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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 2 Physics, 2009

90257 Demonstrate understanding of electricity and electromagnetism

Credits: Five
2.00 pm Tuesday 17 November 2009

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 answer ALL the questions in this booklet.

For all numerical answers, full working must be shown. The answer should be given with an SI unit.

For all 'describe' or 'explain' questions, the answer should be in complete sentences.

Formulae you may find useful are given on page 2.

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 2–8 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.

For Assessor's use only

Achievement Criteria		
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Identify or describe aspects of phenomena, concepts or principles.	Give descriptions or explanations in terms of phenomena, concepts, principles and / or relationships.	Give concise explanations that show clear understanding in terms of phenomena, concepts, principles and / or relationships.
Solve straightforward problems.	Solve problems.	Solve complex problems.
Overall Level of Performance (all criteria within a column are met)		

You are advised to spend 50 minutes answering the questions in this booklet.

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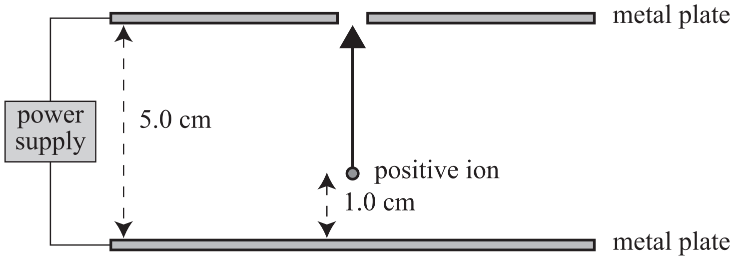
You may find the following formulae useful.

$E = \frac{V}{d}$	$F = Eq$	$\Delta E_p = Eqd$
$I = \frac{q}{t}$	$V = \frac{\Delta E}{q}$	$V = IR$
$P = IV$		$P = \frac{\Delta E}{t}$
$R_T = R_1 + R_2 + \ldots$		$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$
$F = BIL$	$F = Bqv$	$V = BvL$

QUESTION ONE: THE MASS SPECTROMETER

Sean is in the physics lab using a mass spectrometer to measure the mass of an unknown atom. In the mass spectrometer, an electron is removed from an atom, producing a positive ion. The positive ion is then accelerated by a constant electric field between two metal plates.
A positive ion is created 1.0 cm above the bottom plate, as shown in the diagram below.
The positive ion then accelerates towards the top plate.
The ion has a charge of $+1.6 \times 10^{-19}$ C.



(a) On the diagram above, draw an arrow showing the direction of the electric field between the plates.

(b) The current between the plates is 3.5×10^{-6} A.

How many positive ions reach the top plate in one minute?

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(c) Explain what happens to the size of the electric force on the positive ion as it moves towards the top plate.

(d) Explain what happens to the maximum velocity of the positive ion if the power supply voltage is increased.

(e) The electric force on the ion is 3.20×10^{-15} N.

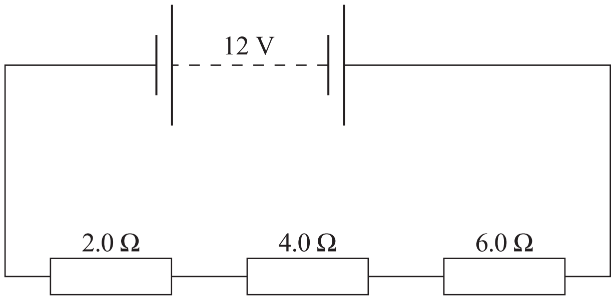
Calculate the strength of the electric field between the plates.

(f) Show that the maximum velocity of the positive ion if it moves from the position shown to the top plate is 6.9×10^{4} m s^{-1}.

The mass of the ion is 5.31×10^{-26} kg.

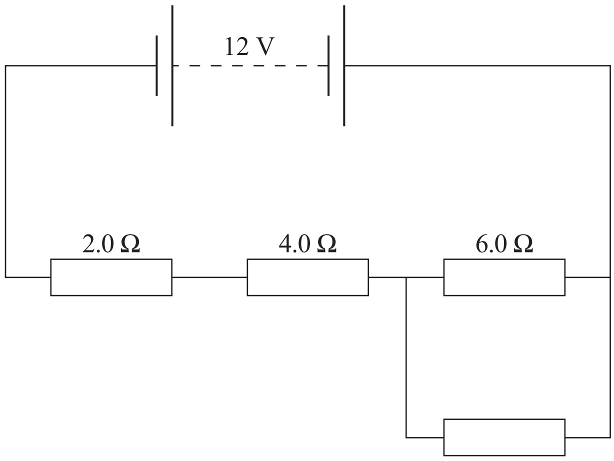
QUESTION TWO: ELECTRIC CIRCUITS

Sean has a yacht with a 12 V power supply. He has various low voltage devices that he wants to run off the power supply. He connects three resistors in series with the power supply as shown in the diagram below.



(a) Calculate the current through the circuit.

(b) Sean connects an electronic game with a resistance of 12.0 Ω in parallel with the 6.0 Ω resistor.



Calculate the voltage across the electronic game.

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(c) Sean switches the electronic game to "standby mode". This causes the resistance of the electronic game to increase. Explain how this affects the voltage across the 4.0 Ω resistor.

(d) Sean is worried that he might accidentally connect the electronic game back to front (positive to negative). He decides to insert a diode in the wire to protect the game.

Describe the function of a diode.

Question Three starts on the following page.

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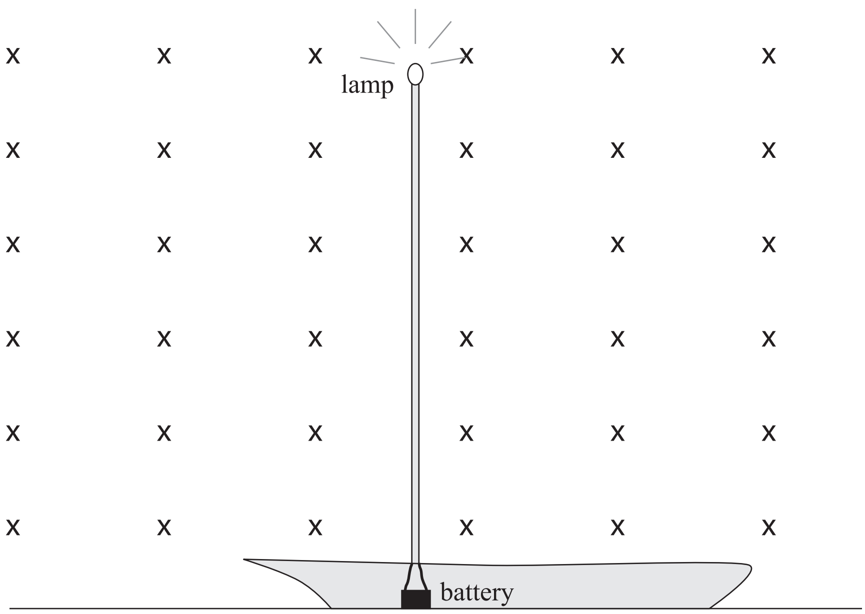
QUESTION THREE: MAGNETIC FIELDS

Sean's yacht has an 8.0 m high mast with a light on top. Two wires connect the 12 V battery to the lamp (nothing else is connected to the battery).

The total resistance of the wires and lamp is 18.0 Ω.

The horizontal component of the earth's magnetic field is 4.0×10^{-4} T.

The charge on an electron is 1.6×10^{-19} C.



The yacht is stationary.

(a) State the direction of the magnetic force acting on the wire that is connected to the negative terminal of the battery.

(b) Calculate the size of the magnetic force acting on ONE wire.

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(c) Will the magnetic force on the two connecting wires produce a net force on the yacht? Explain your answer.

The yacht now moves forward.

(d) Sean switches the light off.

Is there a voltage induced in the wire as the yacht moves forward? Explain your answer.

(e) Calculate the size of the magnetic force acting on a single electron if the yacht moves at 3.0 m s^{-1} perpendicular to the magnetic field.

Extra paper for continuation of answers if required.
Clearly number the question.

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