NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Level 2 Physics, 2003

90257 Demonstrate understanding of electricity and electromagnetism

Credits: Five
2.00 pm Thursday 20 November 2003

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 'describe' or 'explain' questions, the answers should be written or drawn clearly with all logic fully explained.

For all numerical answers, full working must be shown and the answer must be rounded to the correct number of significant figures and given with an SI unit.

Formulae that you may find useful are given on page 2.

If you need more space for any answer, use the pages 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.

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

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

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

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

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

QUESTION ONE: Electric Blanket

Electric blankets are sometimes used to warm beds in camper vans. An electric blanket in Michael's camper van bed has four heating elements. It is connected to a **24 V** battery. A switch allows the user to select one of three heat settings by connecting it to either position **A**, **B** or **C**. The resistance of the elements is shown in the diagram below.
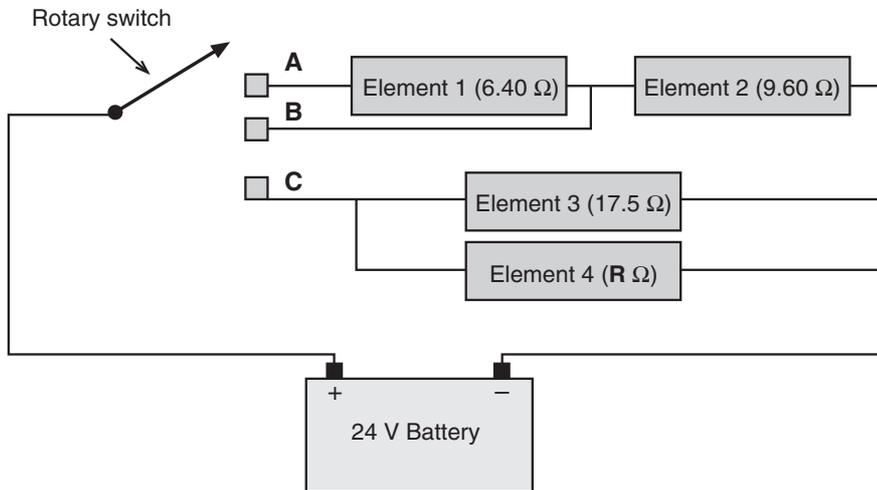
(a)   When the switch is in position **A**, calculate the total resistance of the circuit.

Resistance = _____

(b)   When the switch is in position **A**, calculate the current in the circuit.

Current = _____

(c)   Describe what is meant by the term **electric current**.

(d)   The switch is turned on to position **C**.

Calculate the amount of charge that flows through the **17.5 Ω** resistor in one minute.

Charge = _____

(e) When the switch is in position **C**, the total resistance of the circuit is **5.72 Ω**.

Calculate the resistance **R** of Element 4.
Write your answer to the appropriate number of significant figures.

Resistance =

(f) When the switch is in position **B**, show that the power output of the blanket is **60 W**.

(g) The switch is left in position **B** for **30 minutes**.

Calculate the amount of heat energy that is produced by the electric blanket during that time.

Energy =

(h) When the switch is in position **B**, there is less current in the circuit than when the switch is in position **C**.

In terms of the charge flow, explain why this happens.

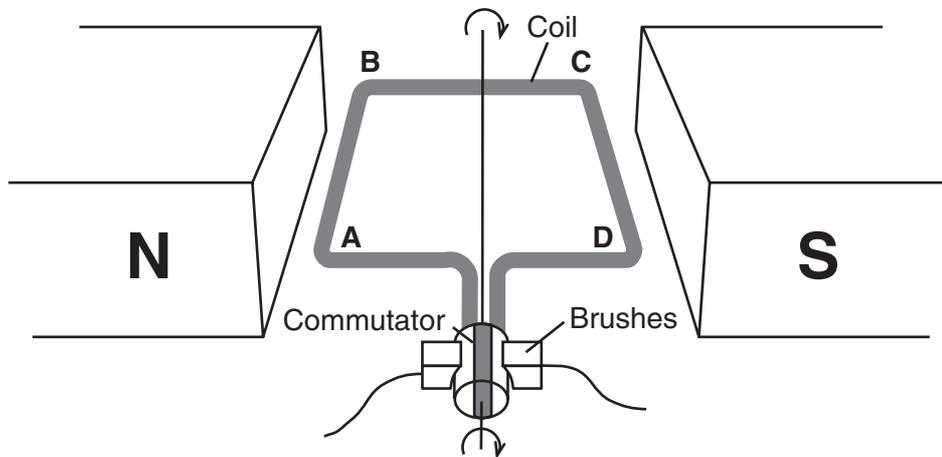## QUESTION TWO: The Aerial

The camper van has a remote-controlled aerial for the radio that is operated by an electric motor. The diagram below shows the essential construction of a basic motor. It consists of a coil of **single turn** that rotates between the poles of a magnet.

The motor is connected to a **24 V** battery. When the motor is turned on, the coil rotates in a clockwise direction, as shown in the diagram above.

(a)   On the diagram, use arrows to show the direction of the conventional current in the coil.

(b)   Give an explanation for your answer in (a).

_____

_____

_____

_____

The current through the coil is **0.65 A** and the size of the magnetic field is **0.55 T**.
The length of side **AB** is **0.045 m**.
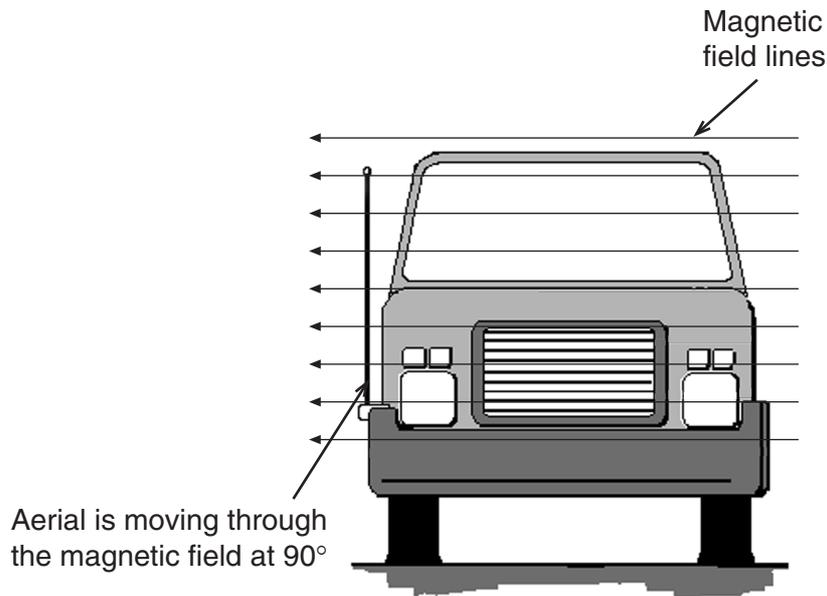
(c)   Calculate the force on side **AB** of the coil.

_____

_____

_____

Force =   _____

The camper van is now travelling at **28 m s⁻¹** in a region where the earth's magnetic field is **5.0 × 10⁻⁵ T**. The motion of the aerial is at right angles to the earth's magnetic field, as shown in the diagram below. The aerial has a length of **1.2 m**.

Magnetic
field lines

Aerial is moving through
the magnetic field at 90°

(d) Calculate the size of the induced voltage across the length of the aerial.
Write down your answer in millivolts.

Voltage = _____ mV

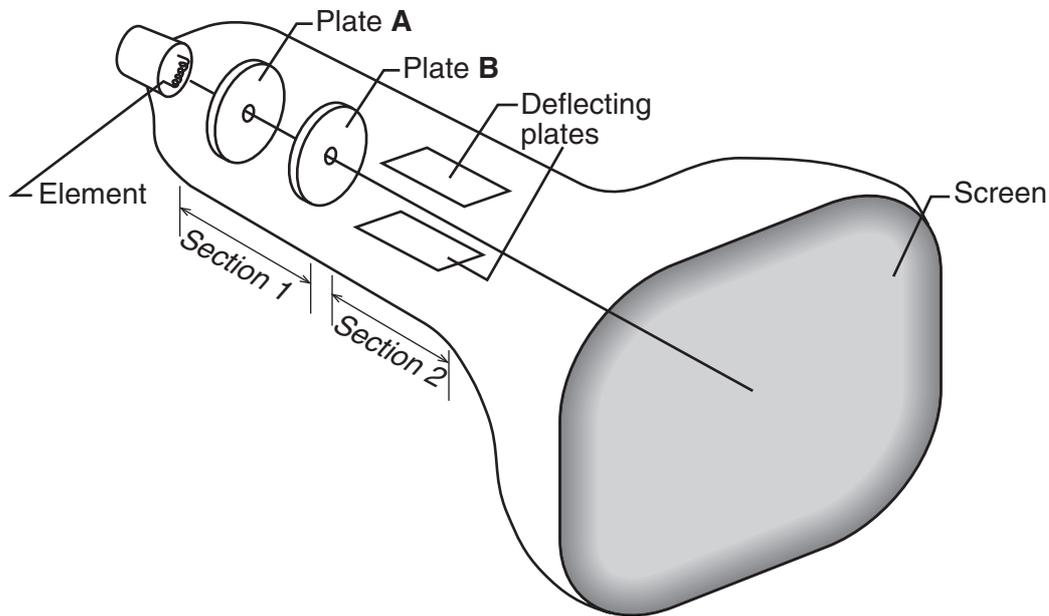(e) Explain why the bottom end of the aerial becomes positively charged as the van moves across the earth's magnetic field.

QUESTION THREE: Charged Beams

Electron beams are commonly used in today's technology to produce images on computer screens. The following diagram shows one way of producing the image on the screen using electron beams.

The element is heated to produce electrons. Plates **A** and **B** are connected to a high voltage supply. The electrons accelerate towards plate **B** and strike the screen. The screen is coated with a fluorescent material so that it glows when electrons strike.

In section 1, plates **A** and **B** are connected across a **5000 V** supply. The electrons accelerate towards plate **B**.

(a)   State what kind of charges are on plate **B**.

_____

(b)   The size of the charge on an electron is **1.6 × 10⁻¹⁹ C**.

Calculate the gain in energy of the electron when it arrives at plate **B**.

_____

_____

_____

Energy = _____

Section 2 shows a pair of deflecting plates that are connected to a **2000 V** supply. They are used to move the electron beam up and down.

(c)   In the diagram below, draw lines to show the correct shape and direction of the electric field formed between the plates.
Indicate the direction of the field using arrows.
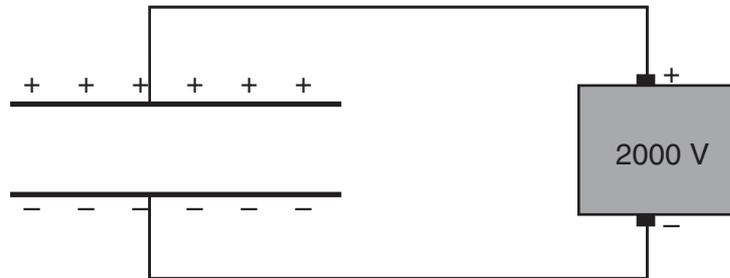
(d)   The size of the charge on an electron is **1.6 × 10⁻¹⁹ C**. The force on an electron in the electric field is **2.1 × 10⁻¹⁴ N**.

Calculate the strength of the electric field. Give your answer with the correct unit.

_____

_____
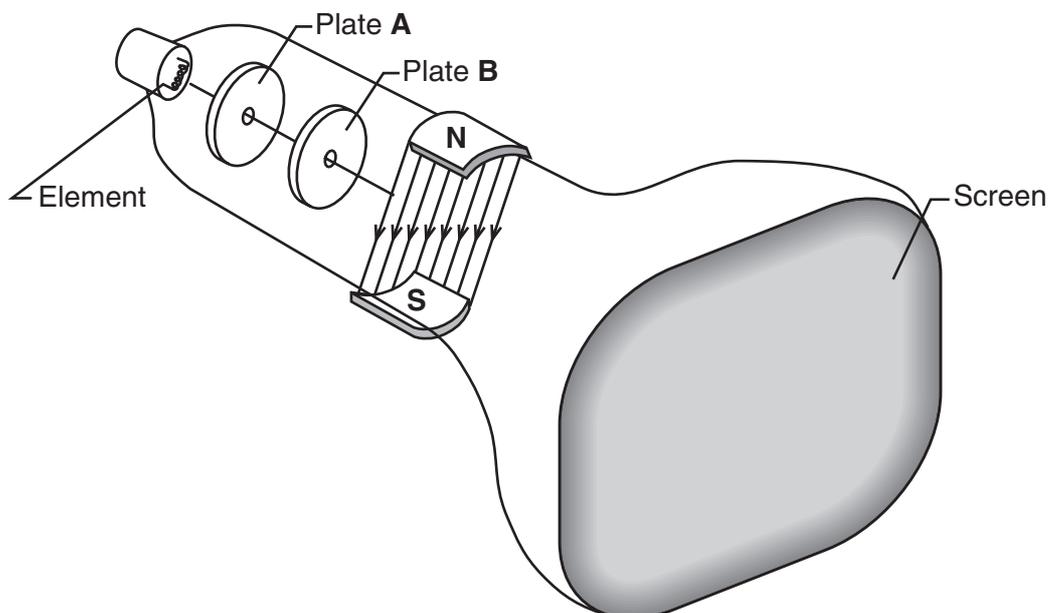
_____

Electric field = _____
                                                              (unit)

Modern television tubes also use magnetic fields to move the electrons from side to side. The diagram below shows a pair of magnetic coils placed above and below the tube.

An electron enters the magnetic field at a speed of **4.2×10^6 m s^{-1}**. The size of the magnetic field produced by the coils is **9.8×10^{-2} T**. The size of the charge on the electron is **1.6×10^{-19} C**.

(e) Calculate the size of the force experienced by the electron when it is in the magnetic field.

Force = _____

(f) The electrons are deflected when they cross the magnetic field.

Explain why the electrons change their direction.

(g) The magnetic coils are replaced by a uniform electric field.

Calculate the electric field strength required to achieve the same force as in (e) above. Assume all other quantities remain unchanged.

Electric field = _____

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

Question Number

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Clearly number the question.**

Question
Number