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91173

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

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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.

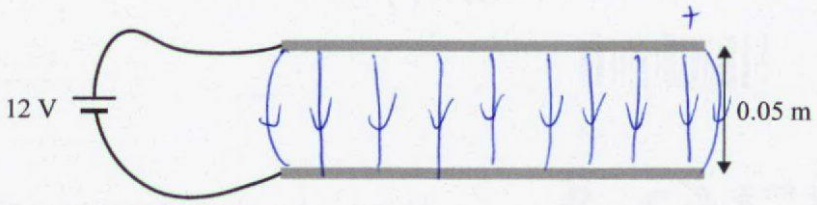
Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA DO NOT WRITE). This area will be cut off when the booklet is marked.

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

Merit 15

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.

$E = V/d$

$= 12/0.00005$ $= 12/0.05$

$= 24000\ V m^{-1}$ $= 240\ V m^{-1}$

Unit: $V m^{-1}$

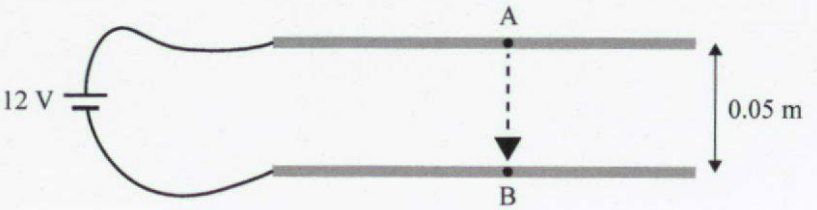
(b) On the diagram above, draw the electric field lines to represent the field between the plates.

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.

On the negative plate there is ~~ΔE_p~~ ~~on~~ ~~the~~ which has no current force which in then converted to E_k which then accelerates to the +ve plate and at the same time will experience a ~~force~~ force away the -ve plate & toward the +ve plate

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

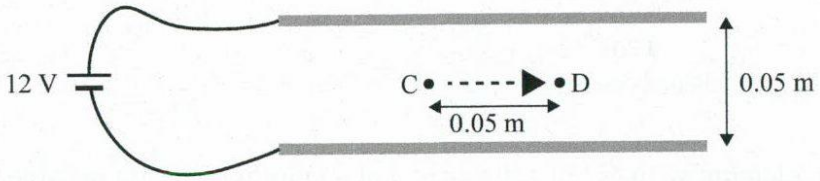


(i) Calculate the change in electric potential energy as the electron moves from point A to point B on the diagram opposite below.

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

$= 19.2 \text{ J}$ $1.92 \times 10^{-18} \text{ J}$

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?

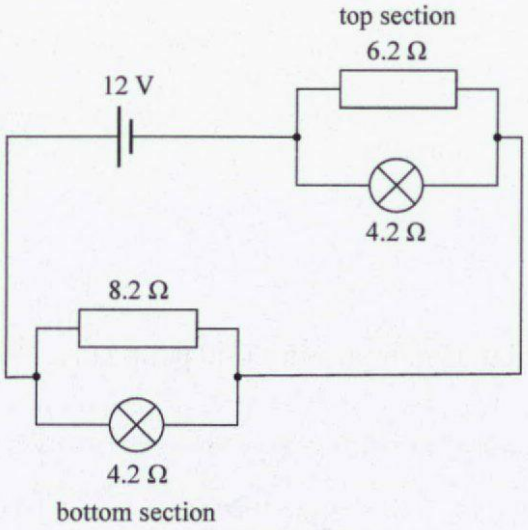
~~To much~~ ~~Heat~~ Re ΔE_p remains constant because it is still in the same distance between the 2 plates

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

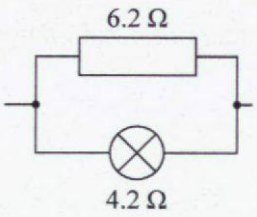
There is a change in ΔE_p in (i) whereas in part (ii) ~~it~~ there is no ~~change in~~ ΔE_p.

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.

$R_p = \left(\frac{1}{6.2} + \frac{1}{4.2}\right)^{-1}$

$= 2.5\ \Omega$ (2sf)

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

$R_{bottom} = \left(\frac{1}{8.2} + \frac{1}{4.2}\right)^{-1}$

$= 2.8\ \Omega$

$R_T = 2.5 + 2.8$

$= 5.3\ \Omega$

$V = IR$

$12 = 5.3I$

$I = 2.3\ A$

(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.

~~The~~ Because the resistance decreases in the bottom lamp the total resistance is decreased as well which means the current increases as a result ~~the~~ at the top lamp as increases in current so will the Power ($P = VI$) which mean the lamp in the top section will be 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.

~~$R_T = 2.5 + 8.2$~~
~~$= 10.7\,\Omega$~~

$V = IR$

~~$12 = 10.7I$~~

~~$I = 1.1\,A$~~

$12 = 8.2\,I$

$I = 1.5\,A$

$P = \frac{\Delta E}{t}$

$18.72 = \frac{\Delta E}{60 \times 2}$

$\Delta E = $ ~~1584~~ ~~20~~

$\Delta E = 2160\,J$

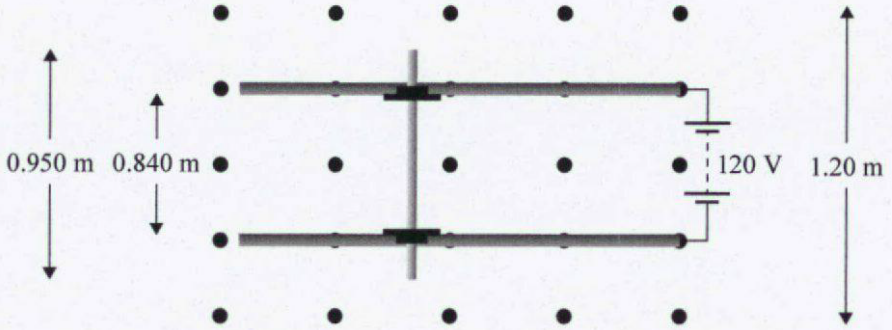
$\Delta E = $ ~~E~~ E_H

$E_H = 2160\,J$

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 $= 8.10 \times 10^{-3}$ 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 $= 42.1\ \Omega$
Voltage of power supply $= 120$ V



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

(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.

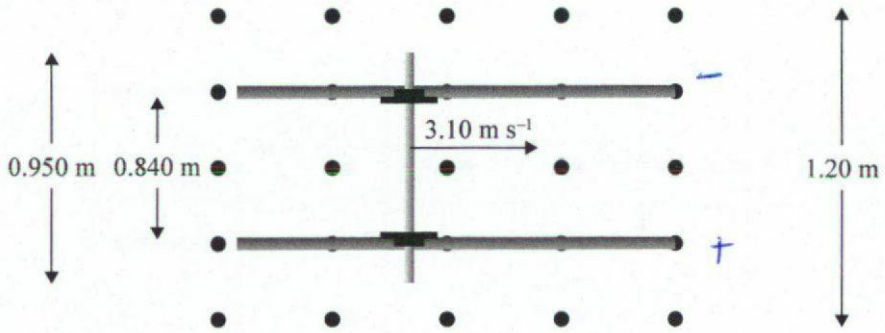
If you think the direction of the force is out of the page, into the page, or there is no force, state this clearly.

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

$F = BIL$
$= 8.10 \times 10^{-3} \times 2.85 \times 0.840$
$= 0.0194$ N

$I = V/R$
$= 120/42.1$
$= 2.85$

(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.

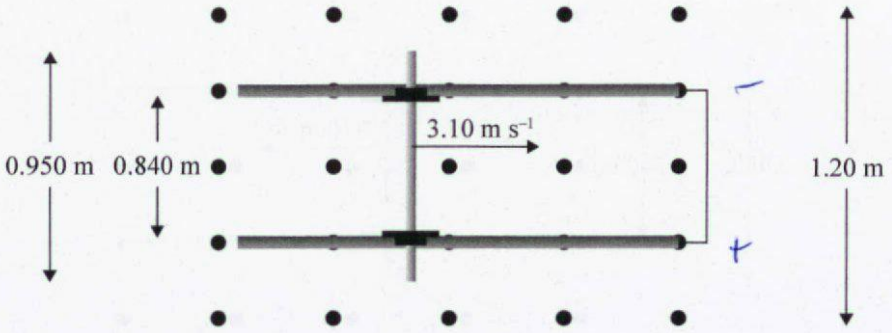
$V = BvL$

$= 8.1 \times 10^{-3} \times 3.1 \times 0.95$

$= 0.0239\ V$

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.

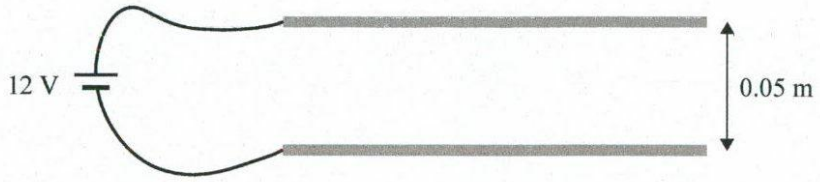
It will ~~rotate~~ travel straight on the rails and will slow down and come to a stop

Justify your answer using electromagnetism physics principles.

the axle is not charged so when it moves in the electric field it will not experience another force. ~~so it will~~ consider the force from the push so the axle ~~it~~ will move right then come to a stop.

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

91173

Standard	91173			Total score	15
Q	**Grade score**	**Marker commentary**			
1	A4	1a: The candidate correctly calculated the electric field strength and supplied a correct unit. (a) 1b. The candidate drew field line downwards. They were not parallel and evenly spaced and they did not leave and enter the plates at right angles. (a) 1c: The candidate discusses energy and does not explain how the force would change. (n) 1d. i. The candidate has correctly calculated the change in electro-potential energy. ii. The candidate states "remains constant because it is still the same distance between the plates." This gains an e because it links the change in potential energy to the distance the electron is from the plates iii. The candidate states no change in potential energy without any evidence. (e) The candidate scored e,a,a making A4 for the question.			
2	M6	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 link power to brightness. In order to get e they needed to state the supply voltage was unchanged and clearly link the increase in current to an increase in power of the lamp (m). 2d The candidate used the correct process in finding the energy but used the circuit voltage instead of the voltage across the lamp. (m) The candidate scored m,m,m,a making M6 for the question.			
3	M5	3a: The did not supply answer. (n) 3b: The candidate has correctly used F=BIL to calculate the force on the axle. (m) 3c: The candidate has correctly identified the negative end of the axle and used V=BvL to find the voltage. (e) 3d: The candidate incorrectly sates the axle will not experience a force. (n) The candidate scored e,m making M5 for the question.			