For Supervisor's use only

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90257

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 2 Physics, 2004

90257 Demonstrate understanding of electricity and electromagnetism

Credits: Five
2.00 pm Thursday 18 November 2004

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 provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 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.

Achievement Criteria *For Assessor's use only*		
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 may find the following formulae useful.

$$E = \frac{V}{d} \qquad F = Eq \qquad \Delta E_p = Eqd$$

$$I = \frac{q}{t} \qquad V = \frac{\Delta E}{q} \qquad V = IR$$

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

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

$$F = BIL(\sin\theta) \qquad F = Bqv \qquad V = BvL$$

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

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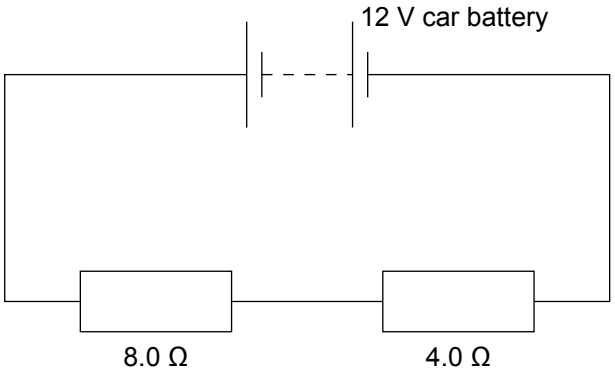
QUESTION ONE: THE CD PLAYER

Amelia has a CD player that requires a 4.0 V DC power supply. To save the expense of buying new batteries, she decides to operate her CD player from her car's battery.

Her friend Shona suggests using a voltage divider, and designs the following circuit.



(a) Calculate the total resistance of the circuit.

Resistance = _____

(b) Calculate the current that would flow from the battery.

Current = _____

(c) Calculate the voltage across the 4.0 Ω resistor.

Voltage = _____

(d) Shona examines the CD player. The label states:

4.0 V	*3.5 W*

Show that the CD player's resistance is 4.6 Ω.

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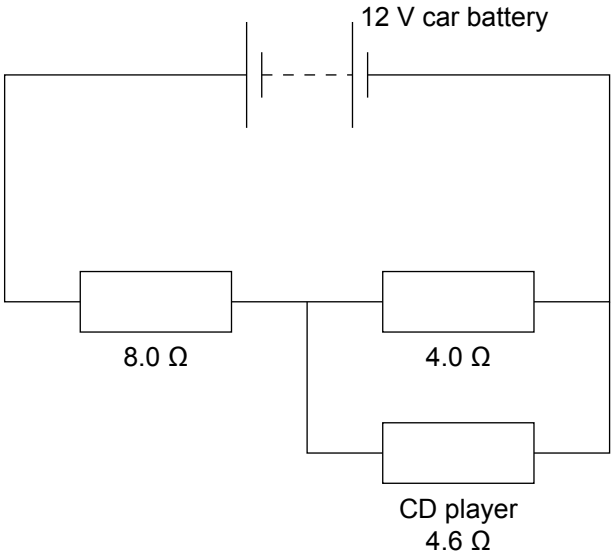
The CD player has a resistance of 4.6 Ω. Shona hopes that by connecting it in parallel with the 4.0 Ω resistor, it will have 4.0 V across it and will work normally. When she tries it, she finds it does not work properly.



(e) Calculate the total resistance of the new circuit.

Resistance = _____

(f) Explain what happens to the voltage across the 8.0 Ω resistor when the CD player is put in the circuit.

(g) Show that the current through the 8.0 Ω resistor is 1.2 A.

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(h) Calculate the voltage across the CD player.

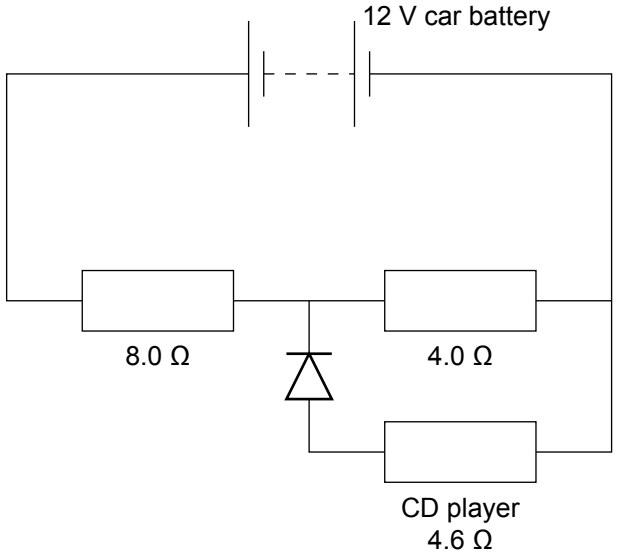
Voltage = _____

Shona could only find two 2.0 Ω resistors and two 16.0 Ω resistors to use to make the voltage divider.

(i) Draw two diagrams to show how she could make a 4.0 Ω resistor and an 8.0 Ω resistor from the ones available.

4.0 Ω resistor	8.0 Ω resistor

(j) Shona thought it was a good idea to put a diode into the circuit in case she connects the battery back to front by mistake. She tries it in the position shown.



Explain how this will affect the CD player.

QUESTION TWO: MEASURING ELECTRONS' SPEED

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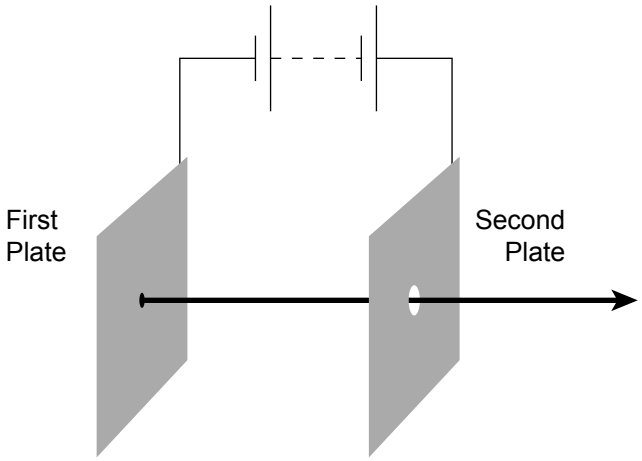
Electron guns are used inside television sets to fire electrons at high speed.

The Electron Gun:
Part of the electron gun consists of two parallel metal plates connected to a high voltage power supply. The electrons start near one plate, accelerate towards the second plate and pass through a hole in it.

Voltage between plates = 1100 V
Plate separation = 3.5×10^{-3} m
Charge on electron = 1.60×10^{-19} C



(a) State the name of the type of energy the electron is losing as it moves between the plates.

_____

(b) On the diagram, draw a labelled arrow to show the direction of the electric field between the plates.

_____

(c) Calculate the strength of the electric field between the plates. Give a unit with your answer.

_____

_____

electric field = _____ _____ (unit)

(d) Calculate the size of the force on the electron due to the electric field.
Give your answer to the correct number of significant figures.

_____

_____

electric force = _____

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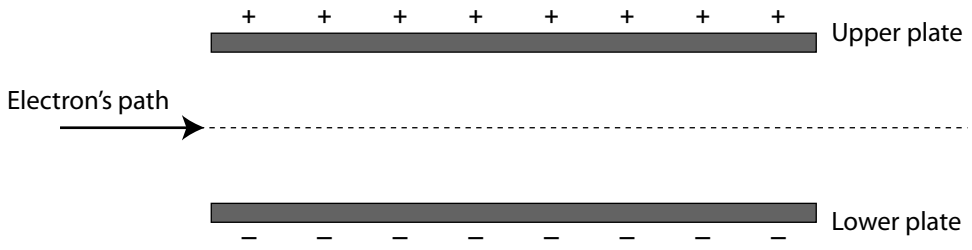
The Speed Detector:
The velocity of the electrons fired from an electron gun can be measured by passing them through an electric field and a magnetic field that are at right angles to each other. The electric field is produced by two charged metal plates as shown in the diagram.



(e) Describe the effect the charged metal plates have on the electron.

(f) There is also a magnetic field which is perpendicular to the page.

The strength of the magnetic field is adjusted so that the electron's path does not bend upwards, but keeps going in a straight line.

Describe the relationship between the two forces that act on the electron.

(g) Describe the direction of the magnetic field required to keep the electron going in a straight line.

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(h) After adjustment, the electric field was measured to be 3.5×10^3 N C^{-1} and the magnetic field was measured to be 1.3×10^{-3} T. Derive an equation for the velocity of the electron in terms of the electric and magnetic fields. Use it to calculate the electron's velocity.

electron velocity = _____

(i) The electric field is then switched off. An electron is fired into the magnetic field so that the electron's velocity is again at right angles to the magnetic field.

(i) Describe the shape of the electron's path as the electron moves through the field.

(ii) Explain why the path of the electron in the magnetic field has this shape.

QUESTION THREE: INDUCTION

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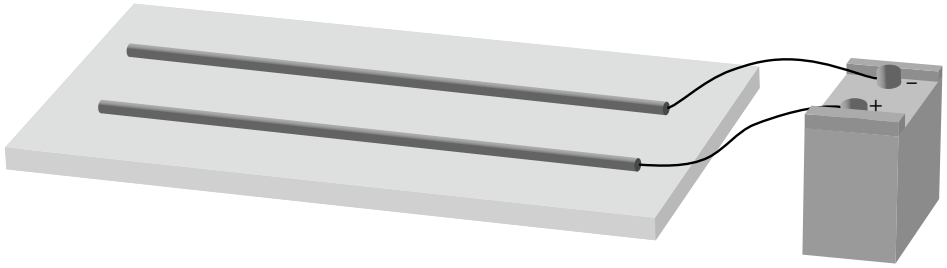
David's teacher Mr Manu asked him to set up an experiment to show the force acting on a conductor in a magnetic field. David put two horizontal, parallel metal rails on a wooden table and connected them to a battery as shown.



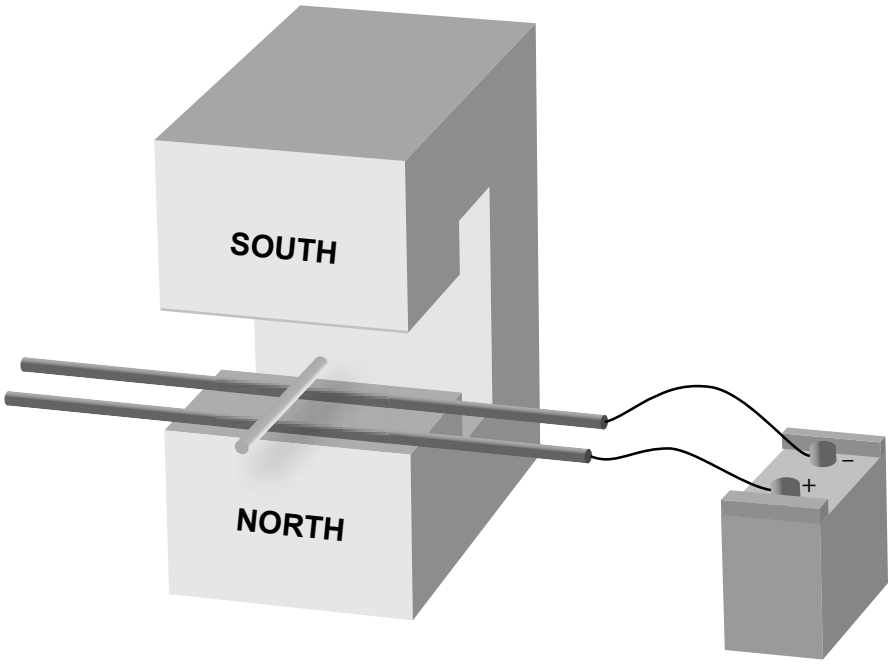
(a) State why the battery did not produce a current.

_____

_____

_____

David then put an aluminium rod across the rails and placed the rod and rails between the poles of a magnet as shown below.



(b) On the above diagram:

(i) Draw an arrow to show the direction of the magnetic field between the rails. Label this arrow '**field**'.

(ii) Draw an arrow to show the direction of the electromagnetic force on the aluminium rod. Label this arrow '**force**'.

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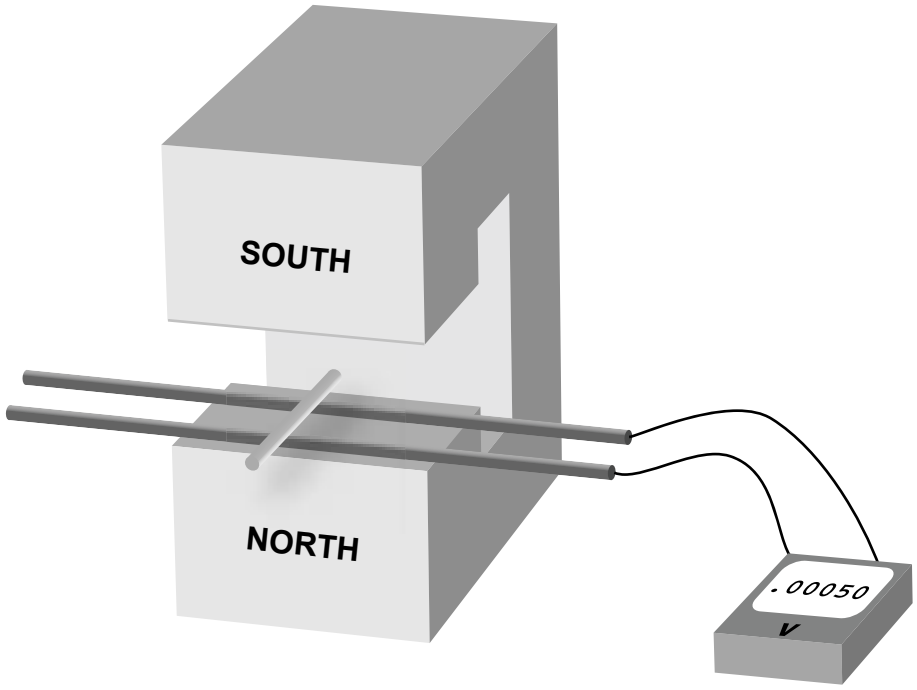
(c) Explain what caused the aluminium rod to experience an electromagnetic force.

(d) Use the data below to calculate the size of the electromagnetic force on the aluminium rod.

Battery voltage	= 12 V
Total resistance of circuit	= 2.5 Ω
Distance between rails	= 6.0 cm
Length of aluminium rod	= 8.0 cm
Magnetic Field strength	= 0.15 T

Force = _____

David then removed the battery and replaced it with a sensitive voltmeter. He pushed the aluminium rod so it rolled along the rails while maintaining electrical contact. At one time the voltmeter reads 5.0×10^{-4} V.



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(e) Calculate the speed of the aluminium rod as it rolled along the rails.

Speed = _____

(f) David observed that as the aluminium rod approached the magnet, it slowed down when the current was produced.

Explain clearly why it slowed down.

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

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Question number