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1

90185

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Level 1 Physics, 2006

90185 Demonstrate understanding of electricity and magnetism

Credits: Five
9.30 am Monday 20 November 2006

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 2–12 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.

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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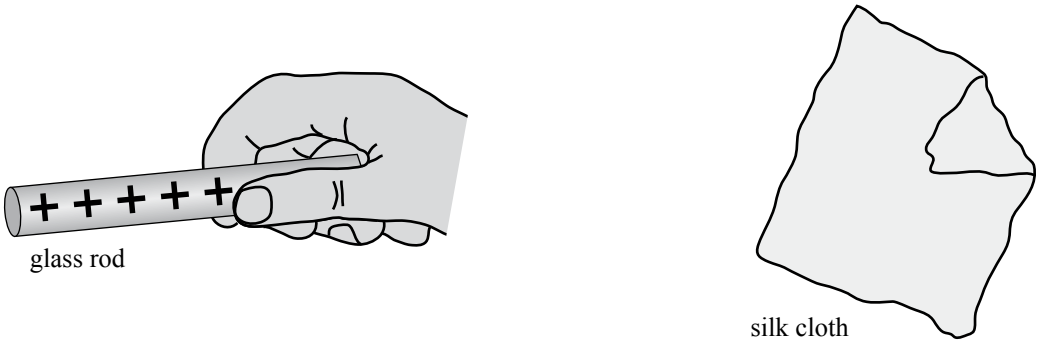
You may find the following formulae useful.

$$V = IR \qquad P = IV \qquad P = \frac{E}{t} \qquad R_T = R_1 + R_2 + \ldots$$

$$B = \frac{\mu_0}{2\pi} \frac{I}{d}$$

QUESTION ONE: ELECTROSTATICS

Tina charges a glass rod by rubbing it with a silk cloth. When she moves the glass rod from the silk cloth, it becomes positively charged, as shown in the diagram below.



(a) On the above diagram, **draw** the type of charge on the silk cloth.

(b) Explain why the silk cloth becomes charged this way.

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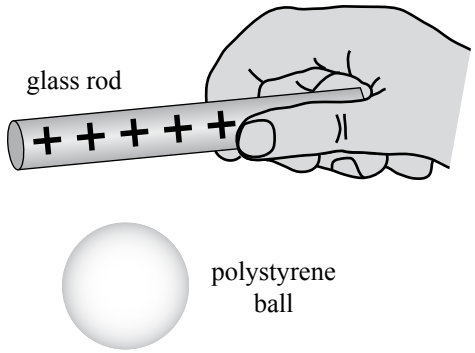
Tina now brings the **positively** charged glass rod near a very light, **uncharged** polystyrene ball, as shown in the diagram.



(c) On the diagram above, **draw** the distribution of charges on the polystyrene ball.

(d) Describe what happens to the polystyrene ball and explain why.

Description: _____

Explanation: _____

_____

_____

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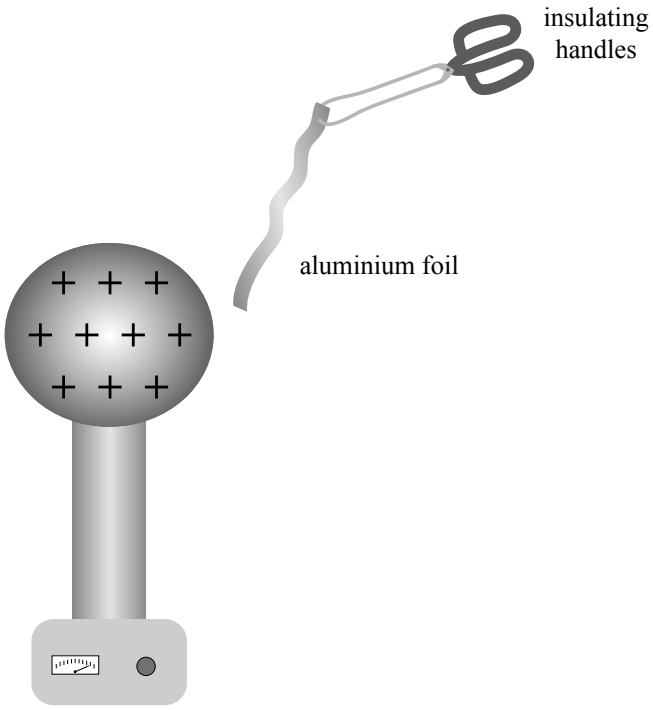
Tina holds a strip of aluminium foil by its upper end, using a pair of tongs with insulating handles. She slowly brings the foil near the **positively** charged sphere of a Van de Graaff generator and notices that the foil is attracted **towards** the sphere, as shown in the diagram.



(e) Explain why, when the end of the foil touches the sphere, it does **not** remain in contact with the sphere.

QUESTION TWO: BUILDING AN ELECTRIC CAR

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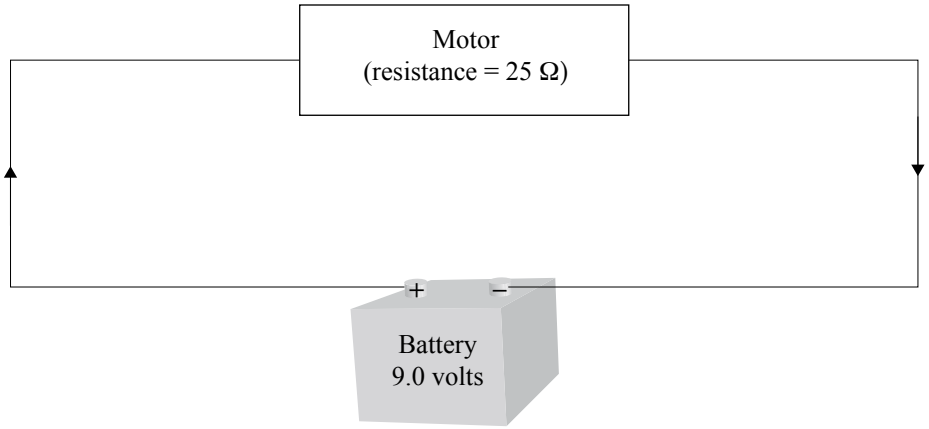
Mark bought an electric motor to build a toy racing car. He tests the motor by connecting it in series with a **9.0 volt** battery as shown in the diagram.



(a) The resistance of the motor is **25 Ω**. Show that the **current** through the circuit is 0.36 A.

(b) Show that the **power** input to the motor is 3.2 W.

(c) Calculate the **energy** supplied by the battery when the motor is turned on for **2 minutes**.

Energy: _____

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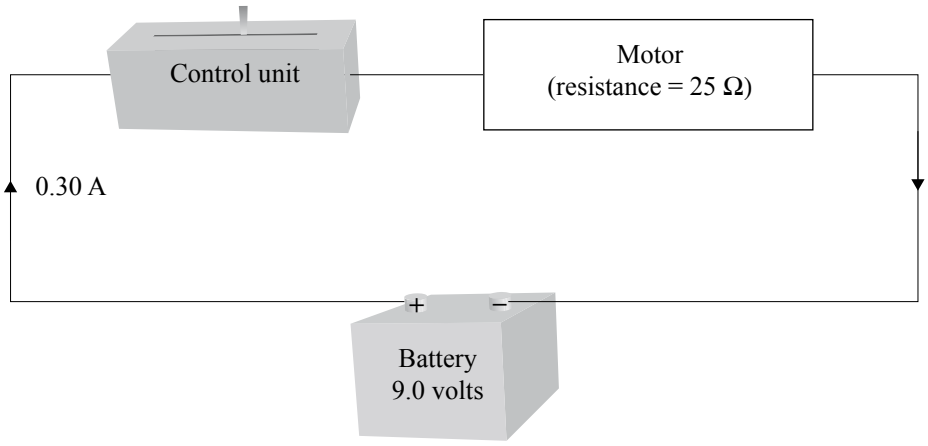
Mark now connects a speed control unit (a variable resistor) in series with the motor and it is set half way along as shown in the diagram.



(d) The resistance of the motor is **25 Ω** and the current through the circuit is now **0.30 A**. Calculate the **voltage** across the motor.

Voltage: _____

(e) Show that the **resistance** of the speed control unit, when it is set half way along, is 5.0 Ω.

(f) Calculate the **total resistance** of the circuit.

Resistance: _____

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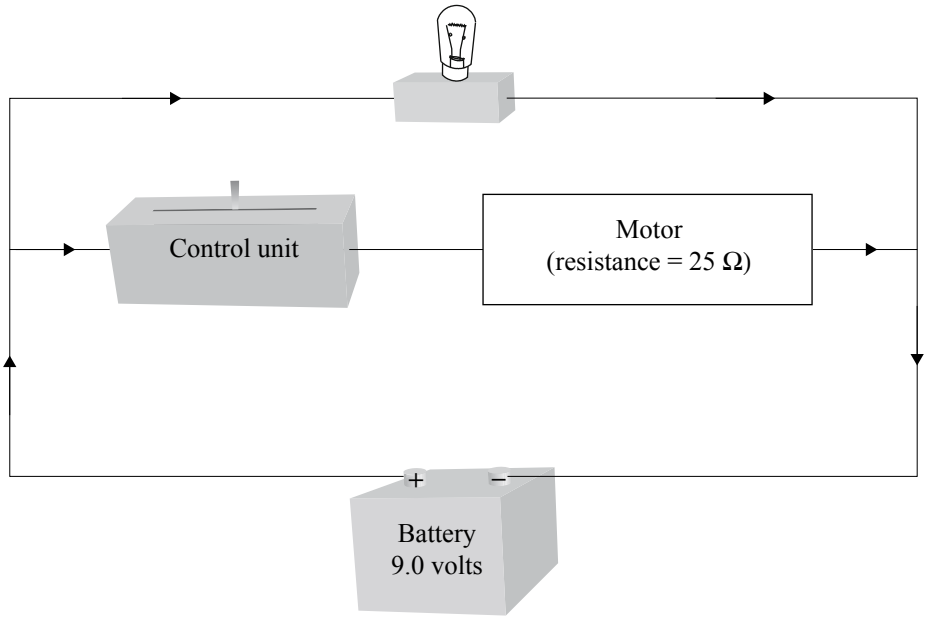
Mark now connects a bulb labelled as "**9.0 volts, 6.5 W**" in parallel with the motor and the speed control unit, as shown in the diagram below.



(g) Calculate the working **resistance** of the bulb.

Resistance: _____

QUESTION THREE: LIFTING ELECTROMAGNETS

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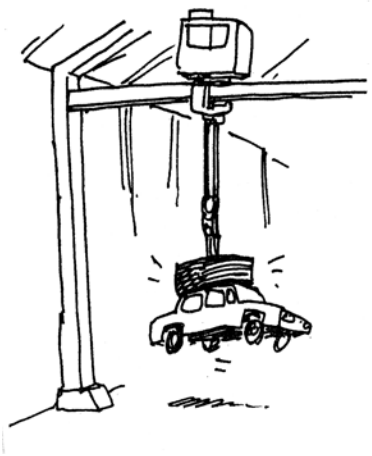
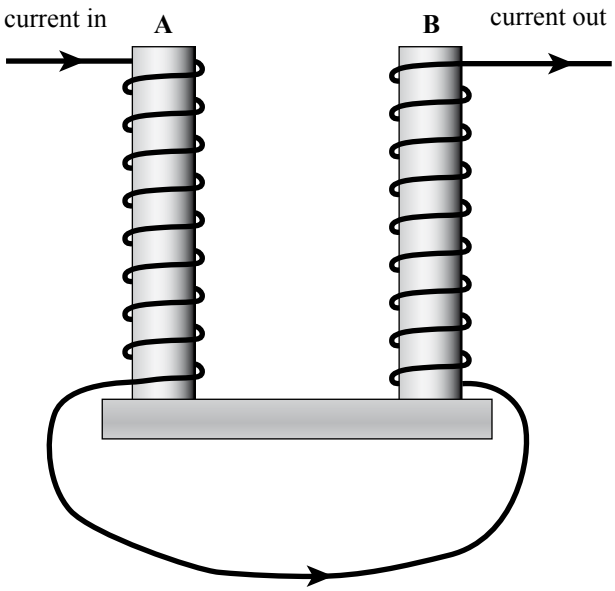
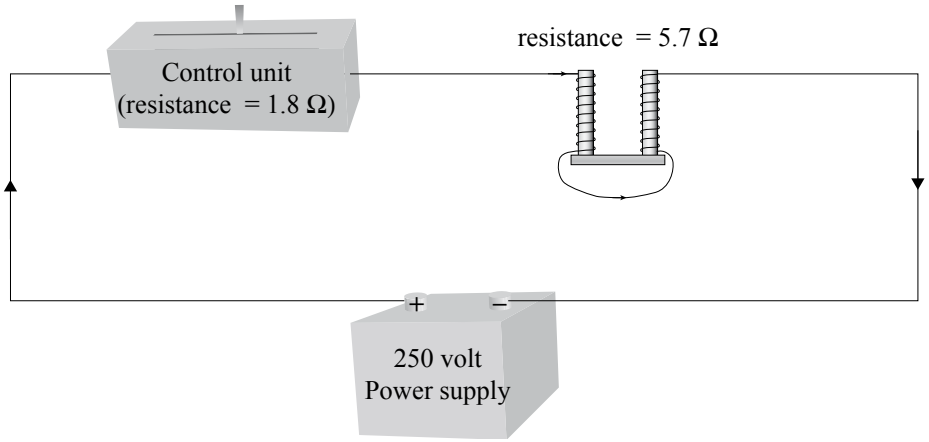


Some car manufacturers use electromagnets to lift car bodies in the factory. A bipolar electromagnet used in a factory has two identical coils of wires on a 'U-shaped' soft iron core. The coil is wound in the opposite directions in each limb of the soft iron core and an electric current flows through the coils, as shown in the diagram below. The soft iron core now becomes an electromagnet.

(a) On the diagram below **draw** the magnetic field pattern formed by the ends **A** and **B** of the coils. Draw **arrows** to show the direction of the magnetic field.



The electromagnet is powered by a **250 volt** power supply and is operated using a control unit. The resistance of the control unit is **1.8 Ω** and the combined resistance of both coils is **5.7 Ω**. The power supply, control unit and the coils of the electromagnet are connected in series, as shown in the diagram below.



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(b) Show that the **current** through the circuit when the electromagnet is switched on, is **33.3 A**.

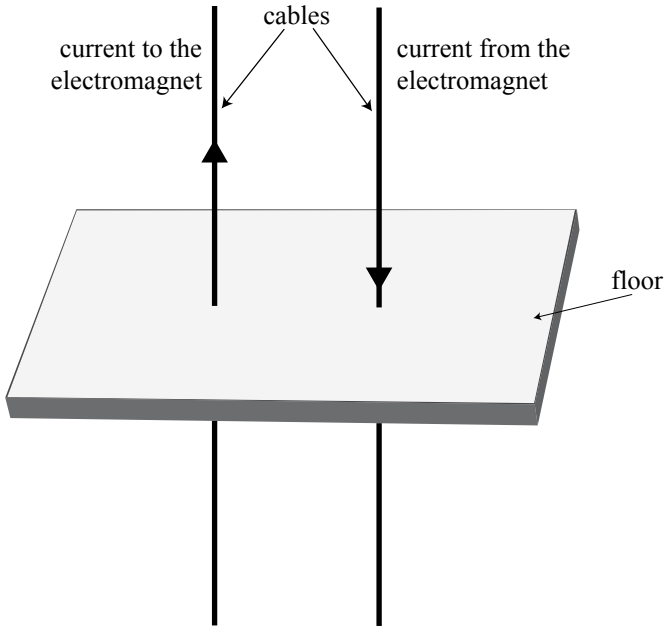
When the electromagnet is switched on, the power provided by the **250 volt supply** is shared between the electromagnet and the control unit.

(c) Calculate the electric **power** used by the electromagnet (not by the control unit) when it is in operation.

Power: _____

The power cables that connect the electromagnet to the control unit pass through the floor and run parallel to each other, as shown in the diagram below. The electromagnet is switched on. A large current now flows through the cables, producing magnetic fields in the space near the cables.

(d) On the diagram below draw the **shape** and the **direction** of the magnetic fields produced by the power cables. Use arrows to show the direction of the magnetic field.



QUESTION FOUR: APPLICATIONS OF PHYSICS IDEAS

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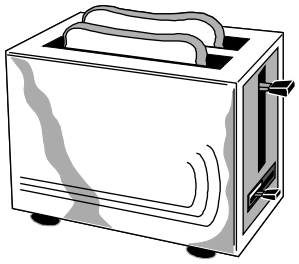
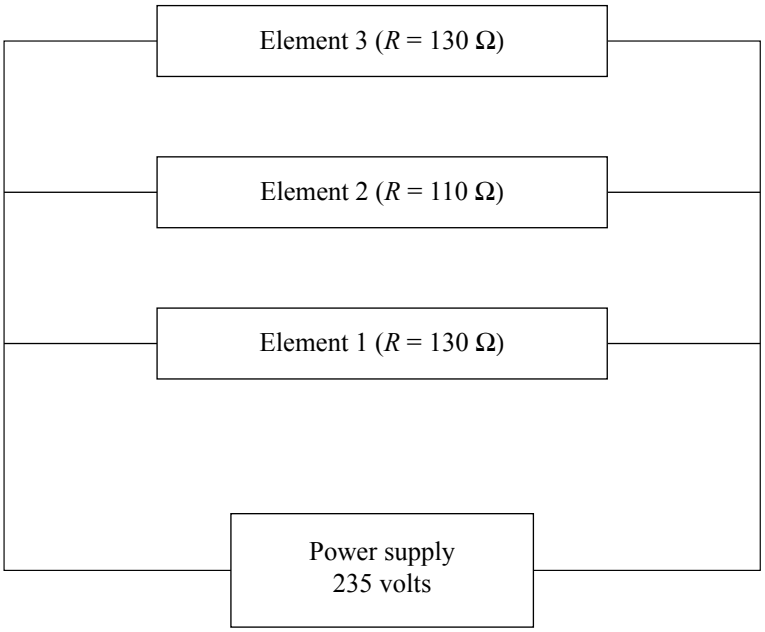
Electric Toaster



A two-slice electric toaster is made up of three heating elements connected in parallel, as shown in the diagram below. **Element 1** has a resistance of **130 Ω**. The toaster is connected to a **235 volt** power supply.



(a) Calculate the current in heating **element 1**.

Current: _____

(b) **Element 2** has a resistance of **110 Ω** and **element 3** has a resistance of **130 Ω**. The toaster is connected to the **235 volt** power supply. By calculating the total current through the heating elements or otherwise, calculate the **power** output of the toaster.

Power: _____

A switch is added to the toaster to make it energy efficient when only one slice of bread is being toasted.

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(c) Mark the circuit diagram on the opposite page with an "**X**" where a switch would have to be placed so that **element 1** can be turned off when one slice of bread is being toasted.

(d) The switch **X** is in the **off** position and the toaster is now switched on. **Describe** how the total power output of the toaster now compares with the total power output, calculated in question (b). **Explain** your answer.

Description: _____

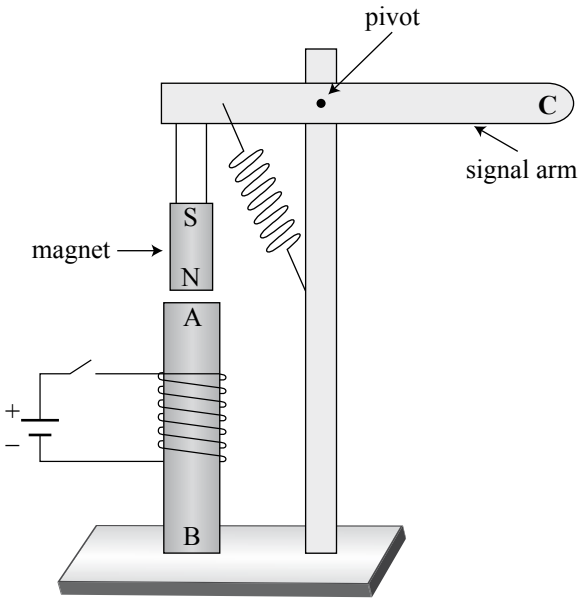
Explanation: _____

_____

_____

Model Railway Signal

The diagram shows the working parts of a model railway signal. It consists of a solenoid AB placed under a magnet, which hangs from the left-hand side of the signal arm. The signal arm is balanced in the horizontal position by the spring and the weight of the magnet.



(e) **Describe** what happens to the end **C** of the signal arm when the switch is turned on. **Explain** why.

Description: _____

Explanation: _____

_____

_____

_____

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

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Question number	