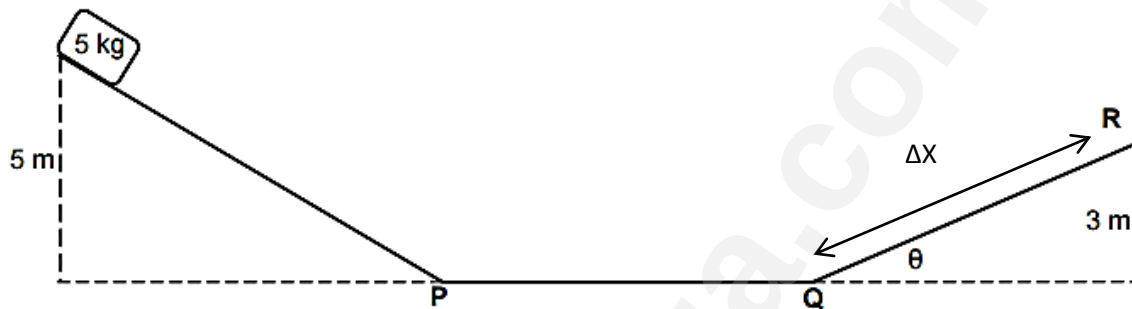
- 5.1 Calculate the velocity of glider A after 0,15 s. (4)
- 5.2 Define *momentum*. (2)
- 5.3 Glider A then collides with a stationary glider B. They stick together and move with a velocity of $1,2 \text{ m}\cdot\text{s}^{-1}$ to the right. Calculate the mass of glider B. (4)
- 5.4 Determine whether or not the collision is elastic. (5)
- 5.5 Two identical objects P and Q with a mass of 10 kg each, are moving side by side with an initial velocity of $5,5 \text{ m}\cdot\text{s}^{-1}$ east on a horizontal surface. The following graphs show the net force experienced by each object respectively during the same time interval.



- 5.5.1 Calculate the total impulse experienced by object Q in 10 s. (5)
- 5.5.2 Compare, without using any calculations, the total impulse for object P with that of object Q. Write down only GREATER THAN, LESS THAN or EQUAL TO. Explain your answer to Q 5.5.2 using a suitable formula. (3)

5.5.3 Calculate the final velocity of **object Q**. (4)

5.6 A 5 kg block is released from rest from a height of 5 m and slides down a frictionless incline to point P as shown in the diagram below. It then moves along a frictionless horizontal portion PQ and finally moves up a second rough inclined plane. It comes to a **stop** at point R which is 3 m above the horizontal. The frictional force, which is a non-conservative force, acting on the block as it slides from Q to R, is 18 N.



5.6.1 State the *Law of conservation of mechanical energy*. (2)

5.6.2 Calculate the speed of the block at point P. (4)

5.6.3 Explain why the kinetic energy at point P is the same as that at point Q. (2)

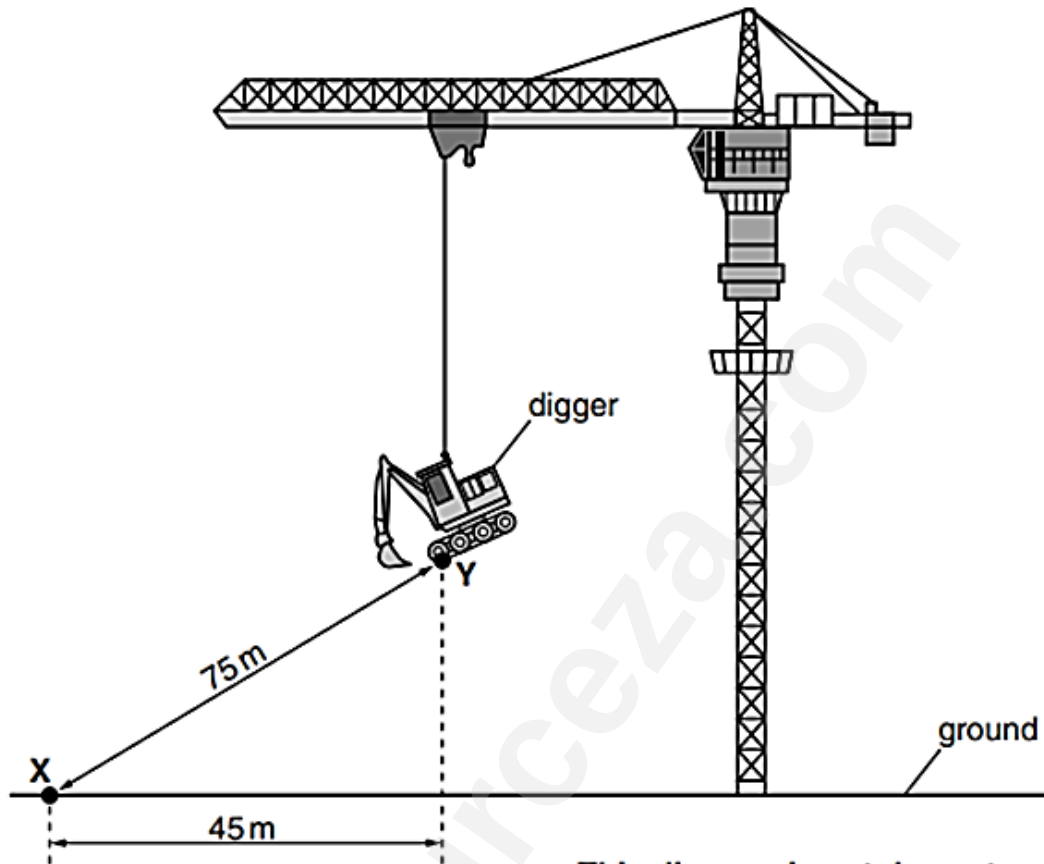
5.6.4 Calculate the work done against gravity by the block at R. (3)

5.6.5 Calculate the work done by the frictional force when the 5 kg block moves from point Q to R. (3)

5.6.6 State the Work-Energy Theorem. (2)

5.6.7 Calculate the angle (θ) of the slope QR. (5)

- 5.7 The figure below shows an electric crane lifting a mechanical digger. The mass of the digger is 5200 kg. The crane takes 1,5 minutes to lift the digger from X to Y.



This diagram is not drawn to scale

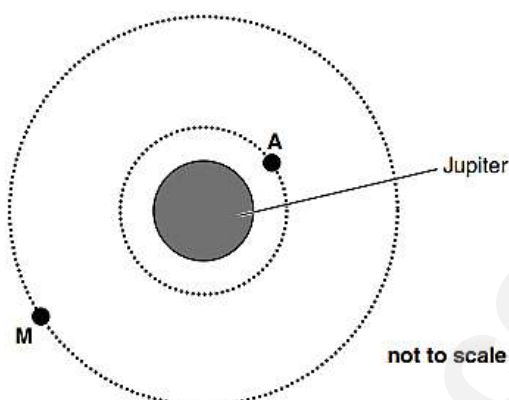
- 5.7.1 Calculate the rate of work done to lift the digger from X to Y. (6)
- 5.7.2 The total input power to the motors of the crane is 50 kW. Calculate the efficiency of the lifting operation. (3)

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QUESTION 6 - FIELDS

The diagram below shows the circular orbits of two of Jupiter's moons: Adrastea **A** and Megaclite, **M**.

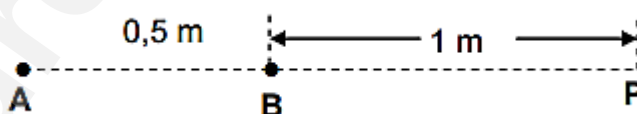


Use the following data in your calculations below:

Orbital radius of **A** = $1,3 \times 10^8 \text{ m}$

g at **A** = $7,5 \text{ m.s}^{-2}$

- 6.1 Calculate the mass of Jupiter. (3)
- 6.2 If the value of g at Adrastea's position is 34 090 times bigger than that at Megaclite's position, calculate the orbital radius of Megaclite without using the given value of g at **A** or the mass of Jupiter that you calculated in Q 6.1. (3)
- 6.3 Two **identical** negatively charged spheres, **A** and **B**, having charges of the same magnitude, are placed 0,5 m apart in a vacuum. The magnitude of the electrostatic force that one sphere exerts on the other is $1,44 \times 10^{-1} \text{ N}$.

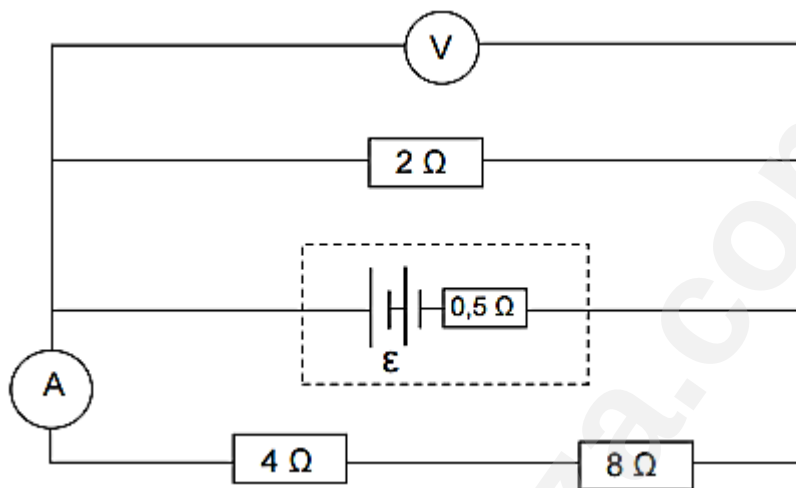


- 6.3.1 State *Coulomb's Law*. (3)
- 6.3.2 Calculate the:
 - 6.3.2.1 Magnitude of the charge on each sphere. (4)
 - 6.3.2.2 Excess number of electrons on sphere B. (2)
- 6.3.3 P is a point at a distance of 1 m from sphere B. What is the direction of the net electric field at point P? (1)
- 6.3.4 Calculate the new charge of sphere B so that the net electric field at point P is $3 \times 10^4 \text{ N.C}^{-1}$ to the right. (4)

[20]

QUESTION 7 - ELECTRIC CIRCUITS

A battery of an unknown emf and an internal resistance of $0,5\ \Omega$ is connected to three resistors, a high-resistance voltmeter and an ammeter of negligible resistance, as shown below. The reading on the ammeter is $0,2\text{ A}$.



7.1 Calculate the:

7.1.1 Reading on the voltmeter . (3)

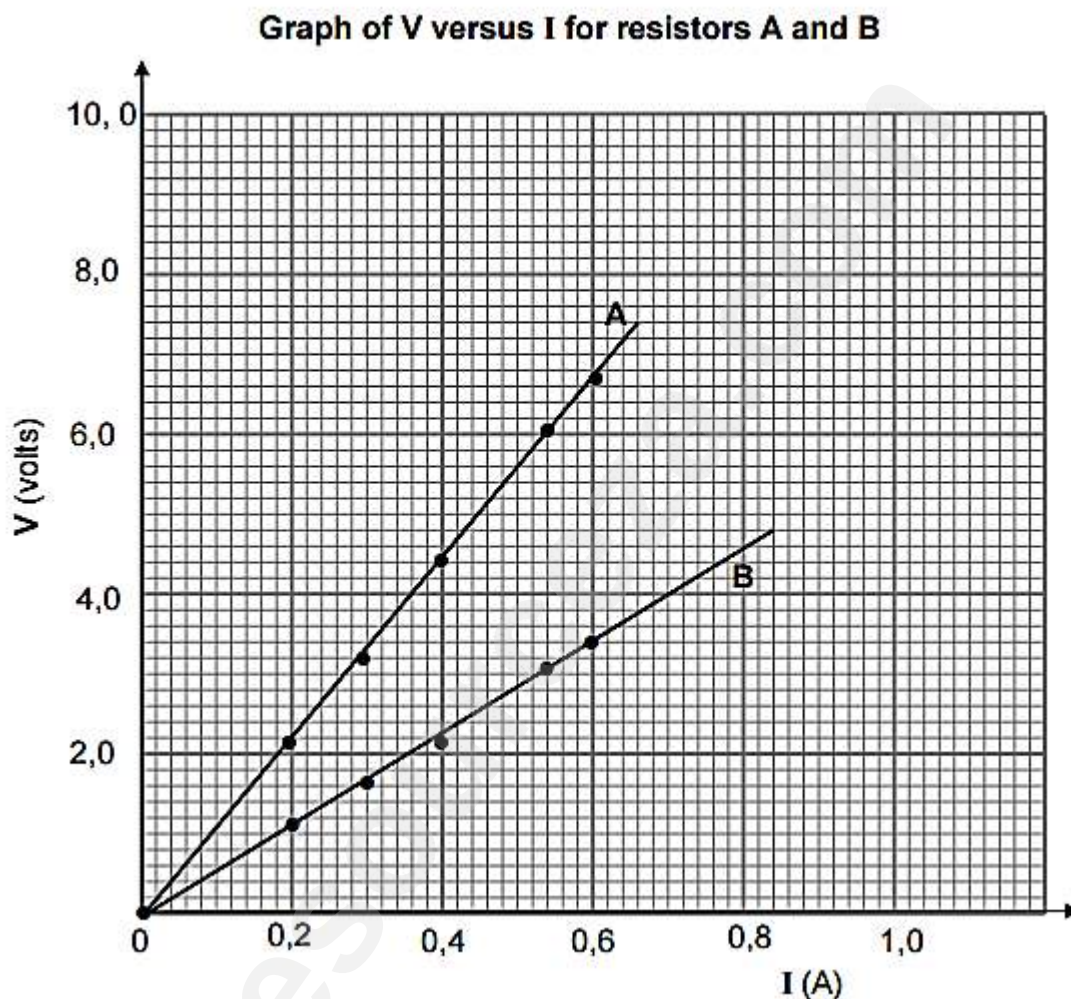
7.1.2 Total current supplied by the battery. (4)

7.1.3 Emf of the battery. (5)

7.2 How would the voltmeter reading change if the $2\ \Omega$ resistor is removed from the circuit? Write down INCREASE, DECREASE or REMAIN THE SAME. Explain the answer.

(3)

- 7.3 Learners want to construct an electric heater using one of two wires of the same material, A and B, of different resistances. They conduct experiments and draw the graphs as shown below.

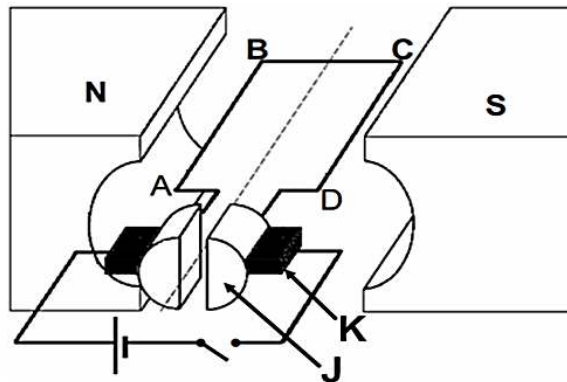


- 7.3.1 State *Ohm's Law*. (2)
- 7.3.2 Apart from temperature, write down TWO other factors that the learners should consider to ensure a fair test when choosing which wire to use. (2)
- 7.3.3 Calculate the resistance of Wire A and Wire B. (5)
- 7.3.4 Assuming all other factors are kept constant, state which ONE of the two wires will be the most suitable to use in the heater. Use suitable formulae to show clearly how you arrive at the answer. (3)

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QUESTION 8 - ELECTRODYNAMICS

The simplified sketch below represents a DC motor.

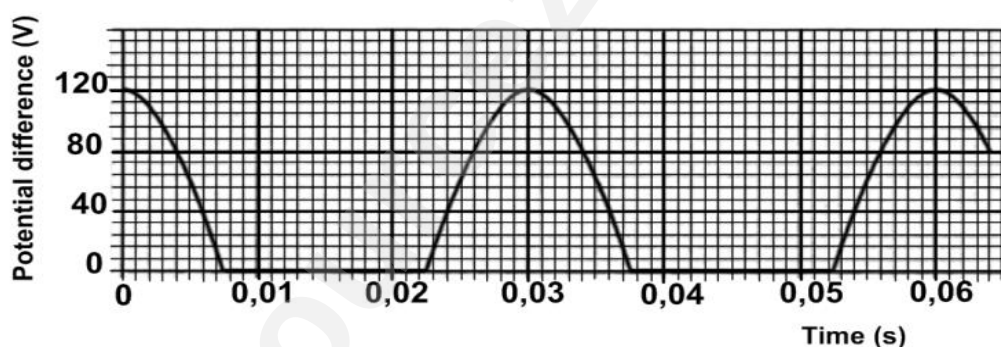


- 8.1 Name the principle on which the motor operates. (1)
- 8.2 State the energy conversion which takes place in a DC motor. (2)
- 8.3 Give a reason why section BC in the above diagram does NOT experience a magnetic force whilst the coil is in the position as shown. (2)
- 8.4 Name the part labelled K. (1)
- 8.5 Name the part labelled J and state its function. (2)
- 8.6 In which direction will the coil rotate, CLOCKWISE or ANTI-CLOCKWISE? (1)

- 8.7 The universal series motor is commonly found on household mains operated washing machines. This motor will operate on either AC or DC. Older models of washing machines used DC and used an inverter to convert (rectify) AC to DC. The rectified AC output is connected across the motor R of resistance $15\ \Omega$ as shown in the diagram below.

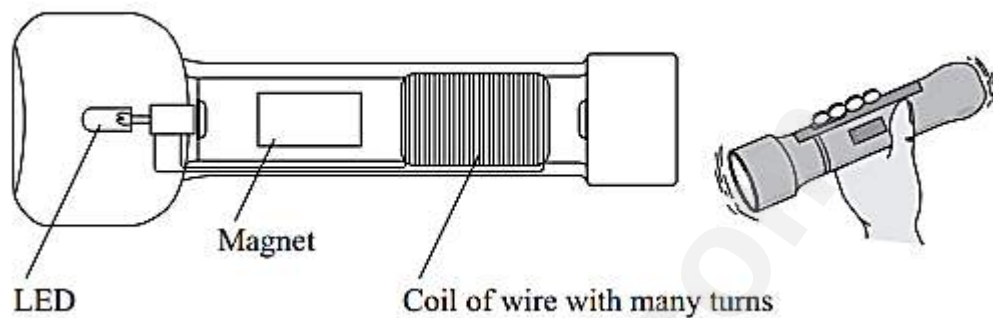


The variation with time t of the potential difference V across R is shown in the graph below:



- 8.7.1 What type of rectification is shown in the graph above? (1)
- 8.7.2 Briefly describe how the rectification shown in the above graph is achieved. (2)
- 8.8 A washing machine is labelled: 240 V; 2750 W.
Calculate the costs of using the washing machine for 6 hours if electricity costs R1,75 per kWh. (3)
- 8.9 You emigrate to America (where the electricity is supplied at 110 V) and decide to take the washing machine with you. In order to use it there a device called a transformer is put into the washing machine.
- 8.9.1 Would this be a step-up or a step-down transformer? (1)
- 8.9.2 If the primary coil has 48 000 turns, calculate the number of turns in the secondary coil. (2)

- 8.10 The diagram shows some parts of a torch which works without batteries. The coil is part of a complete circuit with the LED (light-emitting diode). You have to shake the torch for a short time and then it is ready to use.



- 8.10.1 State *Faraday's Law of electromagnetic induction*. (2)
- 8.10.2 Use the diagram above to help you explain how shaking the torch produces an electric current. Use bullet points in your explanation. (4)
- 8.10.3 Give two changes which you would make to the design of the torch to increase the size of the induced potential difference. (2)

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