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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Physics 2023

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 2–12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA). This area will be cut off when the booklet is marked.

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

QUESTION ONE: STATIC ELECTRICITY – THUNDERSTORMS

Lightning is a giant spark of electricity in the atmosphere between thunderclouds or between the thundercloud and the ground. The air acts as a natural insulator between positive and negative charges. Below is a picture of a thundercloud.

Source: https://en.wikipedia.org/wiki/Cumulonimbus_calvus#/media/
File:Cumulonimbus_seen_from_Milano-Malpensa_airport,_2010_08.JPG

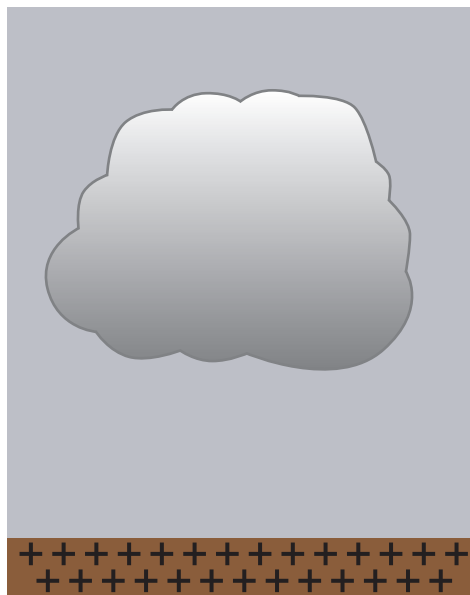(a)   Describe the process that allows thunderclouds to build up a large amount of charge.

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(b)   When thunderclouds move, they build up a large charge. The ground has a large positive charge, as shown in the diagram.

(i)   In the diagram below, draw the charge distribution in the cloud.

> If you need to redraw your response, use the diagram on page 11.

(ii)   Discuss how a part of the cloud can be charged, and yet the overall charge of the cloud is neutral.

In your answer include explanations for:

*   electrically neutral
*   insulator
*   charge distribution.

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Lightning occurs when the charge difference is large enough for the charges to move through the air.

Source: www.youtube.com/watch?v=ktsNyfXi0f8

(c)   A lightning strike creates a huge amount of energy. In one particular instance, a lightning strike hits the Auckland Sky Tower, as shown in the picture above, with a current of 20 000 A and a voltage of 500 000 V that lasts 0.1 seconds.

Calculate the energy transferred.

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(d) A lightning rod is a metal rod mounted on a structure designed to protect the structure from a lightning strike.

Discuss how a lightning rod works.

In your answer you should include:

- how the lightning rod is charged, and discharged

- why lightning rods are made of metal

- how this protects the structure.

**QUESTION TWO: DC ELECTRICITY – SIMPLE DC CIRCUITS WITH RHEOSTATS**

Thomas is learning about Ohm's law at school. He is asked to set up a simple series circuit, as is shown below. In the circuit there are a 12 V variable power supply, an ammeter in series, a voltmeter connected in parallel, a rheostat, which is a variable resistor used to control the electric current, and a closed switch.
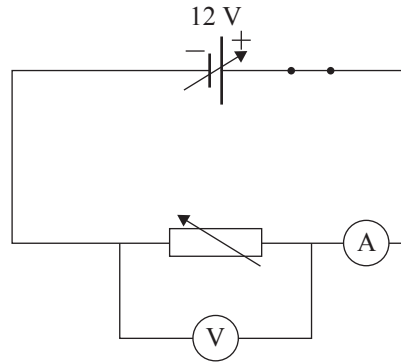
(a)   Thomas decides to increase the voltage at 2 V intervals up to 12 V, while keeping the rheostat resistance the same.

Using Ohm's law, describe what happens to the current when the voltage is increased.

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(b)   When Thomas increases the variable power supply to 12 V, he sees that the ammeter reads 1.6 A.

Calculate what the current would be at 2 V.

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(c) Thomas is now asked to create a simple parallel circuit. He adds another path for the current to travel, but forgets to add the light (resistance), and inadvertently creates what is known as a short circuit.

Short circuit

Discuss, using Ohm's law, how a short circuit affects the circuit when Thomas closes the switch.

Your answer should include:

* what the reading on the voltmeter will be
* why the overall current in the circuit increases dramatically
* why the rheostat is no longer able to control the current.

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(d) Rheostats are made from a high resistance wire such as nickel-chromium. Thomas wants to make his own rheostat, but has only copper wire, which has a much lower resistance than nickel-chromium.

Discuss why using copper, instead of nickel-chromium, is a safety hazard.

In your answer explain how using an equal length of copper wire would affect:

- how well the rheostat works

- the current and voltage in the circuit

- how this could be a safety hazard.

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QUESTION THREE: SOLENOIDS

(a)   A solenoid is a long, thin loop of wire which produces a magnetic field when an electric current is passed through it.

Below are two solenoid diagrams, one with air in the middle, and the other with a magnetisable metal.

Draw the respective magnetic fields on the diagrams below, using the right-hand grip rule, and label the north and south poles in the circles provided.
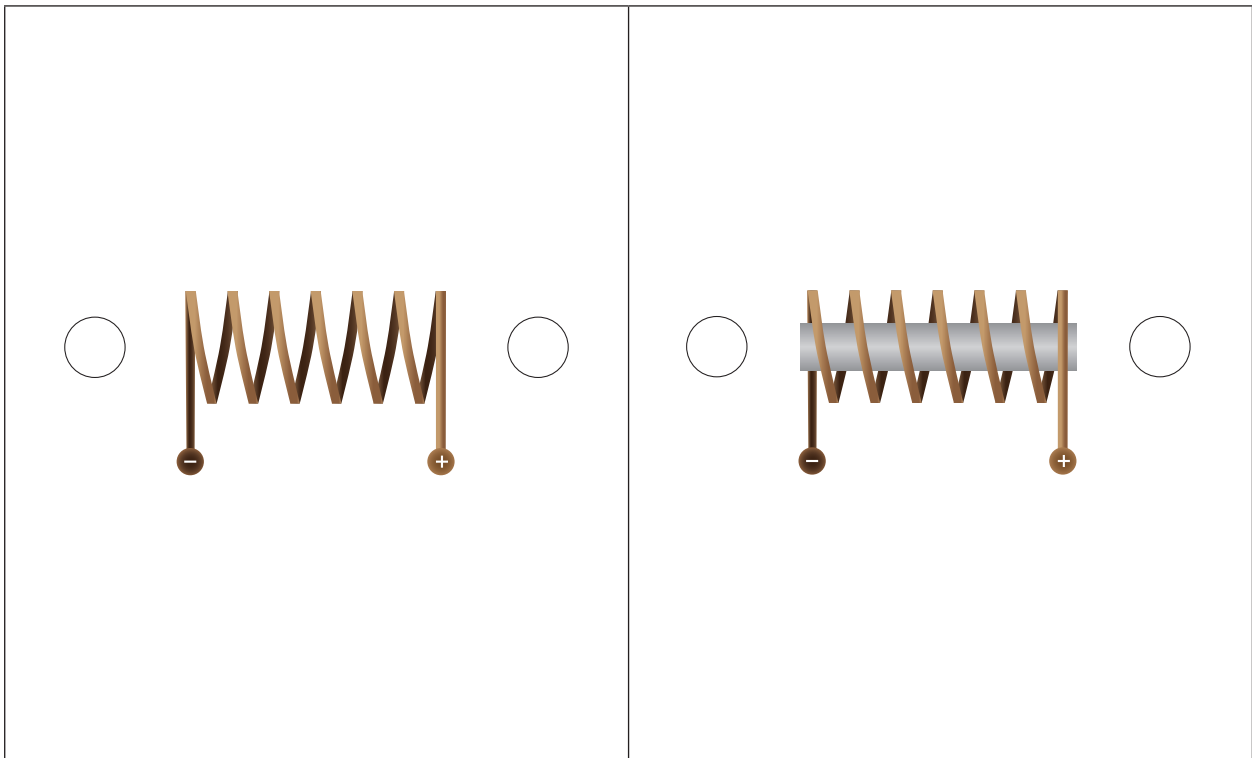
(b)   Often a solenoid is wrapped around a magnetisable metal such as iron.

If you need to redraw your response, use the diagram on page 11.

What is the purpose of adding a magnetisable metal to the solenoid?

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(c) A direct acting solenoid valve is a device that can start the flow of a liquid or gas by applying an electric current to the solenoid with a moveable iron 'plunger' in the middle.

Using the diagram below, discuss how the solenoid valve works when an electric current is applied.

Adapted from: www.researchgate.net/publication/344666093_
Concept_study_of_a_piston_pump_based_on_ferrofluid_manipulation

Your answer should include:

• why the 'plunger' is made of iron

• what happens to the plunger when the electric current is turned on and off

• what happens to the liquid when the current is on.

(d) A magnetic field sensor can be used to detect the magnetic field strength along a wire.

A sensor is placed near a straight part of the wire leading to the solenoid that has a current of 0.67 A. The sensor reads a magnetic field strength of 44.6 µT, (44.6 × 10⁻⁶ T).
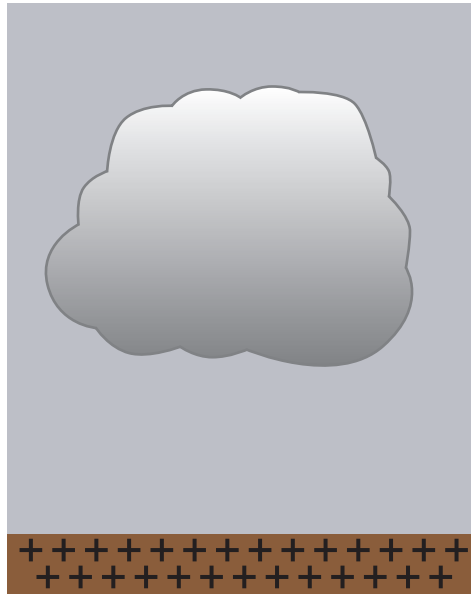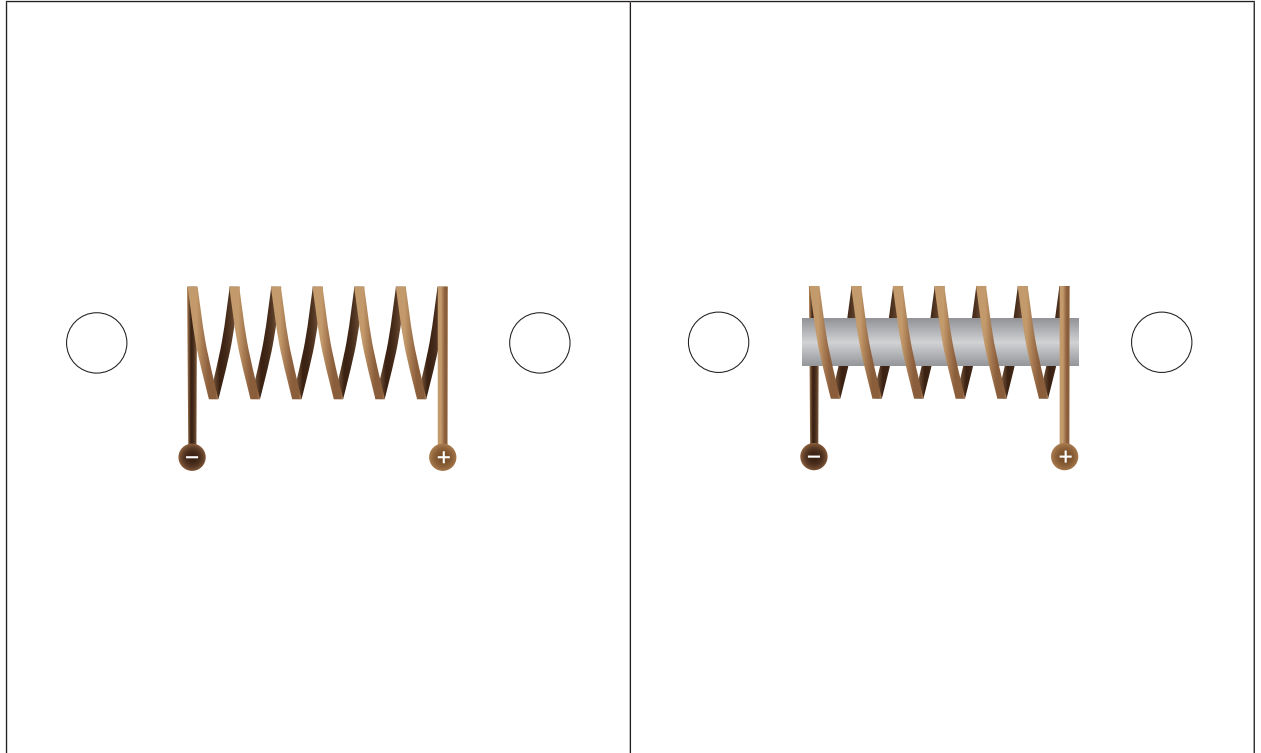
Calculate the distance between the sensor and the wire.

SPARE DIAGRAMS

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

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

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

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