SUPERVISOR'S USE ONLY

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91173

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Draw a cross through the box (☒) if you have NOT written in this booklet

NZQA
Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Physics 2023

91173 Demonstrate understanding of electricity and electromagnetism

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 room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

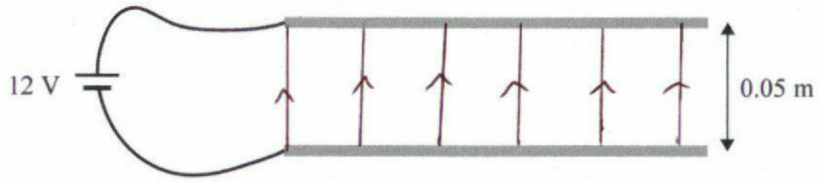
Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA). This area will be cut off when the booklet is marked.

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

Achievement **10**

QUESTION ONE: PARALLEL PLATES

A set of parallel plates 0.05 m apart are connected to 12 V.



(a) Show that the value of the electric field strength between the plates is 240, and state its unit.

$E = V/d$

$= 12/0.05$

$= 240 \text{ Vm}^{-1}$

Unit: 240 Vm^{-1}

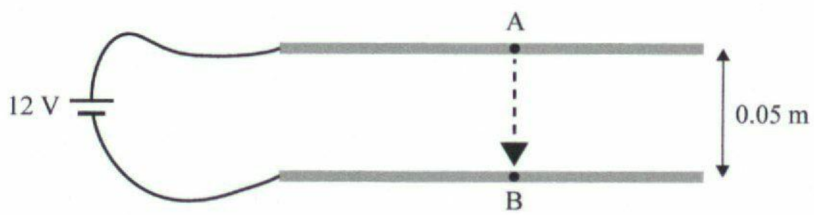
(b) On the diagram above, draw the electric field lines to represent the field between the plates.

If you need to redraw your response, use the diagram on page 8.

(c) Use physics principles to explain how the electric force on an electron would vary as it moved from the negative plate to the positive plate.

As an electron moves from the positive to negative plate the electron loses electric potential energy as the distance is shorter and $\Delta E_p = Eqd$.

(d) An electron is moved from point A to point B, as shown below.



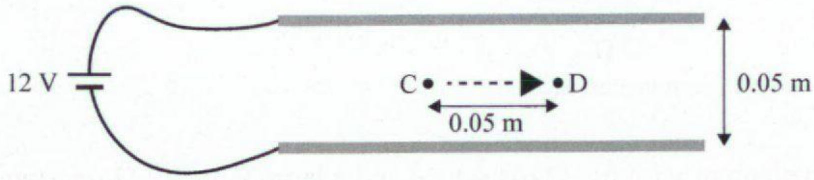
(i) Calculate the change in electric potential energy as the electron moves from point A to point B on the diagram opposite below.

$\Delta E_p = Eqd$

$= 240 \times 1.6 \times 10^{-19} \times 0.05$

$= 1.92 \times 10^{-18}$ J.

The electron is now moved 0.05 m from point C to point D.



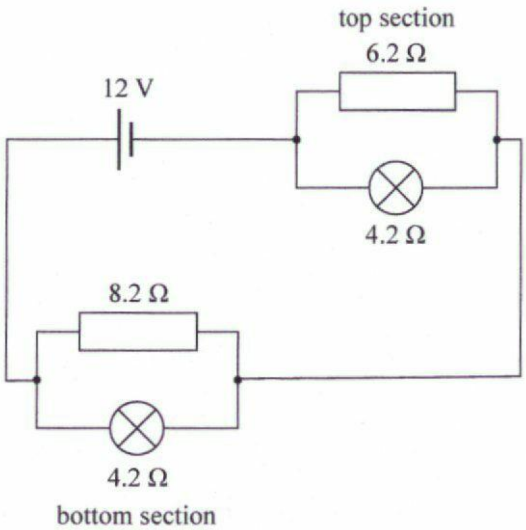
(ii) What is the change in electrical potential energy as the electron moved from point C to point D?

There is no change in the electrical potential energy as the cricuit is uniform, meaning all the field lines are evenly spaced apart and the forces are equal everywhere.

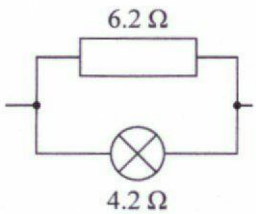
(iii) Use physics principles to explain any difference in the change in electrical potential energies found in parts (i) and (ii).

QUESTION TWO: CIRCUITS

A simplified version of the circuit in a camping oven is shown below. The oven consists of two sections.



(a) The top section has an element with 6.2 Ω resistance and a lamp with 4.2 Ω resistance.



Show that the total resistance of the top section is 2.5 Ω.

Total resistance $= \left(1/6.2 + 1/4.2\right)^{-1} = 2.5\,\Omega$

(b) Calculate the current flowing from the power supply to the oven when both sections are working.

$R_T = \left(1/8.2 + 1/4.2\right)^{-1} + 2.5$

$= 5.25\,\Omega$

$I = V/R$

$= 12/5.25$

$= 2.3\,A.$

(c) While both sections are working correctly, the lamp in the bottom section develops a fault and its resistance decreases.

Use physics principles to explain what happens to the brightness of the other lamp.

If the resistance in the ~~bulb~~ lamp on the bottom of the circuit decreases then because of $I = V/R$, a decrease in resistance causes an increase in total current in the circuit. This means that the other lamp will become brighter.

(d) The lamp in the bottom section now stops working.

Calculate the amount of energy converted to heat in two minutes by the 8.2 Ω resistor.

$P = IV$

$= 2.3 \times 12$

$= 27.4\ W$

$P = \Delta E / t$

$\Delta E = P \times t$

$= 27.4 \times 120$

$= 3288$

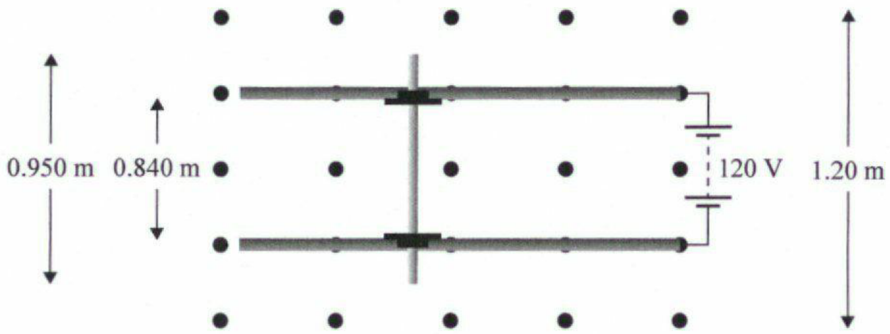
$= 3290\ J$ converted to heat.

QUESTION THREE: ELECTROMAGNETISM

The diagram below shows a metal axle that is free to roll on two parallel metal rails. The rails and the axle are in a magnetic field. The ends of the rails are connected to a 120 V power supply.

Strength of magnetic field = 8.10×10^{-3} T
Length of axle = 0.950 m
Distance between parallel metal rails = 0.840 m
Width of magnetic field = 1.20 m
Total effective resistance = 42.1 Ω
Voltage of power supply = 120 V

Source: https://upload.wikimedia.org/wikipedia/commons/7/76/Rollingstock_axle.jpg



Force is out of Page

(a) Draw an arrow on the diagram above to show the direction of the electromagnetic force that acts on the axle when the power supply is switched on.

If you think the direction of the force is out of the page, into the page, or there is no force, state this clearly.

(b) Calculate the strength of the magnetic force on the axle when the power supply is turned on.

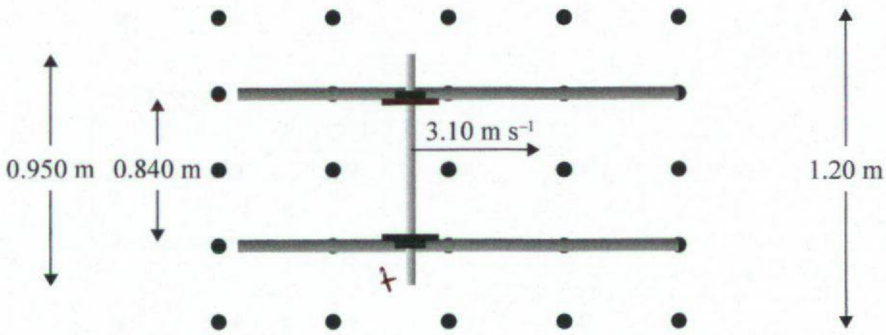
$F = BIL$

$= 8.1 \times 10^{-3} \times \left(\frac{120}{42.1}\right) \times 0.950$

$=$ ~~[illegible] N~~. 0.0383 N

02900

(c) The power supply is removed, and the metal axle is given a push so that it is moving to the right at 3.10 m s^{-1}, as shown in the diagram.



(i) Clearly mark the negative end of the axle on the diagram above.

(ii) Calculate the voltage induced in the axle immediately after it is set moving.

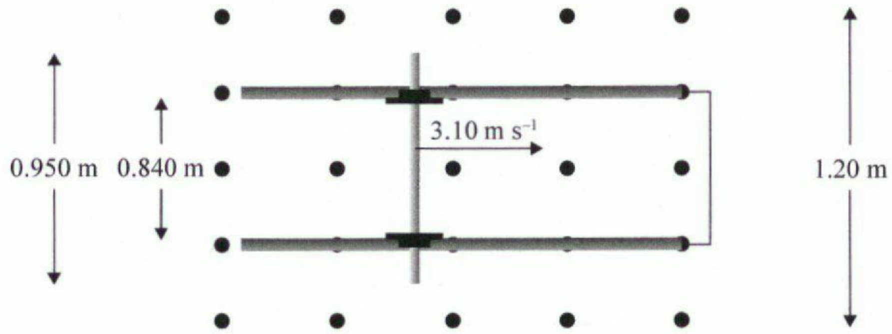
$V = BvL$

$= 8.10 \times 10^{-3} \times 3.1 \times 0.950$

$= 0.0240 \text{ V}$

Question Three continues on the next page.

(d) With the power supply still disconnected, a wire is connected between the rails, and the axle is given a push so that it is moving to the right at 3.10 m s^{-1}.



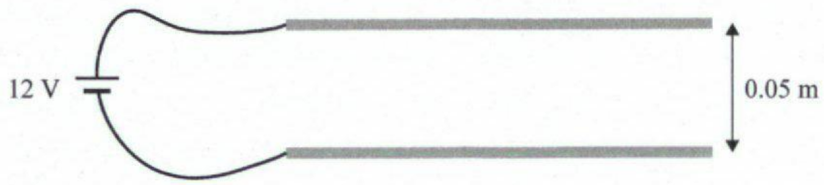
Describe the motion of the axle after it is set moving.

The axle will continue to move even in the absense of a power supply ~~the~~ due to the magnetic field.

Justify your answer using electromagnetism physics principles.

SPARE DIAGRAMS

If you need to redraw your response to Question One (b), use the diagram below. Make sure it is clear which answer you want marked.



Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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QUESTION NUMBER

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Standard	91173			Total score	10
Q	**Grade score**	**Marker commentary**			
1	N2	1a: The candidate correctly calculated the electric field strength and supplied a correct unit. (a) 1b. The candidate drew field lines going the wrong direction. (n) 1c: The candidate has not explained about the nature of the force. (n) 1d. i. The candidate has correctly calculated the change in electro-potential energy. ii. The candidate states " no change". It is not clear that this means 0J or no change from part i. The candidate was awarded no credit for this answer. iii. The candidate supplied no answer. (a)			
2	A4	2a: The candidate has correctly used the formula for adding resistors in parallel to get the required answer. (a) 2b. The candidate has correctly calculated the total current in the circuit. (m) 2c. The candidate has described the effect the faulty lamp would have on the total resistance of the circuit and how this would affect the circuit current given the supply voltage was constant. They then link this to how the voltage of the top lamp would change and how the power and hence brightness of the top lamp would change. (e) 2d. The candidate has correctly found the energy output.(e)			
3	A4	3a: The candidate has incorrectly identified the direction of the force by stating it's out of the page. (n) 3b: The candidate has correctly calculated the current but has used the incorrect length to find the force. (a) 3c: The candidate has correctly identified the negative end of the axle- by labelling the bottom plus- and used V=BvL to find the voltage. (e) 3d: The candidate has incorrectly stated the axle will continue to move. (n)			