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# 2

91173



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## Level 2 Physics, 2015

### 91173 Demonstrate understanding of electricity and electromagnetism

9.30 a.m. Tuesday 17 November 2015  
Credits: Six

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of electricity and electromagnetism.	Demonstrate in-depth understanding of electricity and electromagnetism.	Demonstrate comprehensive understanding of electricity and electromagnetism.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

**You should attempt ALL the questions in this booklet.**

Make sure that you have Resource Sheet L2-PHYSR.

In your answers use clear numerical working, words and/or diagrams as required.

Numerical answers should be given with an appropriate SI unit.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

**YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.**

**Not Achieved**

TOTAL

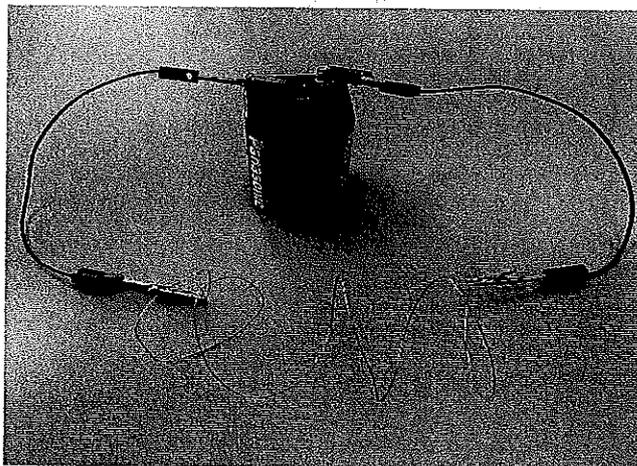
**06**

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**QUESTION ONE: ELECTRIC FIELD IN A WIRE**ASSESSOR'S  
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Charge on an electron =  $-1.6 \times 10^{-19}$  C

Hamish connects a circuit as shown in the picture below. The circuit comprises a 6.0 V battery, 1.0 m of Nichrome resistance wire and two connecting wires. The battery produces a uniform electric field in the Nichrome resistance wire.



Assume that the connecting wires have no resistance.

- (a) Calculate the strength of the electric field in the Nichrome resistance wire.

$$E = \frac{V}{d} = \frac{6}{1} = \underline{6 \text{ Nm}^{-1}}$$

- (b) Explain what happens to the size of the electric force on an electron as it travels through the Nichrome resistance wire.

The electric force increases. This is because the size of the wire is thinner. So ~~forth~~ the force in the wire will be under greater rates of power (the distance in the wire is smaller, hence the electric force is larger).

- (c) Calculate the distance moved by an electron as it loses  $9.6 \times 10^{-20}$  J of electrical potential energy.

- (d) Hamish then adds another 6.0 V battery in series AND shortens the wire to 0.50 m.

Write a comprehensive explanation on what will happen to the size of the force on the electron.

Calculations are not needed.

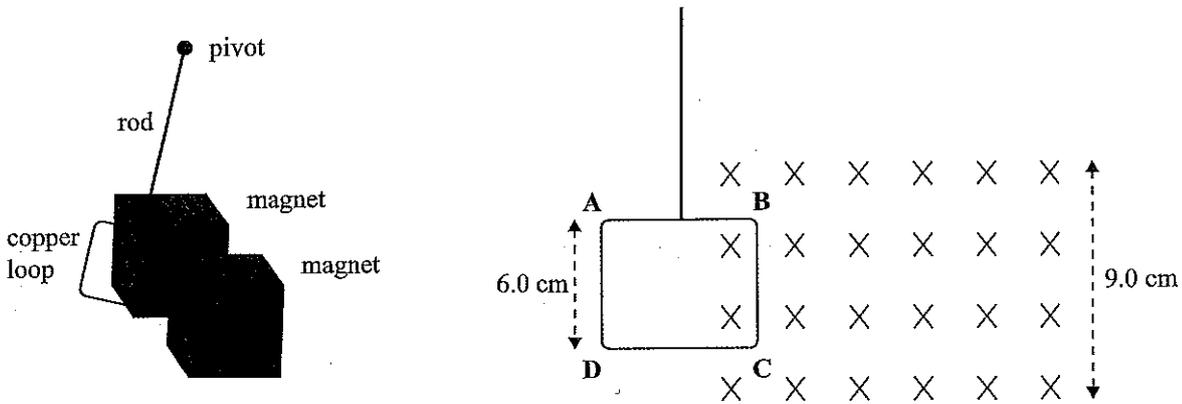
Increasing the power supply will increase the energy produced, hence creating a higher rate of potential energy. Decreasing the distance will also further increase the strength of the electric field, as the charged particles are closer together. Overall, the force acting on the electron will be significantly stronger as the two independent variables are changed to both increase.

Needs to argue from  $F = Eq$   
 $E = \frac{V}{d}$

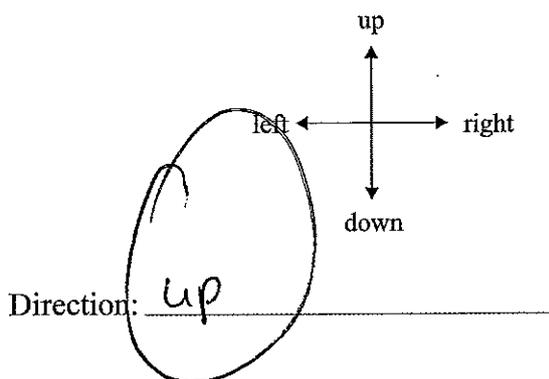
## QUESTION TWO: THE ELECTROMAGNETIC SWING

Monique builds a swing to show electromagnetic induction. It comprises a light rod, pivoted at the top so it can swing, and a loop of copper wire at the bottom. She places two strong magnets at the lowest point of the motion with opposite poles facing each other.

The diagrams below show the loop entering the magnetic field.



- (a) Determine the direction of the force acting on **electrons** in the wire BC, due to their motion in the magnetic field.



Applied rh rule to proton.

- (b) At the instant shown in the diagram, the voltage across the wire BC is 0.15 mV.

Calculate the speed of the wire loop.

The magnetic field strength is  $3.0 \times 10^{-3}$  T.

$$V = \frac{\Delta E}{\Delta t} = \frac{3.0 \times 10^{-3}}{0.0015}$$

$$E = 2 \text{ mV} = 0.002 \text{ V}$$

$$V = Bvl$$

$$v = \frac{V}{Bl}$$

$$v = \frac{0.0015}{(3.0 \times 10^{-3}) \times 0.06}$$

- (c) Monique repeats the experiment, but starts the swing from a greater height. The speed of the loop at the point shown in the diagram is doubled.

Explain what happens to the size of the current in the loop.

It increases, as the speed increases, so does its interaction with particles

not specific

- (d) A short time later the whole loop is inside the magnetic field.

Write a comprehensive explanation about the current in the loop when the whole loop is in the magnetic field.

The loop will be colliding with the electric field, this will cause the particles to collide / interact with a stronger, more present force. This will generate a force that will ultimately produce velocity for the loop to increase (remain moving)

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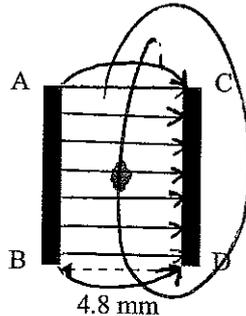
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**QUESTION THREE: THE SMOKE DETECTOR**

Charge on an electron =  $-1.6 \times 10^{-19} \text{ C}$

One type of smoke detector comprises a pair of metal plates 4.8 mm apart, connected to a battery. Alpha particles from a radioactive source ionise particles of smoke between the plates. This causes the smoke particles to lose one or more electrons and become charged.

The diagram below shows a positively charged smoke particle. The force on the particle is towards AB.



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- (a) Draw lines showing the electric field between the plates.  
Include the direction of the field lines.



The mass of the smoke particle is  $1.7 \times 10^{-7} \text{ kg}$

- (b) A particular smoke particle loses two electrons. It then experiences a force of  $5.88 \times 10^{-16} \text{ N}$  due to the electric field.

Calculate the strength of the electric field.

$$E = \frac{F}{q}$$

$$= \frac{5.88 \times 10^{-16}}{-1.6 \times 10^{-19}} = 3.675 \times 10^3 \text{ Nm}^{-1}$$

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- (c) Maria brings a magnet close to the smoke detector. The magnet produces a magnetic field of strength  $3.0 \times 10^{-2} \text{ T}$ , which, with reference to the diagram above, is directed into the page.

State the size of the force due to the magnet on the stationary smoke particle.

Explain your answer.

Maria is decreasing the distance between the magnetic force. Increasing this variable, increasing increases the electric field strength. Hence the size of the force would be greater

- (d) The smoke particle becomes ionised by losing two electrons when it is 2.4 mm from plate AB.

Calculate the speed of the smoke particle when it reaches the plate AB.

Assume that only the electric force acts on the smoke particle.

$$V = Ed$$

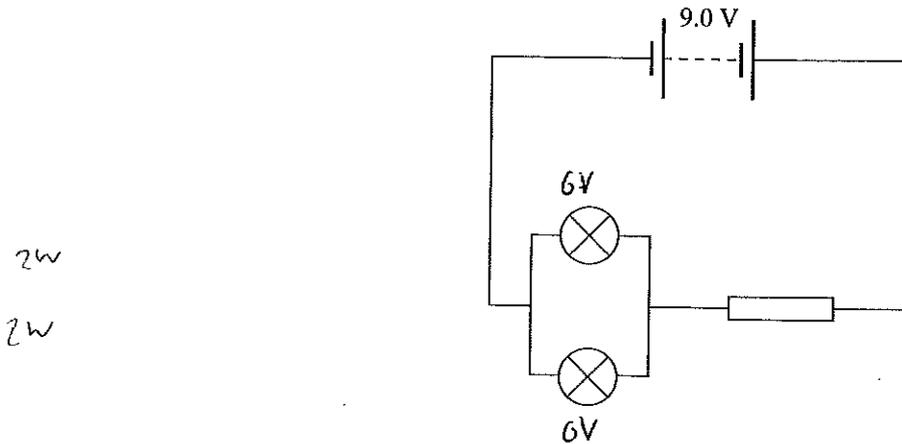
$$V = 3.675 \times 10^3 \times 0.0024$$

$$= 8.82 \text{ ms}^{-1}$$

### QUESTION FOUR: CIRCUITS

Kahu has two identical lamps marked 6.0 V, 2.0 W. He wants to connect them to a 9.0 V battery. He realises that he will have to connect a resistor to reduce the voltage across the lamps.

He connects the circuit shown below.



- (a) Calculate the current in each lamp when it is operating at its normal brightness!

$$V_T = V_1 + V_2 \quad I_T = I_1 + I_2 \quad V_T = 6V + 6V$$

$$= 6V + 6V = 12V$$

- (b) Calculate the resistance of the resistor that he should use so that the lamps are at their normal brightness.

$$V = IR$$

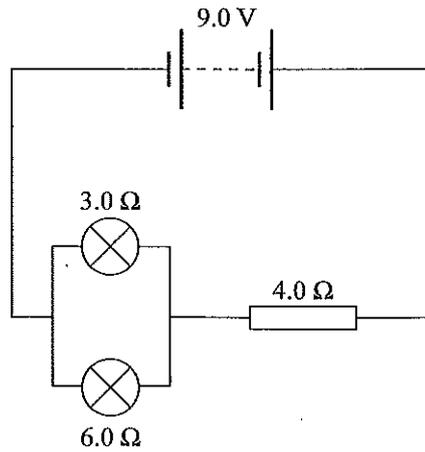
$$R = \frac{V}{I} = \frac{12V}{9A} = 1.33 \Omega \text{ (3sf)}$$

- (c) What will happen to the current in the resistor if one lamp "blows"?

Explain your answer.

It will not change. This is because the arrangement of the bulbs are in parallel. This means that each bulb is supplied the same voltage (not shared). Hence it does not change.

Kahu sets up a new circuit with different lamps and resistor, as shown in the diagram below.



- (d) Calculate the voltage across the 4.0 Ω resistor.

$$R_T = R_1 + \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

$$R_T = \frac{1}{\frac{1}{3} + \frac{1}{6}} = \frac{1}{\frac{2}{6} + \frac{1}{6}} = \frac{1}{\frac{3}{6}} = \frac{1}{\frac{1}{2}} = 2 \Omega$$

$$R_T = \frac{9}{\frac{1}{2}} = 2 \Omega$$

$$9V - 2\Omega = 7V$$