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MANA TOHU MĀTAURANGA O AOTEAROA

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Level 1 Physics, 2009

90185 Demonstrate understanding of electricity and magnetism

Credits: Five
2.00 pm Thursday 26 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 2–11 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 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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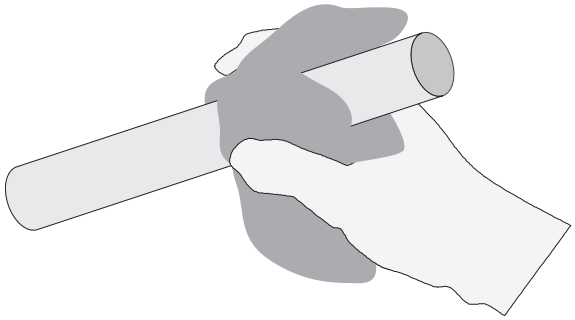
You may find the following formulae useful.

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

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

QUESTION ONE: ELECTRIC SHOCK

When a polythene rod is rubbed with a piece of cotton, the rod becomes **negatively** charged.



(a) (i) **Name** the particles that move during this charging process.

(ii) Describe the direction of the particles' movement.

(b) When the rod is negatively charged, the charges on it do not spread evenly over the rod. However, when a metal ball is negatively charged, the charges spread evenly over the ball.

Explain why the charges spread out evenly over the metal ball, but not on the polythene rod.

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Jen is wearing cotton clothing and is sitting on a car seat that is covered with material made from polythene. The friction between her clothing and the seat causes the material of the seat to become **negatively** charged. She gets out of the car, and when she touches a metal door handle on the car, she feels a small electric shock and sees a spark between her finger and the metal door handle.

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(c) Explain why Jen feels a small electric shock and sees a spark between her finger and the metal door handle.

(d) A static electricity eliminator device can be used to avoid shocks. The eliminator consists of an electric circuit that allows the person to discharge static electricity safely through the device as shown in the diagram.

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When the person touches the eliminator against the car body, the voltage between the person and the car is 3 000 V and a current of 1.6×10^{-6} A flows through the static electricity eliminator.

(i) Calculate the resistance of the static electricity eliminator device.

resistance = _____

(ii) One mega-ohm is equal to 10^6 ohms.

Write down your answer to question (d)(i) in mega-ohms.

resistance = _____ mega-ohms

(e) It is common for people to become charged to a high voltage by friction. In a playground, a boy slides down a long polythene slide. The voltage that builds up between his body and the ground is 5 000 V. When he touches the ground, a current flows for 0.0010 s, and the energy transferred by the spark is just 1.0×10^{-6} J.

Use this information to calculate the amount of current that flows during sparking.

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current = _____

QUESTION TWO: BICYCLE LAMPS

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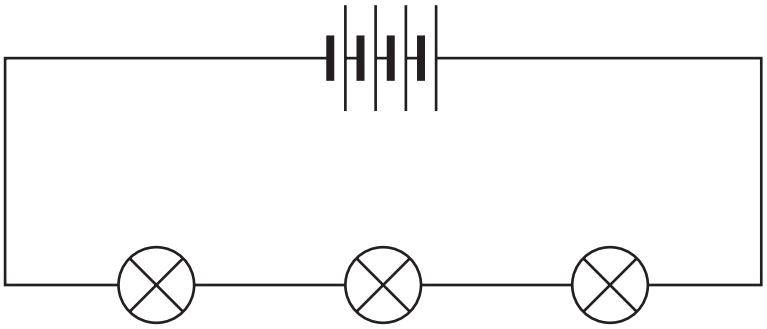

Three bicycle bulbs are connected in series. They are then connected to a four-cell battery, as shown in the above diagram.

(a) The output voltage of each cell is 1.5 V. Each bulb requires 2.0 V to light up with normal brightness.

Explain why this circuit causes each bulb to light up with normal brightness.

(b) The voltage across each bulb is 2.0 V and a current of 0.015 A flows through it.

Calculate the power output of each bulb.

power = _____

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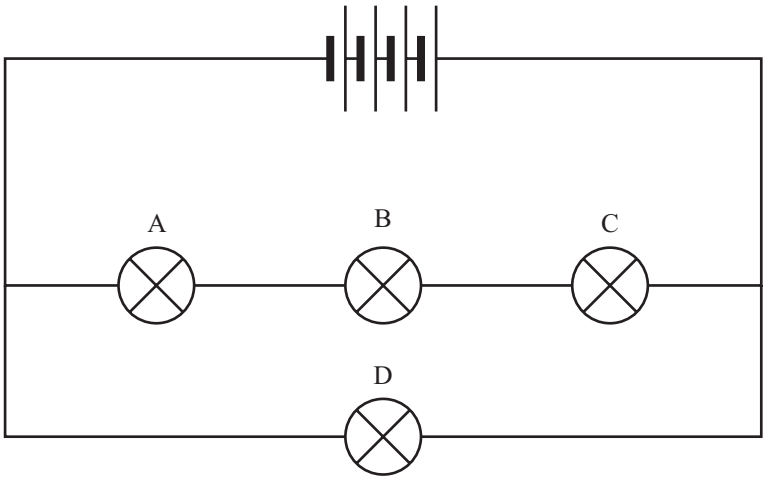
(c) Calculate the total resistance of the circuit.

total resistance _____

(d) An identical bulb is connected parallel to the previous circuit as shown below. Each bulb requires 2.0 V to light up with normal brightness.



Describe what will happen to the brightness of each of the bulbs in this arrangement. Explain your answer.

Statement: _____

Explanation: _____

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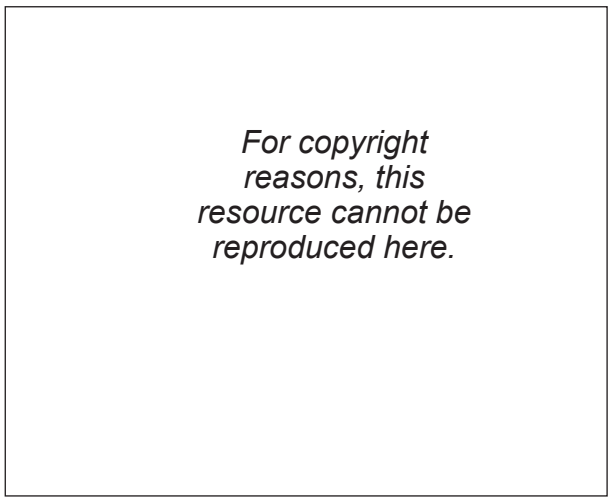
(e) An overhead power cable for an electric train delivers 200 A of current to the train motor. A person on a platform is 8.0 m from the power cable. At this point, the strength of the earth's magnetic field is 5.0×10^{-5} T.



http://www.rtd-fastracks.com/images/uploads/main/EMU.jpg

Calculate the strength of the magnetic field produced by the overhead cable at the point where the person is, and **compare** its value with the strength of the earth's magnetic field.
(The value of $\mu_0 = 1.26 \times 10^{-6}$ T A m^{-1}.)

field strength = _____

Comparison: _____

QUESTION THREE: MAGNETIC EFFECTS

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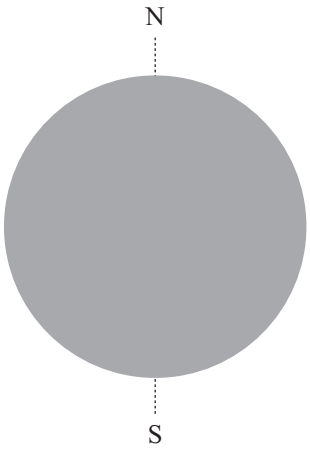

(a) The diagram above shows the **geographic** north and south poles of the earth. The earth behaves like a giant magnet.

On the diagram above, sketch TWO magnetic field lines, one on each side of the earth, to show the **shape** and **direction** of the earth's magnetic field.

(b) A compass needle on earth always points to the direction shown in the diagram below.

(i) Using letters "N" and "S", label the north and the south ends of the compass needle in the diagram.

(ii) Explain why the compass needle points in the direction shown in the diagram.

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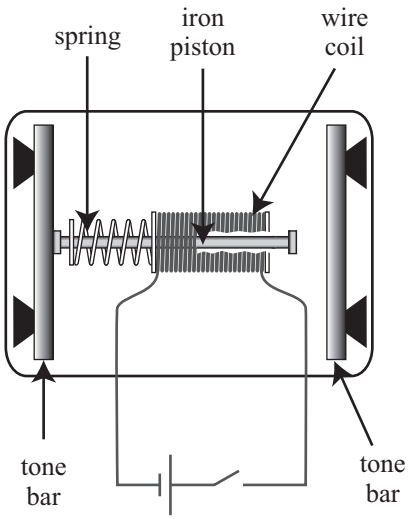
(c) The diagram shows the structure and the operating circuit for a chime doorbell, which uses a wire coil. The iron piston is inside the wire coil, and it is free to move horizontally. A spring pushes the piston to the left. On either side of the wire coil there is a metal tone bar, which is made from non-magnetic material.



Explain what happens when the switch is turned on and off momentarily.

Question Three continues on the following page.

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(d) The strength of the magnetic field produced by the wire coil when the switch is turned on, is given by the formula:

$$B = \frac{\mu_0 NI}{L}$$

$\mu_0 = 1.26 \times 10^{-6}$ T A m^{-1}
N = number of turns of wire in the coil
I = the current through the coil
L = the length of the coil in metres

The coil has 150 turns of wire. When a current of 0.75 A flows through it, a magnetic field of strength 4.73×10^{-3} T is produced.

Calculate the length of the coil.

length = _____

(e) When the switch is turned on, a current of 0.75A flows through the coil and it uses 6.75 watts of power.

Calculate the resistance of the coil.

resistance = _____

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

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Question number	

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