91173

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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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SUPERVISOR'S USE ONLY

Level 2 Physics, 2013

91173 Demonstrate understanding of electricity and electromagnetism

2.00 pm Wednesday 13 November 2013
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 2–9 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.

TOTAL

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You are advised to spend 60 minutes answering the questions in this booklet.

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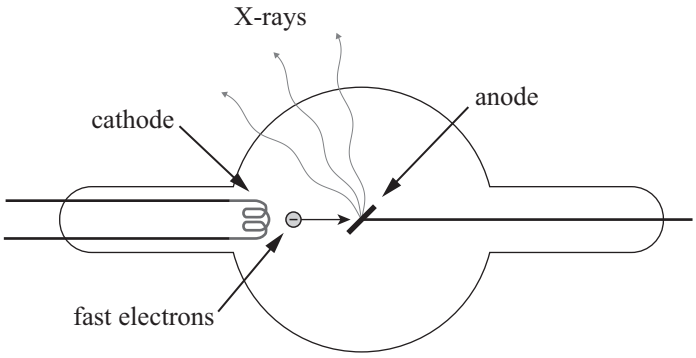
QUESTION ONE: THE X-RAY TUBE

Tavita is working on the design of an X-ray tube for hospitals. The diagram below shows the main parts of the X-ray tube. Electrons are emitted by a filament in the cathode. A high voltage between the cathode (negative electrode) and anode (positive electrode) causes them to accelerate until they crash into the anode.

Mass of an electron = 9.1×10^{-31} kg

Charge on an electron = 1.6×10^{-19} C



(a) Approximately 1×10^{15} electrons leave the cathode every second.

Calculate the size of the current.

(b) The X-ray tube is in the Earth's **magnetic field**. The direction of the magnetic field is from the cathode to the anode.

State the size of the magnetic force on the moving electrons.

Explain your answer.

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(c) The electrons start from rest and reach a speed of 3.0×10^7 m s^{-1}.

By considering the energies involved, calculate the size of the voltage between the cathode and the anode.

(d) Tavita decides to reduce the distance from the cathode to the anode by half.

Explain fully what will happen to:

(i) the size of the force acting on an electron

(ii) the kinetic energy gained by an electron.

QUESTION TWO: CIRCUITS

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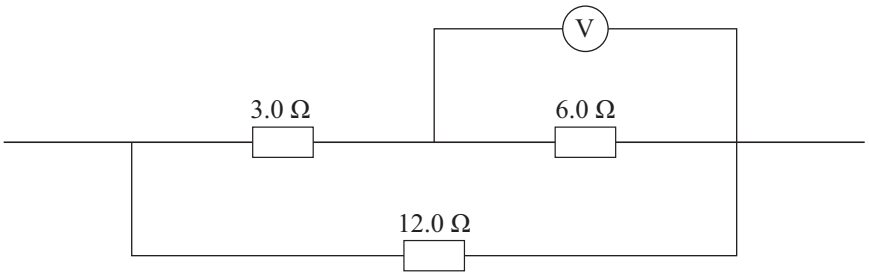
Tavita is also working on the power supply for the X-ray tube. The diagram below shows part of the circuit that Tavita is testing.



(a) The voltmeter reads 18.0 Volts.

Calculate the size of the current through the 6.0 Ω resistor.

Write your answer with the correct number of significant figures.

(b) Explain what happens to the power output of the 6.0 Ω resistor if the voltage across it doubles.

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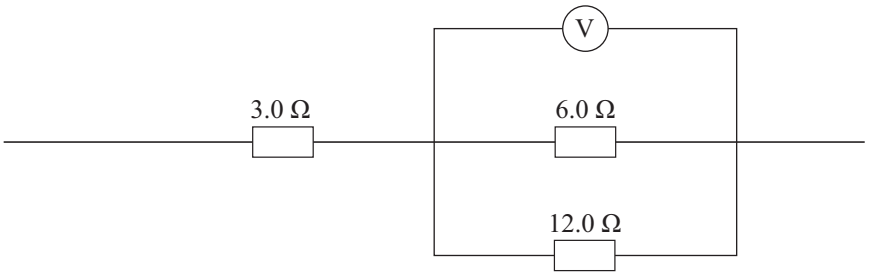
Tavita reconnects the three resistors as shown below.



(c) The circuit is changed so that the current through the 6.0 Ω resistor is now 2.0 A.

Calculate the power output of the 3.0 Ω resistor.

(d) Explain what would happen to the voltage across the 3.0 Ω resistor if the 12.0 Ω resistor is removed, but the total voltage remains the same.

QUESTION THREE: ELECTROMAGNETISM

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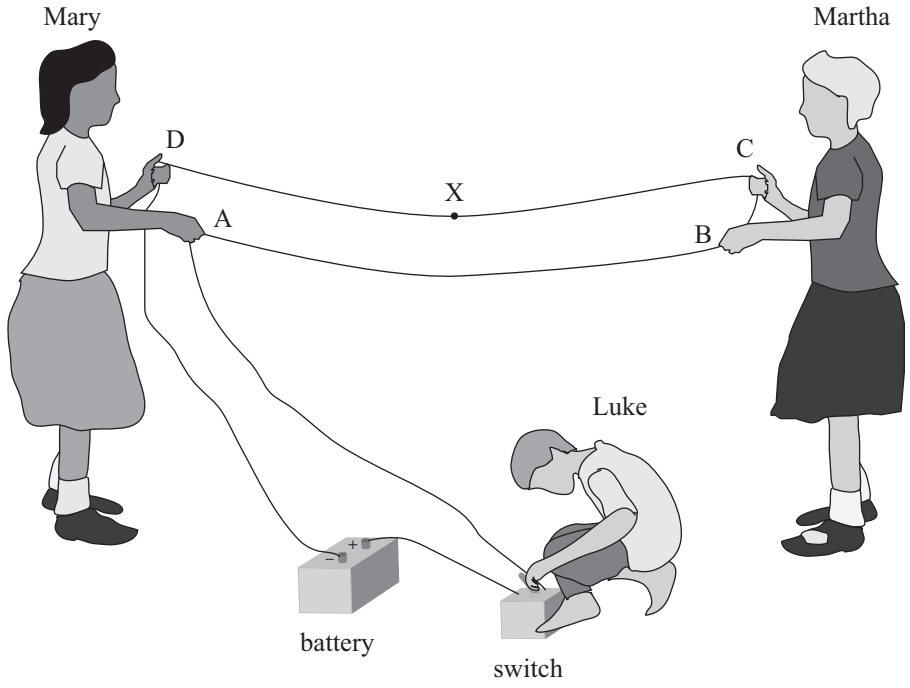
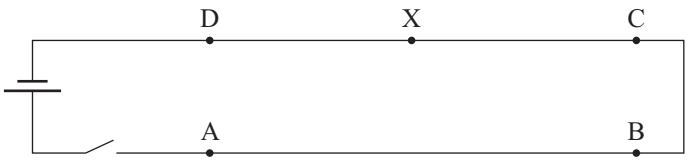
Mary, Martha and Luke are doing some experiments with wires and batteries. They connect a long wire to a car battery and a switch, and hold the wire as shown in the diagram below.

When Luke closes the switch, they notice that the wires move.

Charge on an electron = 1.6×10^{-19} C



The diagram below shows the experiment looking down from above.



(a) Referring to the second diagram, determine the direction of the **magnetic field** at the point "X" due to the wire AB.

Hence determine the direction of the **magnetic force** on the wire CD.

Choose from:
Out of the page
Into the page
Towards the top of the page
Towards the bottom of the page
Left
Right

Direction of magnetic field at X: _____

Direction of magnetic force on CD: _____

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(b) The length of the wire between Mary and Martha is 5.0 m. The size of the force between the wires is 0.013 N. The current in the wire is 35 A.

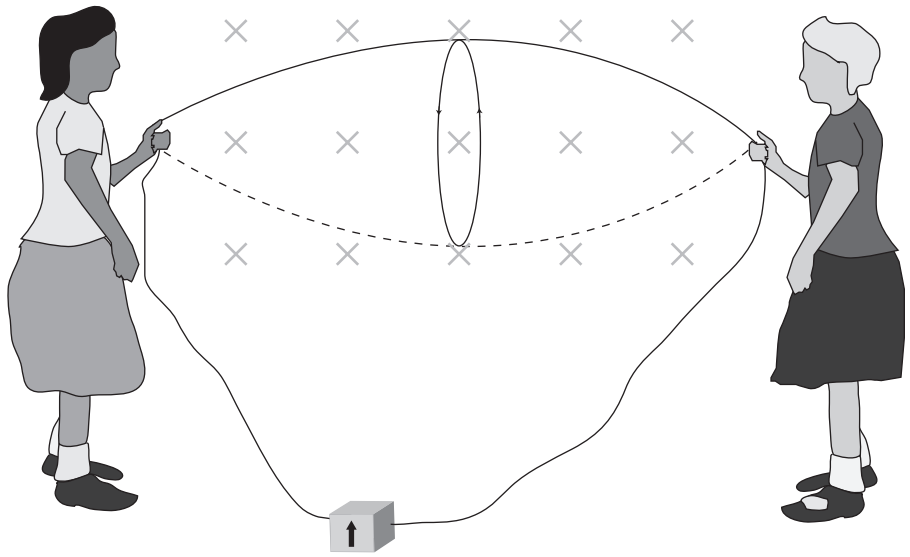
Calculate the size of the magnetic field at the point "X".

Give the correct unit with your answer.

Mary and Martha next try to produce an electric current by spinning the wire in a circle like a skipping rope so that it cuts across the Earth's magnetic field as shown in the diagram below.

The ends of the wire are connected to a sensitive centre-zero ammeter.

The earth's magnetic field is parallel to the ground and has a strength of 3.1×10^{-5} T.



centre-zero ammeter × – magnetic field into page

(c) The average speed of any part of the wire is 3.0 m s^{-1}. The wire's resistance is 1.5 Ω. The length of the wire remains at 5.0 m.

Calculate the size of the maximum current in the wire.

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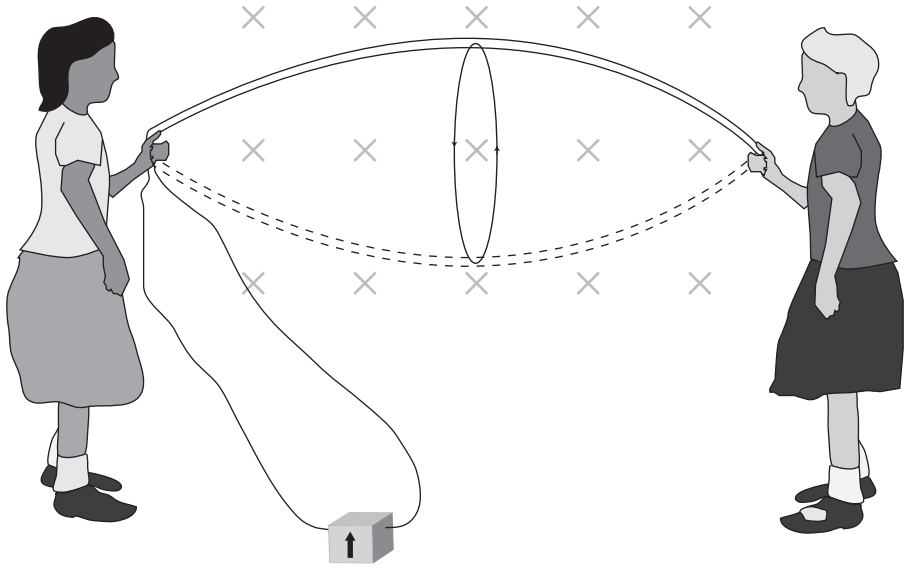
(d) Mary and Martha have been told that more wire will produce a larger current. They try the arrangement shown in the diagram below, swinging both sides of the wire loop together.



centre-zero ammeter × – magnetic field into page

Explain what happens to the size of the maximum current.

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

QUESTION NUMBER

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