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NAME: _____ SET: _____

St Andrew's College & Diocesan School for Girls



GRADE 12

PHYSICAL SCIENCES: PAPER 1 (PHYSICS)

Date: Thursday 21 July 2016
Time: 08h00

Examiner: K Cobbing
Moderator: AC Smith

Duration: 3 hours

200 marks

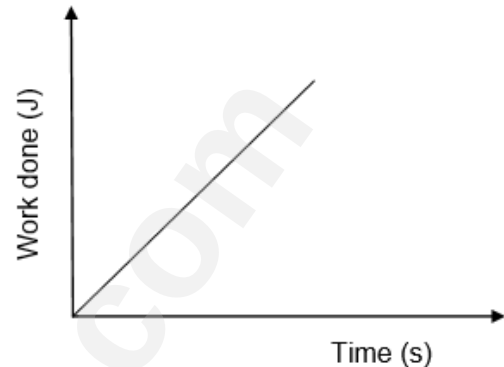
READ THE FOLLOWING INSTRUCTIONS CAREFULLY:

1. Write your name at the top of each page, on your answer sheet and on your question paper.
2. Please check that your paper is complete:
 - This question paper has FOURTEEN pages, including this coversheet.
 - You should also have a formula sheet, and an answer sheet.
3. Please hand in your question paper as well as your answer pages.
4. Read the questions carefully.
5. Start each question on a new page.
6. Present your work neatly and legibly.
7. Answer ALL the questions.
8. Number your answers exactly as the questions are numbered.
9. All working must be shown and units must be given with answers.

QUESTION 1 MULTIPLE CHOICE QUESTIONS

On your ANSWER SHEET indicate with a cross the letter that corresponds to the correct answer for each of these questions. 10 x (2) marks

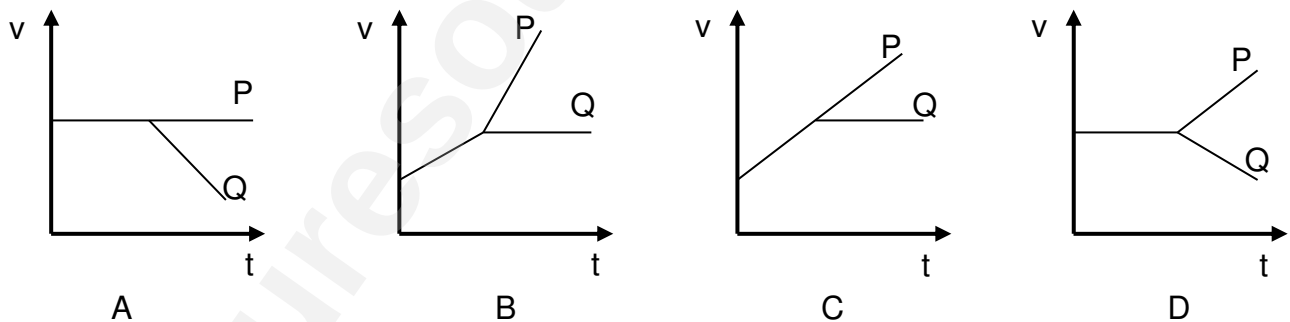
- 1.1 The graph below represents the relationship between the work done on an object and the time taken for this work to be done.



The gradient of the graph represents the ...

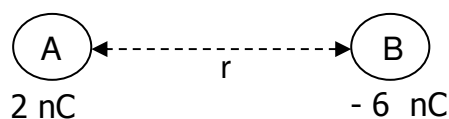
- A potential energy.
- B momentum.
- C kinetic energy.
- D power.

- 1.2 Two objects P and Q tied by a string are pulled along a frictionless horizontal surface by a force F. The string between them is then cut. Which of the following graphs best represents the velocities of P and Q before and after the string is cut:



The following information should be used to answer questions 1.3 and 1.4:

Two point charges A and B, of charge 2 nC and -6 nC respectively are held at a distance r apart. They exert a force F on each other. They are then brought together and allowed to touch before being separated again to a distance of $2r$.



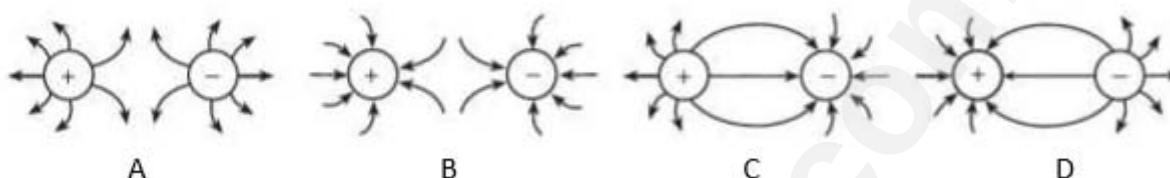
- 1.3 The new charge on point charge A is ...

- A. 1 nC
- B. -2 nC
- C. -4 nC
- D. 4 nC

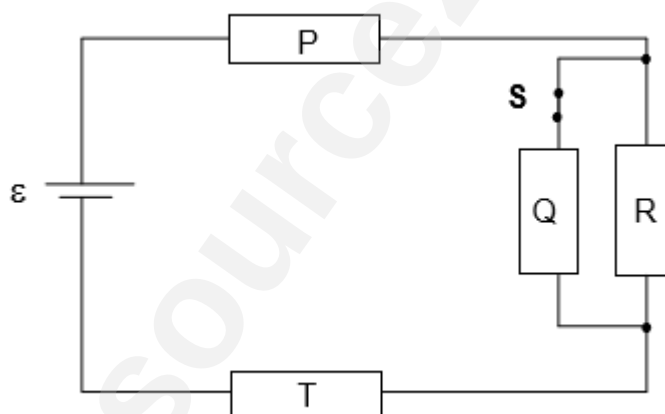
1.4 The magnitude of the force that they now exert on one another is

- A. $F/12$
- B. $12F$
- C. $4F$
- D. $F/4$

1.5 Which diagram represents the electric field between two oppositely charged conducting spheres?



1.6 The four resistors P, Q, R and T in the circuit below are identical. The cell has an emf ϵ and negligible internal resistance. The switch is initially CLOSED.

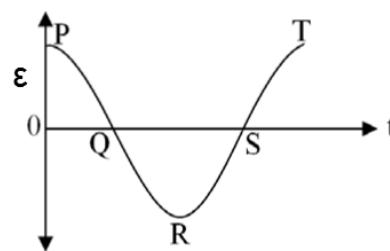


Switch S is now OPENED. Which ONE of the following combinations of changes will occur in P, R and T?

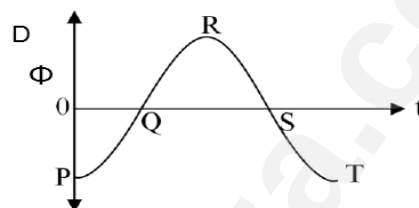
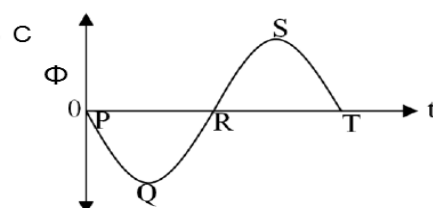
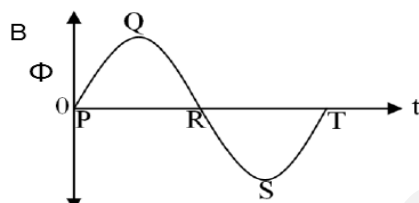
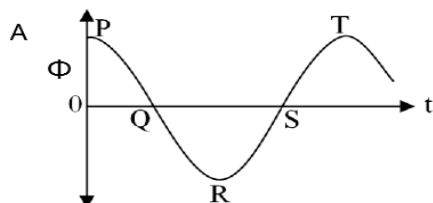
	CURRENT IN P	CURRENT IN R	CURRENT IN T
A	Increases	Increases	Increases
B	Increases	Remains the same	Increases
C	Decreases	Remains the same	Decreases
D	Decreases	Increases	Decreases

P.T.O.

- 1.7 A coil is rotated in a magnetic field. The graph shows how the induced EMF (ϵ) changes with time for one complete rotation of the coil.



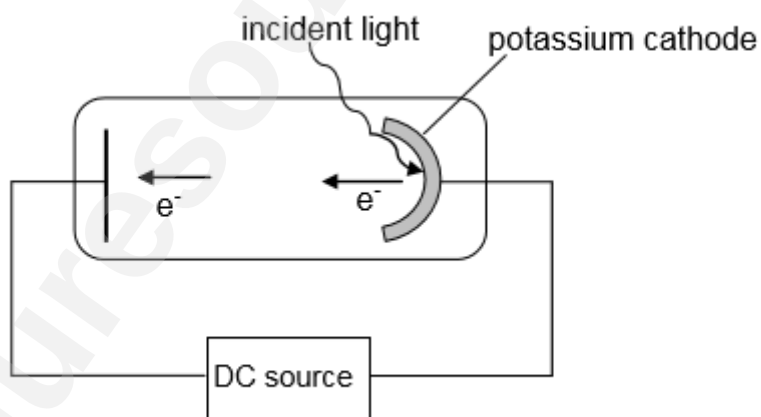
Which one of the following graphs shows the corresponding magnetic flux (Φ) with time for one complete rotation of the coil?



(2)

Refer to the information below to answer questions 1.8 and 1.9:

Ultraviolet light is incident onto a photocell with a potassium cathode as shown below. The threshold frequency of potassium is $5,548 \times 10^{14}$ Hz. The maximum speed of an ejected photoelectron is $5,33 \times 10^5$ m.s⁻¹.



- 1.8 The work function of potassium is

- A. $8,41 \times 10^{47}$ J
- B. $3,47 \times 10^{33}$ J
- C. $1,34 \times 10^{29}$ J
- D. $3,66 \times 10^{-19}$ J

The photocell is now replaced by another photocell with a rubidium cathode. The maximum speed of the ejected photoelectron is $6,10 \times 10^5 \text{ m.s}^{-1}$ when the same ultraviolet light source is used.

1.9 Compared to the work function of potassium, the work function of rubidium is

- A. smaller.
- B. greater.
- C. equal to.
- D. impossible to know from the information given.

1.10 When light of a certain wavelength is incident on a metal surface, no electrons are ejected. Which ONE of the following changes may result in electrons being ejected from the metal surface?

- A. Increase the intensity of the light.
- B. Use light with a much shorter wavelength.
- C. Use metal with a larger work function.
- D. Increase the surface area of the metal.

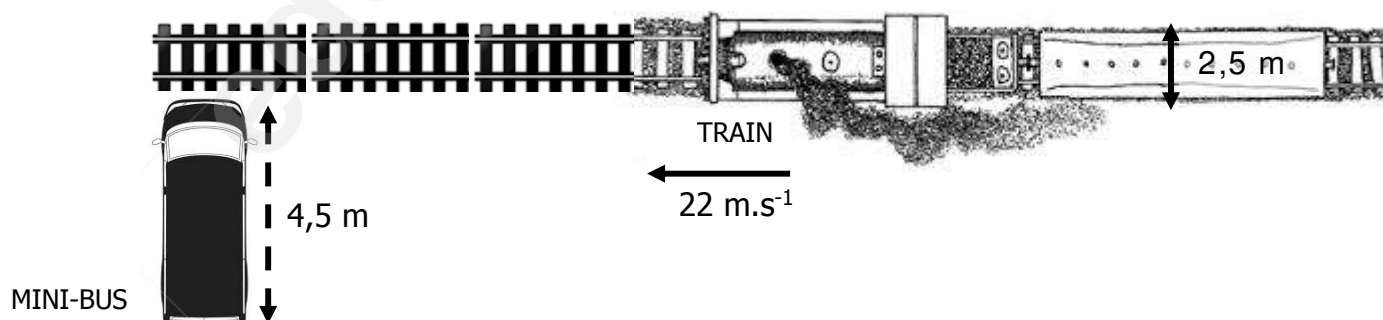
[some of these questions were taken or adapted from papers from: DBE Nov 2014 & Nov 2015, Clifton College 2014]

20 marks

QUESTION 2 TRAIN CROSSING

(START THIS QUESTION ON A NEW PAGE)

A train is travelling at a constant velocity of 22 m.s^{-1} along a straight railway track. A mini-bus, which is $4,5 \text{ m}$ long, is approaching the train track at 16 m.s^{-1} . The driver stops the mini-bus (as indicated in the sketch) and then decides that it is safe to accelerate across the tracks in front of the train. The mini-bus is capable of accelerating at $2,0 \text{ m.s}^{-2}$ and the width of the train is $2,5 \text{ m}$.



2.1 Assuming the train continues at a constant velocity, what is the closest that the train could be for the mini-bus to safely cross the track? (5)

P.T.O.

Another mini-bus is less lucky. Its engine cuts out while on the tracks. The driver jumps out and a train collides with the empty bus. The mass of the empty bus is 2000 kg and the mass of the train is 186 000 kg. The train was travelling at 22 m.s^{-1} when it hit the bus. The bus and train move off together after the collision. Assume that friction is negligible.

- 2.2 State the principle of conservation of momentum. (2)
- 2.3 Calculate the velocity of the vehicles after the collision. (4)
- 2.4 Describe what would happen to a passenger on the train who was standing and not holding on when the train collided with the mini-bus. Use an appropriate law or principle to support your answer. (3)
- 2.5 Determine the change in momentum that a 80 kg passenger travelling in the train would experience during the collision with the mini-bus, if the passenger was seated and wearing a seatbelt. (4)
- 2.6 If the collision lasts 0,15 seconds, determine the force that the passenger in question 2.5 would experience as the train collided with the mini-bus. (3)

21 marks

QUESTION 3 TOSSING BRICKS

(START THIS QUESTION ON A NEW PAGE)

The building team at Spencer Chapman are throwing building rubble into a truck directly below the building site. They are arguing about which method of throwing bricks will give the bricks a minimum velocity when they land in the truck (and so make less noise, as the teachers keep asking them to work more quietly).

Andile wants to throw the bricks upwards (method A).

Barry wants to drop the bricks (method B).

Chris wants to throw the bricks downwards (method C).

- 3.1 Explain to the builders which of the methods would achieve the smallest velocity, assuming that the bricks are thrown with the same magnitude of velocity in methods A and C. (4)
- 3.2 If a brick is thrown upwards at 4 m/s from the new room that is being built and takes 1,5 seconds to hit the bed of the truck parked directly below, what is the height of the new room above the truck bed? (3)
- 3.3 With what velocity will this brick (thrown up at 4 m/s) hit the truck? (4)
- 3.4 Sketch a velocity-time graph for the brick for the 1,5 seconds that it takes to fall. (4)

QUESTION 4 TRIP TO PORT ELIZABETH

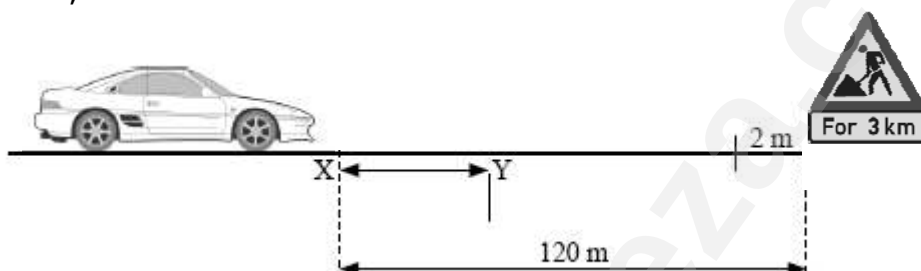
(START THIS QUESTION ON A NEW PAGE)

Lola is driving forward at a constant speed of 20 m.s^{-1} on a horizontal road on her way from Grahamstown to Port Elizabeth.

As she rounds a bend in the road, she maintains her speed of 20 m.s^{-1} .

4.1.1 Is her velocity constant as she rounds the bend? Explain your answer. (2)

The road straightens out again as she continues at 20 m.s^{-1} and at point X she sees a stop-go barricade 120 m ahead and realises that she will have to stop. At point Y, after travelling at a constant speed for time Δt , she applies the brakes and the magnitude of the acceleration of her car is then $2,5 \text{ m.s}^{-2}$.



4.1.2 Define, in words, *acceleration*. (2)

4.1.3 Calculate how far Lola's car travels, after the brakes have been applied at point Y, until it stops at the stop-go. (3)

4.1.4 When the car actually stops, it is 2 m from the barricade. Calculate the distance XY travelled by the car, during the time Δt . (2)

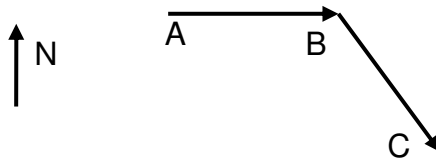
4.1.5 Determine the time Δt . (3)

4.1.6 Draw a position-time graph of the car from point X to the barricade. Take point X as the point of origin. (4)

P.T.O.

Lola was on her way to Port Elizabeth to watch a sailing race in Algoa Bay.

- 4.2 The diagram below shows the path followed by a small yacht during the race. The yacht sails from buoy A to B to C. B lies 360 m due east of A and C lies 360 m on a bearing of 135° from B.



The speed of the yacht from A to B is 2 m.s^{-1} and the speed from B to C is 4 m.s^{-1} .

- 4.2.1 Calculate the total time taken for the trip from A to B to C. (5)
- 4.2.2 Find the average speed of the yacht. (3)
- 4.2.3 Find the magnitude of the average velocity of the yacht. (6)

30 marks

QUESTION 5 HAULING EQUIPMENT

(START THIS QUESTION ON A NEW PAGE)

A box containing building equipment with a total mass of 100 kg is raised up to the ledge which is 4 m above the ground. This is done using a cable.

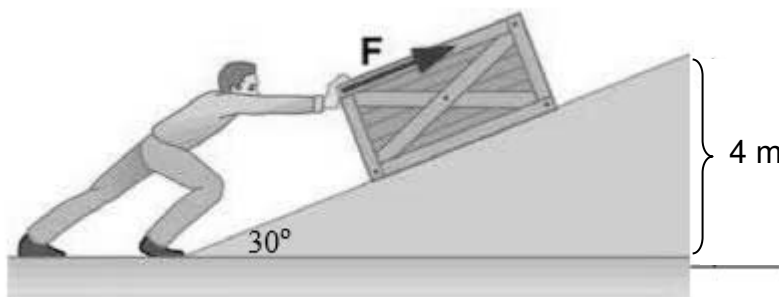
- 5.1 Define *work*. (2)
- 5.2 Calculate the amount of work done in raising the box to the ledge. (3)

The empty box (with a mass of 8 kg) is lowered using the cable, accelerating downwards at 4 m.s^{-2} .

- 5.3 Draw a labelled free body diagram of the forces acting on the box as it is lowered. (2)
- 5.4 What will be the tension in the cable as the box is lowered? (4)

Instead of lifting the box up to the ledge, a man pushes the same box (mass 100 kg) up a metal incline constructed to reach the ledge. The incline is at an angle of 30° to the ground and just reaches the ledge at 4m above the ground. The diagram below is not to scale!

The effective coefficient of dynamic friction between the metal incline and the wooden box is 0,4.



- 5.5 Draw a free body diagram of the forces acting on the box as it is pushed up the incline at constant velocity. (3)
- 5.6 Determine the frictional force between the box and the incline as it is pushed up the incline at constant velocity. (5)
- 5.7 Calculate the distance that the box must be pushed up the incline from the ground to reach the ledge. (2)
- 5.8 Determine the force that the man has to exert on the box to push it up the slope at a constant velocity. (5)
- 5.9 How much work does the man do in pushing the box to the ledge? (3)
- 5.10 Briefly justify which method of raising the box you think would be preferred by the workers. (2)

The man stops pushing the box after pushing it 2 m along the incline because he is tired. He holds the box still for a moment and then jumps out of the way, allowing the box to slide down the incline.

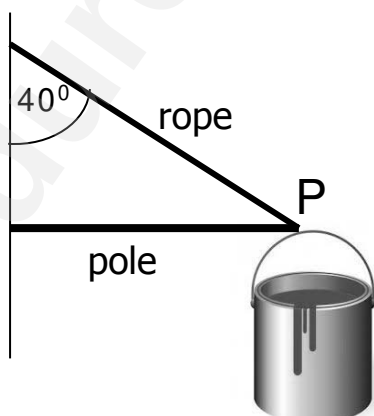
- 5.11 State *the Work Energy Theorem*. (2)
- 5.12 How fast would the box be sliding when it reaches the bottom of the incline? (6)

39 marks

QUESTION 6 HANGING PAINT

(START THIS QUESTION ON A NEW PAGE)

A 7kg tin of paint is hung from the roof by a rope, but held away from the wall with a horizontal pole, as shown in the diagram below. The rope makes an angle of 40° to the wall where it is tied on.



- 6.1 Draw a labelled free body diagram showing the forces acting on point P where the paint is tied to the rope. (3)
- 6.2 Determine the tension in the rope. (4)

QUESTION 7 FIELDS

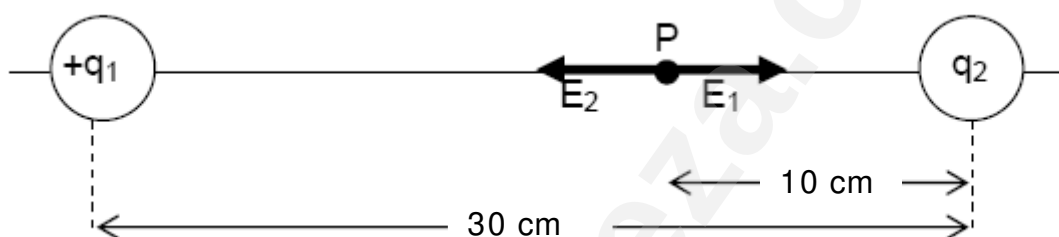
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Rebecca, who is four years old, maintains that dinosaurs are not extinct, but live on Mars.

Mars has a mass of $0,642 \times 10^{24}$ kg and a radius of 3 396 km.

7.1 Calculate the magnitude of the force that a 850 kg dinosaur would experience on the surface of Mars. (4)

7.2 Two positive point charges, $q_1 = +16 \times 10^{-6}$ C and $q_2 = +4 \times 10^{-6}$ C, are separated by a distance 30 cm.



7.2.1 Draw the electric field pattern between the charges q_1 and q_2 . (3)

7.2.2 Define the term *electric field*. (2)

7.2.3 Determine the electric field strength due to both charges at point P, which is 10 cm from q_2 . (5)

7.2.4 If the distance between q_1 and q_2 is doubled, how will the force between the charges change? (1)

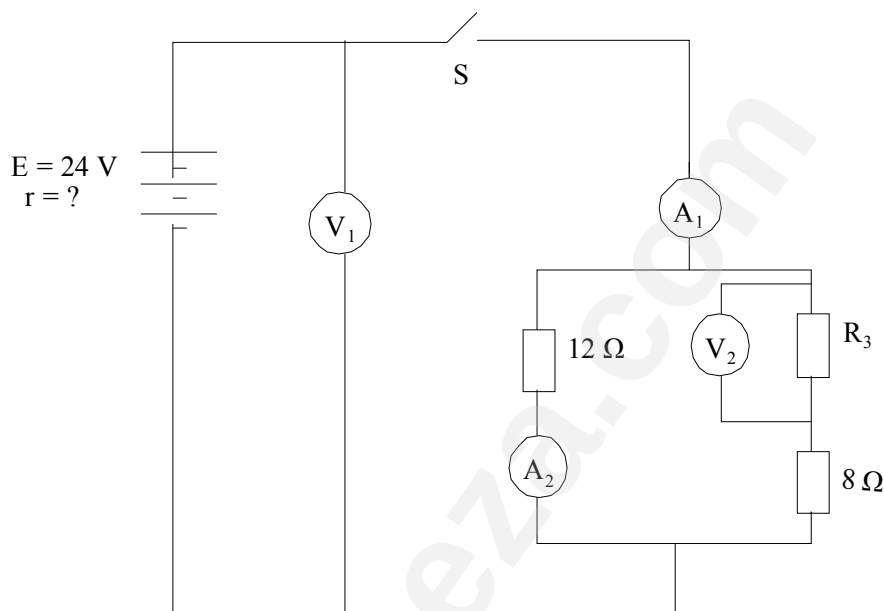
[7.2 Adapted from IEB September 2011]

15 marks

QUESTION 8 CIRCUITS

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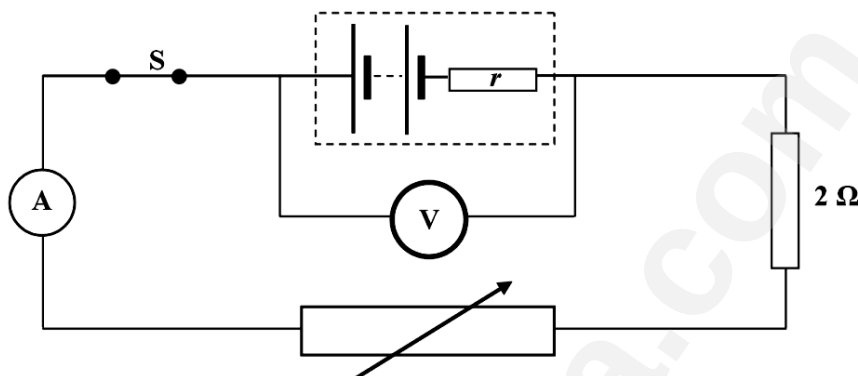
- 8.1 When the switch S is closed in this circuit, the reading on A_1 is 2 A and the reading on A_2 is 1,5 A.



- 8.1.1 What is the reading on V_1 when S is open? (1)
- 8.1.2 Calculate the reading on V_1 when S is closed. (3)
- 8.1.3 Determine the value of R_3 . (3)
- 8.1.4 Calculate the internal resistance of the battery. (4)
- 8.1.5 Calculate the reading on V_2 when S is closed. (3)
- 8.1.6 Calculate the rate of dissipation of energy in the internal resistance of the battery. (3)

P.T.O.

- 8.2 Two pupils conduct an experiment to determine how the potential difference across the terminals of a battery is affected by the size of the current through the battery. They set up the circuit shown below. They change the current through the battery by adjusting the resistance of the rheostat (variable resistor). They record the potential difference across the terminals of the battery as given by the reading on the voltmeter. The battery has significant internal resistance. The resistances of the wires and ammeter is negligible. The voltmeter has high resistance.



Results

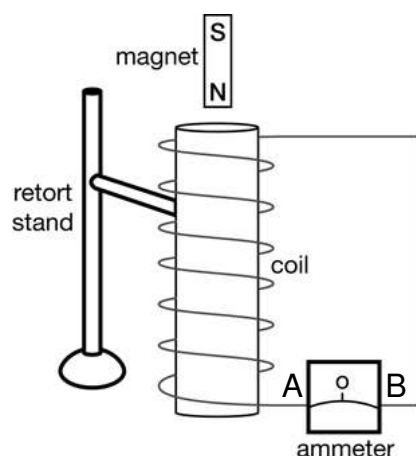
Current (A)	Potential difference (V)
0,0	15,0
0,6	13,5
1,2	12,0
2,0	10,0
2,6	8,5
3,2	7,0

- 8.2.1 Define *emf*. (2)
- 8.2.2 What is the emf of the battery used in this experiment? (1)
- 8.2.3 What is the dependent variable in this experiment? (1)
- 8.2.4 Explain why the potential difference across the battery decreases as the current through the battery increases. Make reference to one or more suitable formulae to support your answer. No calculations are required. (3)
- 8.3 An electric kettle of resistance $40,33 \, \Omega$ is operated using a 220 V, AC voltage from a wall socket.
- 8.3.1 Calculate the power rating of the kettle. (3)
- 8.3.2 If the kettle takes 3 minutes to boil a litre of water, what does it cost to boil a litre of water if electricity costs R1,54 for kWh? (3)

QUESTION 9 ELECTRODYNAMICS

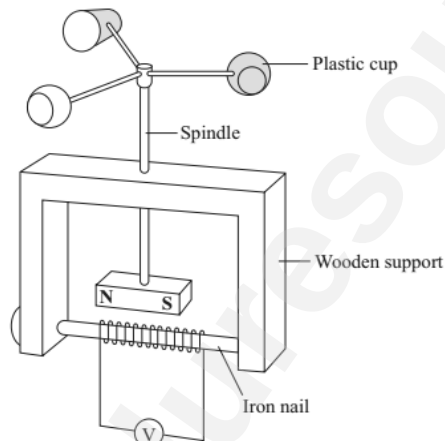
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The diagram below shows a demonstration set up to show how an electric current can be generated.



- 9.1 As the magnet enters the coil (as shown), which way will the current flow in the ammeter? (write only A to B or B to A) (2)

The diagram below shows a student's design for a simple wind speed gauge, along with the results that she obtained when conducting an investigation to determine the effect of the size of plastic cup on the generated emf.

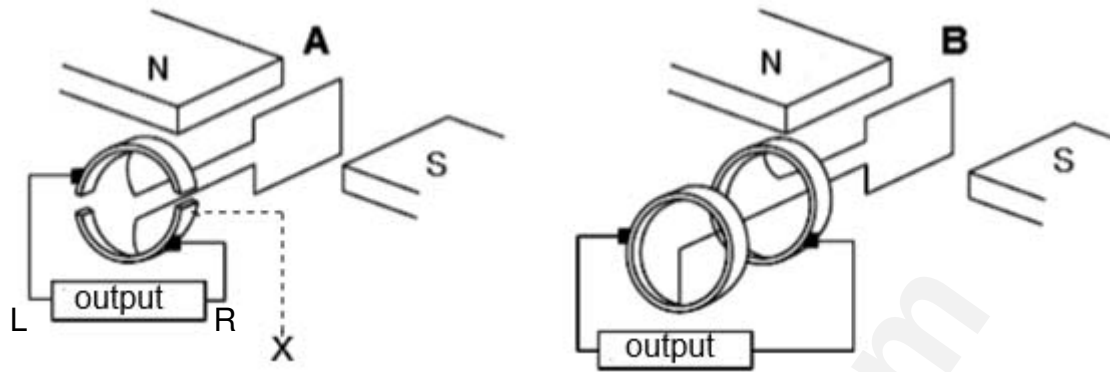


Diameter of Cup (cm)	Voltage (V)
2.5	6.5
5.0	13.0
10.0	25.0
15.0	55.0
20.0	125.0
25.0	185.0

- 9.2.1 State *Faraday's Law of Electromagnetic Induction*. (2)
- 9.2.2 Explain how the wind will cause the voltmeter within the gauge to produce a reading. (3)
- 9.2.3 The gauge is not sensitive enough to measure light winds. Suggest THREE ways that the design can be modified to make the gauge more sensitive. (3)

P.T.O.

Two devices, A and B, are shown below:



- 9.3.1 Identify the component labelled X on device A. (1)
- 9.3.2 Explain the function of the component labelled X in device A. (2)
- 9.3.3 What energy conversion takes place in device A? (2)
- 9.3.4 Which way will current flow in the output of device A if the armature is rotated clockwise in the position shown? (write only L to R or R to L) (2)
- 9.3.5 Draw a sketch graph of the emf output from device B vs time, when the armature is rotated, beginning with the armature in the position shown. No values are needed. (3)
- 9.3.6 The rate of rotation of B is halved. On your sketch, add a line to show the emf that is generated now. (2)
- 9.3.7 Give one advantage of the output of device B over the output of device A. (1)

[Adapted from St Stithians 2013, Woodridge 2015 & DBE Nov 2015]

23 marks

END OF PAPER: 200 Marks