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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2 Physics, 2007

90257 Demonstrate understanding of electricity and electromagnetism

Credits: Five
2.00 pm Friday 30 November 2007

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 2–11 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)		

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

You may find the following formulae useful.

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

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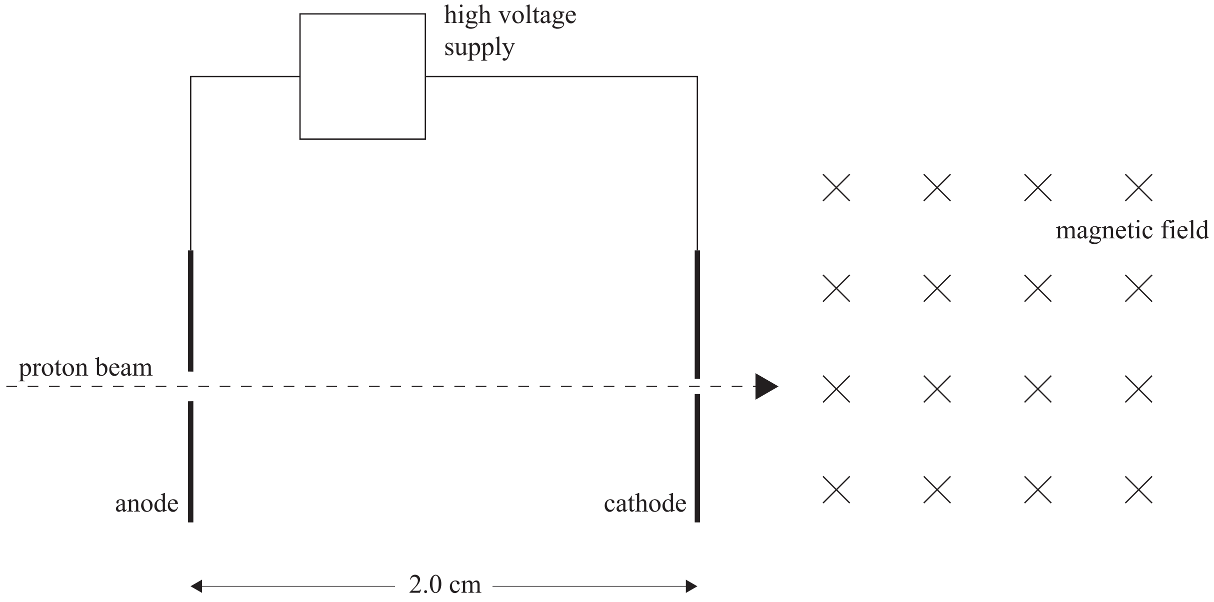
QUESTION ONE: THE PARTICLE ACCELERATOR

A particle accelerator is a machine designed to accelerate charged particles to very high speeds. In one type of accelerator, **protons** are accelerated by an electric field and then deflected by a magnetic field. The diagram below shows part of the particle accelerator. **Protons** pass through the hole in the anode, and are accelerated towards the cathode. The **protons** pass through the hole in the cathode and travel to the right.

The distance between the anode and cathode is	2.0 cm.
The charge on a proton is	$+1.6 \times 10^{-19}$ C.
The mass of a proton is	1.67×10^{-27} kg.



(a) Draw an arrow on the above diagram to show the **direction** of the **electric field** between the anode and the cathode.

(b) Describe the change in the **type of energy** of the proton as it moves from the anode to the cathode.

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(c) A proton passes through the anode at 6.2×10^5 m s^{-1}, and passes through the cathode at 8.8×10^5 m s^{-1}. Show that the strength of the electric field is 100 000 V m^{-1}.

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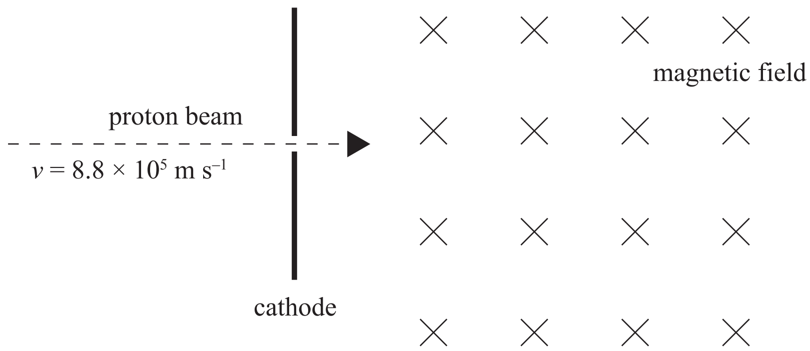
(d) State a unit for electric field strength other than V m^{-1}.

(e) Calculate the **voltage** between the anode and the cathode.

When the protons pass through the hole in the cathode, they enter a magnetic field as shown in the diagram below. The direction of the magnetic field is into the page.
Magnetic field strength = 3.5 mT.



(f) State the **direction** of the force acting on the proton as it enters the magnetic field.

(g) Calculate the **size** of the magnetic force acting on the proton in the magnetic field.
Write your answer to the correct number of **significant figures**.

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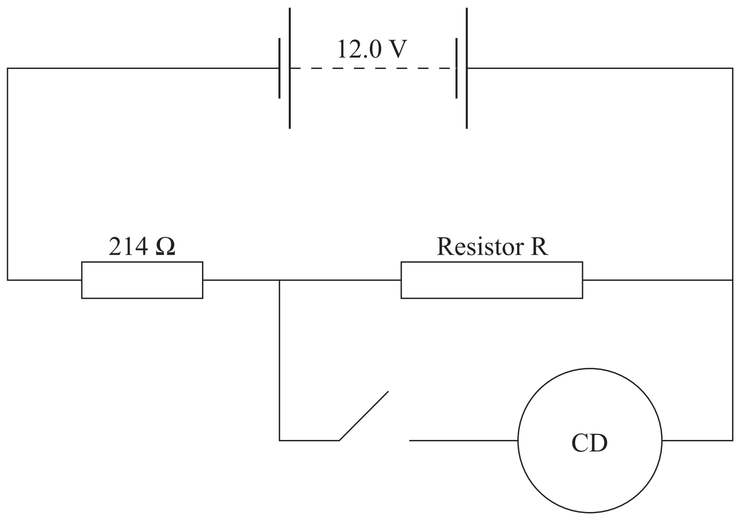
QUESTION TWO: ELECTRIC CIRCUITS

Ella has a battery-operated CD player that she wants to connect to her car battery. The voltage of her car battery is **12.0 V** and her CD player is marked **"4.5 V, 25 mA"**. She knows she cannot connect it directly to the car battery, so she decides to connect it in a circuit as shown in the diagram below. The switch is **initially closed**.



(a) Calculate the resistance of the CD player.

(b) Calculate the **voltage** across the 214 Ω resistor if the CD player has the correct voltage across it when the **switch** is **closed**.

(c) Show that the appropriate value of **resistor R** is 450 Ω .

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Ella now **opens** the switch.

(d) Explain what happens to the voltage across the 214 Ω resistor when she **opens** the switch.

(e) The switch remains open.

Explain which resistor produces more heat in a given time.

(f) Ella does not have a 450 Ω resistor, but she does have three 300 Ω resistors.

In the box below, draw a diagram to show how she could connect the three 300 Ω resistors to give a total of 450 Ω.

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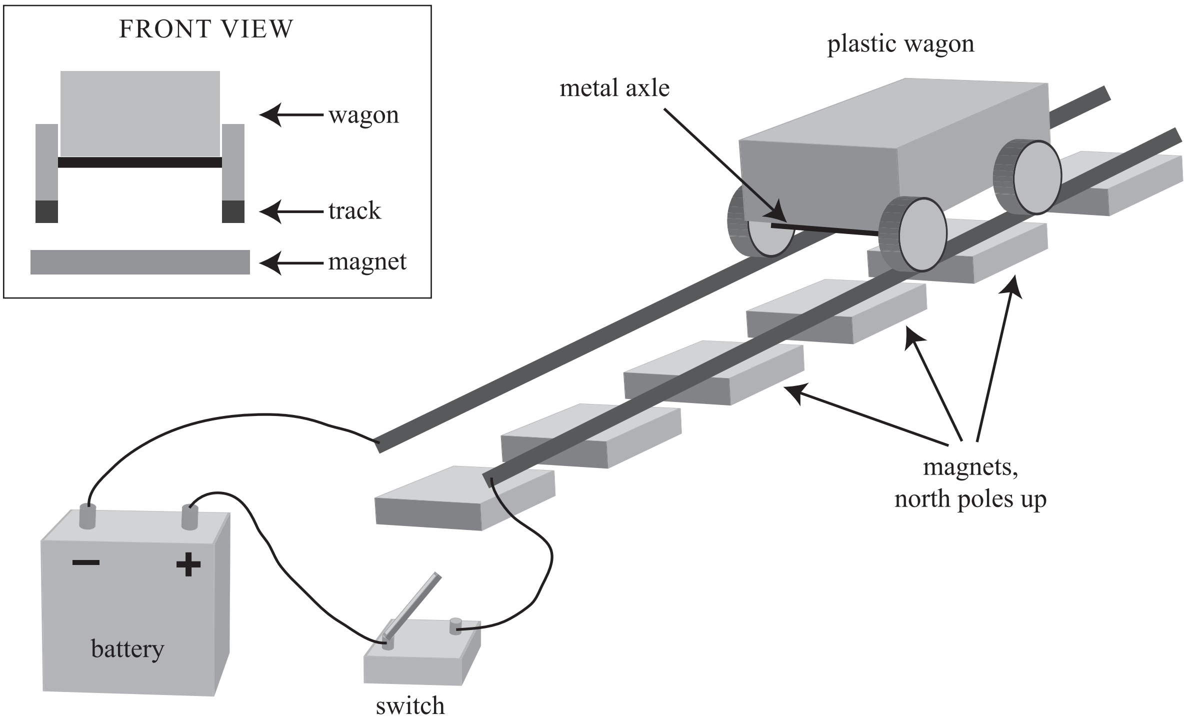
QUESTION THREE: THE MODEL RAILWAY

Tana is playing with a model railway. He wants to make one of the plastic wagons move without an electric motor. He places a row of magnets under (but not touching) the horizontal tracks, with the north poles pointing up. He then connects the tracks to a battery and puts a wagon on the tracks. The wheels, axles and track conduct electricity.

The magnets produce a uniform magnetic field of 0.25 T.
The tracks are 35 mm apart.
The resistance of the circuit is 0.55 Ω.



(a) Explain what causes the wagon to move when the switch is closed.

(b) Draw an arrow on the diagram above to show the **direction** of the **electromagnetic force** on the wagon.

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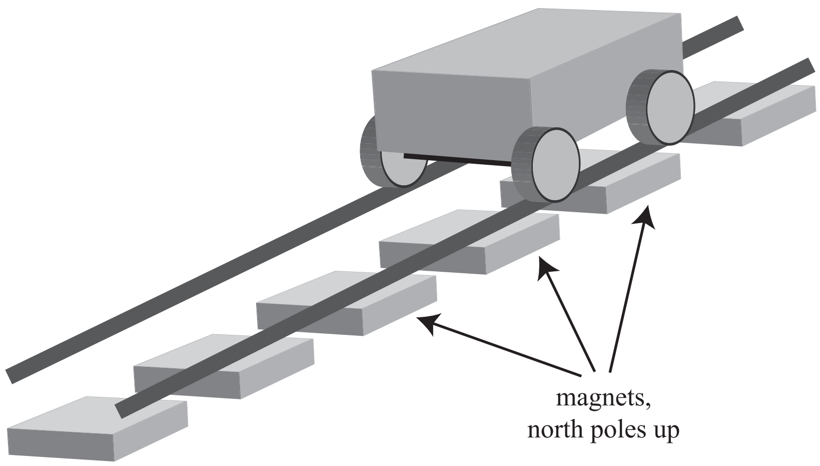
(c) When the switch is closed, the size of the electromagnetic force on the wagon due to the **two axles** is 0.052 N.

Calculate the **battery voltage**.

Tana disconnects the battery, then gives the carriage a horizontal push.



(d) Calculate the **induced voltage** across each axle when the carriage is travelling at 0.29 m s^{-1}. Write your **answer in mV**.

(e) Explain clearly why one end of the axle becomes **negatively** charged.

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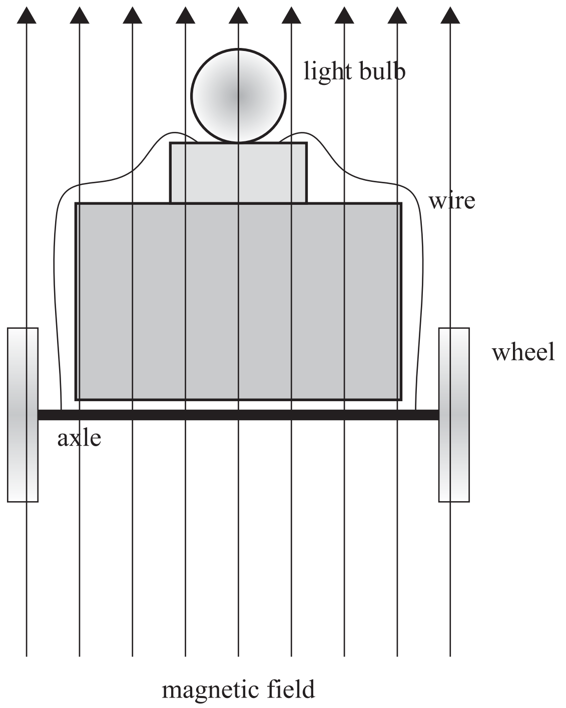
(f) Tana wants to use the induced voltage to light a lamp. With the battery still disconnected, he puts a low-power lamp on the carriage and connects it to the axles as shown below.

Explain what will happen in the **circuit** of the **lamp** and **axle**, as the wagon cuts across the magnetic field.



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

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