90937

909370

1

SUPERVISOR'S USE ONLY

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Tick this box if you have NOT written in this booklet

Level 1 Physics 2022

90937 Demonstrate understanding of aspects of electricity and magnetism

Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of electricity and magnetism.	Demonstrate in-depth understanding of aspects of electricity and magnetism.	Demonstrate comprehensive understanding of aspects of electricity and magnetism.

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 attempt ALL the questions in this booklet.

Make sure that you have Resource Sheet L1–PHYSR.

In your answers use clear numerical working, words, and / or diagrams as required.

Numerical answers should be given with an appropriate SI unit.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (//). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

© New Zealand Qualifications Authority, 2022. All rights reserved.
No part of this publication may be reproduced by any means without the prior permission of the New Zealand Qualifications Authority.

QUESTION ONE: CHILD'S PLAY

Thomas plays on the slides at the playground. The playground has a plastic slide and a metal slide. On his way down the plastic slide, he gains a negative charge which makes his hair stand up.

Source: www.pinterest.nz/pin/546694842255086586/

Source: www.indiamart.com/proddetail/park-slides-2022890048.html

(a) State the name of the process by which he gained his charge.

(b) Explain, in terms of interaction of charges, why his hair stands up, as shown in the picture.

Source: www.energieversorgung-mainspessart.de/wp-content/uploads/2020/12/Web_EMS_Magazin_03_2020.pdf

(c) When Thomas's dad catches him at the bottom of the plastic slide, his dad gets a small electric shock.

(i) The electric shock has a power of 0.50 W and involves an energy transfer of 40 mJ (40×10^{-3} J).

Calculate the time the shock takes.

(ii) Explain this in terms of moving subatomic particles.

(d) Thomas goes down the metal slide. This time, when his dad catches him at the bottom, he does not get an electric shock.

Explain why the dad gets an electric shock when he catches Thomas going down the plastic slide, but not when he goes down the metal slide.

In your answer, you should:

- compare the electric properties of the plastic slide and the metal slide
- explain the process of charge separation
- link these processes to Thomas acquiring or not acquiring an electric charge.

QUESTION TWO: DANGER, HIGH VOLTAGE

Transmission cables, such as overhead power lines, transmit electrical energy over long distances. The electrical energy lost in the cables depends on the current carried: the smaller the current, the smaller the amount of electrical energy lost. Therefore, transmission cables transmit small currents at very high voltages.

Source: https://www.stuff.co.nz/taranaki-daily-news/news/120494851/transpower-confirm-25km-of-high-voltage-lines-and-pylons-will-be-removed-from-near-port-taranaki

(a) The power input of the plant into a cable is 80.5 MW (8.05×10^7 W) and carries a current of 700 A.

Show that the required voltage is 115 000 V.

(b) The current in a cable causes a magnetic field around the transmission cable.

(i) In the diagram below, draw TWO magnetic field lines with arrows to show the direction of the field lines.

If you need to redraw your response, use the diagram on page 8.

(ii) The direction of the field lines can be determined when a compass is brought near the cable.

On the compass in the above diagram draw the direction in which the needle will point, and explain how the compass will show the direction of the magnetic field lines.

(c) Long-term exposure to magnetic fields stronger than 40 mT (0.040 T) is a health hazard.

(i) Calculate the distance that you would need to be away from the cable that can produce a 40 mT magnetic field that carries a current of 700 A.

(ii) Explain if there is a significant health hazard by living near a transmission cable.

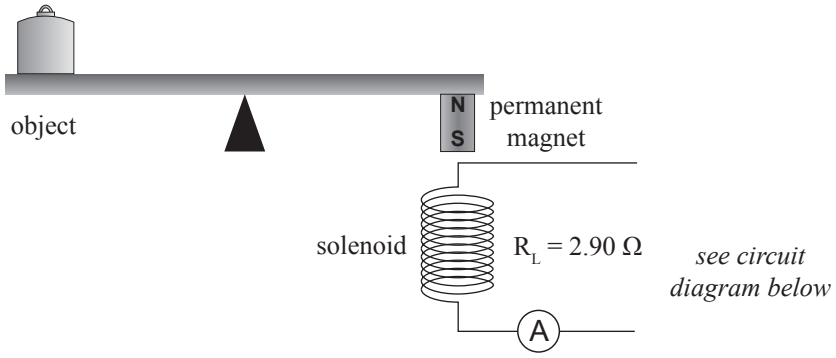
(d) The resistance of a piece of transmission cable of 1.0 km length is 0.035 Ω. A longer cable can be modelled as several 1.0 km pieces connected in series with each other.

Calculate the power loss over 100 km of cable when a voltage of 660 V is applied to its length.

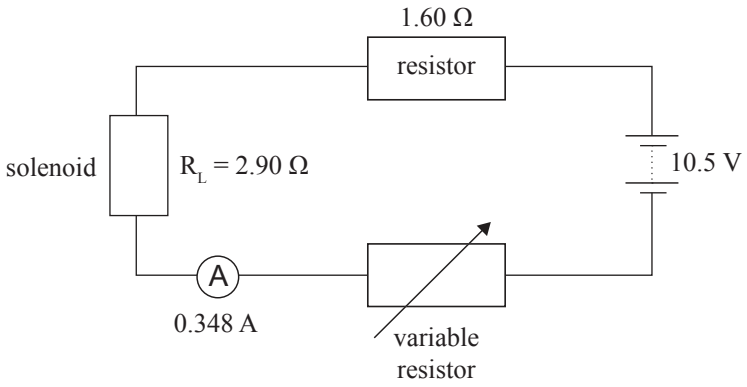
QUESTION THREE: A BALANCING ACT

The electromagnetic balance scale, as shown below, uses a simplified electric circuit. The circuit has a solenoid of resistance $R_L = 2.90\ \Omega$, a resistor of 1.60 Ω, and a variable resistor that adjusts the current and controls the strength of the electromagnet.

Diagram of scale and solenoid



Circuit diagram with solenoid



When an object is placed on the scale, the variable resistor is adjusted to bring the scale into balance (level). The ammeter reading is 0.348 A.

(a) Calculate the voltage across the solenoid.

(b) Calculate the resistance of the variable resistor when the current through the circuit is 0.348 A.

(c) Explain how decreasing the resistance of the variable resistor affects the current in the circuit.

(d) Explain how a current in the circuit can balance the arms of the balance scale when an object of unknown mass is placed on the left-hand side.

In your answer, you should:

- determine the direction of the current on the solenoid
- state where the north pole is on the solenoid
- explain how the interaction of magnetic fields can level the balance arms.

SPARE DIAGRAM

If you need to redraw your response to Question Two (b)(i), use the diagram below. Make sure it is clear which answer you want marked.

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

90937