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NZQA

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# Level 1 Physics, 2018

## 90937 Demonstrate understanding of aspects of electricity and magnetism

2.00 p.m. Friday 23 November 2018
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 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.**

**TOTAL**

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## QUESTION ONE: VAN DE GRAAFF GENERATOR

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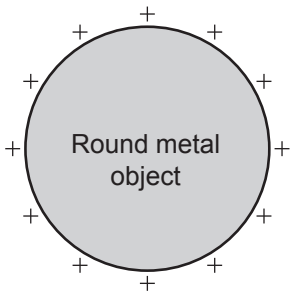
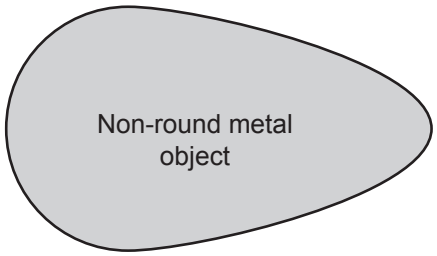
(a) Below are two **positively** charged metal objects. The round object has charge evenly distributed over the surface, as shown.

Draw the charge distribution to show how the positive charges are distributed along the surface of the non-round metal object.

*If you need to redraw this, use the diagram on page 11.*




(b) Explain why copper is a good conductor of electricity, whereas glass is a poor conductor of electricity.

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A Van de Graaff generator is an electrostatic generator that uses a moving belt to accumulate electric charge on a hollow metal globe, which sits on the top of an insulated column. The largest air-insulated Van de Graaff generator in the world was built in the 1930s. It is now on display at Boston's Museum of Science.

The Van de Graff generator can generate 2.0 MV ($2.0 \times 10^6$ V). During a demonstration, a spark was measured to last for 0.001 s. The spark carried 100 kJ ($1.0 \times 10^5$ J) of energy.

https://en.wikipedia.org/wiki/Van_de_Graaff_generator#/media/File:Boston_Museum_of_Science,_Theater_of_Electricity.jpg

(c) (i) Calculate the amount of current that flows during the spark.

(ii) Electrical currents above 100 mA are extremely hazardous for humans.

Explain whether or not the current created by this demonstration is safe.

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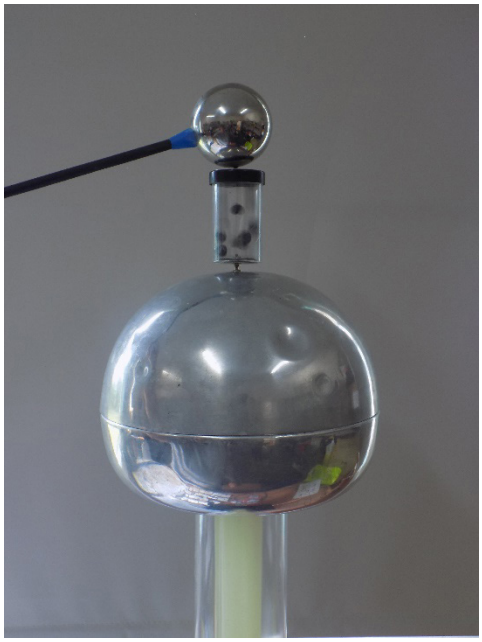
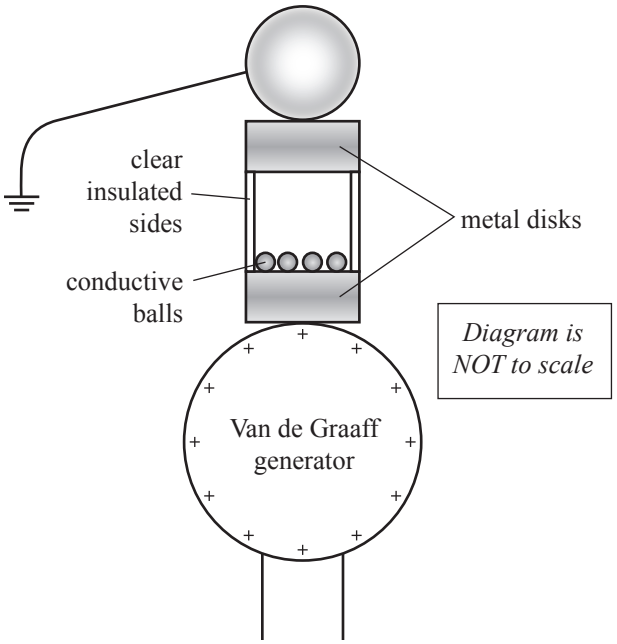
(d) A smaller Van de Graaff generator is used for a class activity. The teacher places a container of conductive balls onto the top of the Van de Graaff generator, as shown in the picture. The top and bottom of the container contain metal discs. They then touch the ground sphere against the top of the container. The conductive balls start to bounce back and forth between the top and bottom metal discs. This is called a Volta Hailstorm.

Explain why the balls bounce back and forth between the discs.

As part of your answer you should:

- explain why the balls initially move towards the top disc
- explain why the balls then fall back down.





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## QUESTION TWO: POWER STRIP

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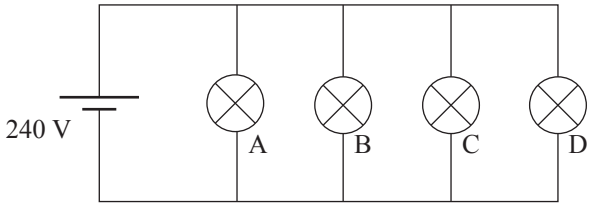
Andrew is a DJ, and often needs multiple plugs to power his equipment and lights. Andrew plugs the power strip, as seen at right, into a wall outlet that provides 240 V. He then plugs in four identical lights each with a power of 60 W. A power strip is always wired in parallel.

(a) Describe why a power strip must be wired in parallel.

(b) Andrew connects four identical 60 W lights in parallel with a 240 V DC power supply to test them, as shown in the diagram below.




*all lights are identical*

Show by calculation that the current through one of the lights is 0.25 A.

(c) Bulb C is replaced by an energy-efficient light that has a lower power rating than the original light, but has the same brightness.

Explain whether the energy-efficient light bulb has a higher or lower resistance than the original light.

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(d) Andrew decided to replace all four lights with energy-efficient light bulbs. When this happened, the total current for all four lights was 0.20 A.

Calculate the electrical energy used by ONE energy-efficient bulb over a period of two hours, AND compare this with the energy used by ONE 60 W light bulb over two hours.

## QUESTION THREE: RELAY SWITCHES

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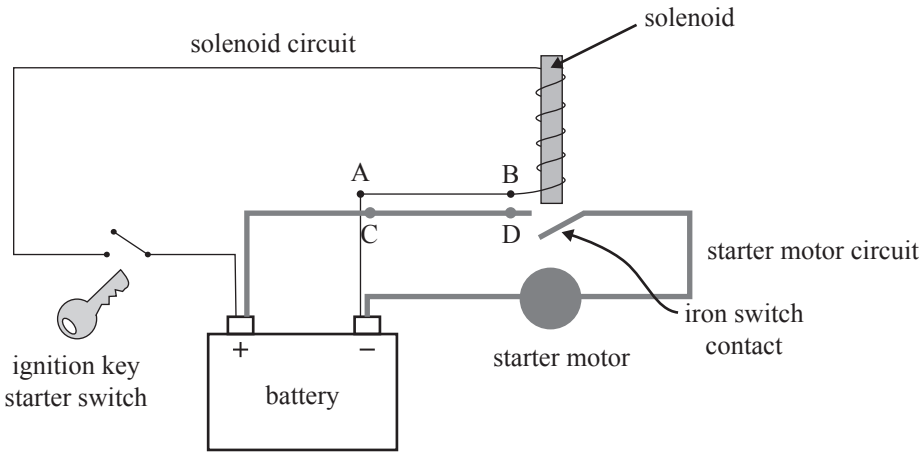
A car starter motor is operated by two separate circuits; the solenoid circuit which has a small current flowing through it; and the starter motor circuit which has a large current flowing through it. A relay switch consists of a solenoid placed near an iron switch contact. The iron switch contact is used to operate the starter motor. The diagram below shows the two circuits.




(a) (i) On the diagram above, label the magnetic south pole on the solenoid when the ignition switch is closed.

(ii) State the name of the rule you used to determine where the south pole is located.

(b) Explain how closing the ignition switch turns the starter motor on.

As part of your answer you should explain what occurs in the solenoid, and in the iron switch contact, when the ignition switch is closed.

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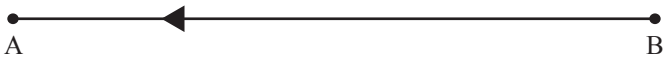
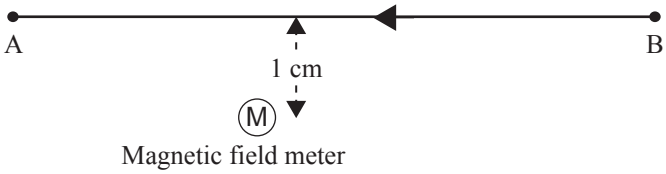
(c) Below is section AB of the solenoid circuit.

Draw the direction of the magnetic field produced by section AB, both above and below the wire, when the current is flowing in the solenoid circuit.

*If you need to redraw this, use the diagram on page 11.*




(d) A magnetic field meter is placed 1 cm away from the wire to measure the strength of the magnetic field, as shown.




(i) The magnetic field meter measured the strength of the magnetic field produced by section AB to be 40 μT ($4.0 \times 10^{-5}$ T) at a distance of 1.0 cm from the wire.

Calculate the current in section AB of solenoid circuit.

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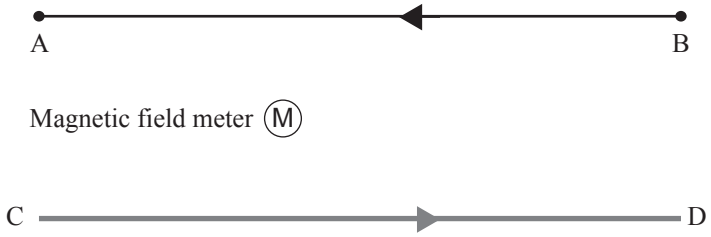
(ii) When the starter motor is operating, current also flows through the wire CD in the starter motor circuit. The wire CD is below the magnetic field meter, as shown. The current in CD flows in the opposite direction to the current in AB, as shown below.

Explain how the current through the wire CD affects the magnetic field strength in the region between the two wires.

Start by drawing the direction of the magnetic fields above and below each wire.

*If you need to redraw this, use the diagram on page 11.*



## SPARE DIAGRAMS

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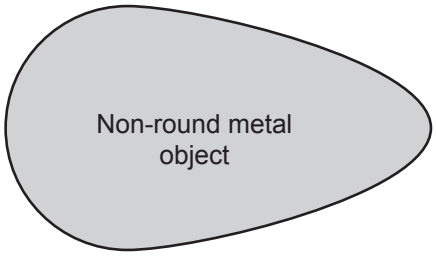
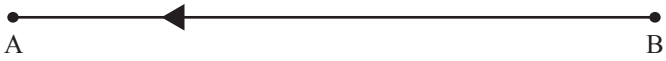
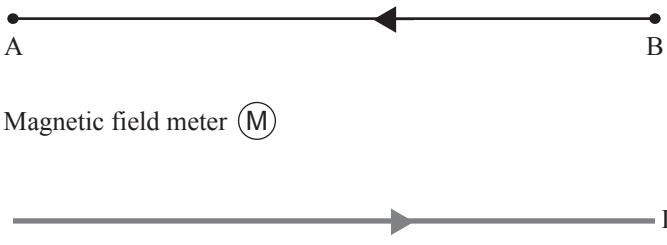
If you need to redraw your diagram from Question One (a), draw it below. Make sure it is clear which answer you want marked.




If you need to redraw your diagram from Question Three (c), draw it below. Make sure it is clear which answer you want marked.




If you need to redraw your diagram from Question Three (d)(ii), draw it below. Make sure it is clear which answer you want marked.



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

QUESTION NUMBER

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