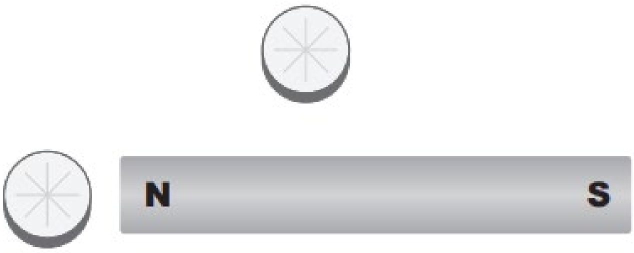
Demonstrate understanding of aspects of electricity and magnetism

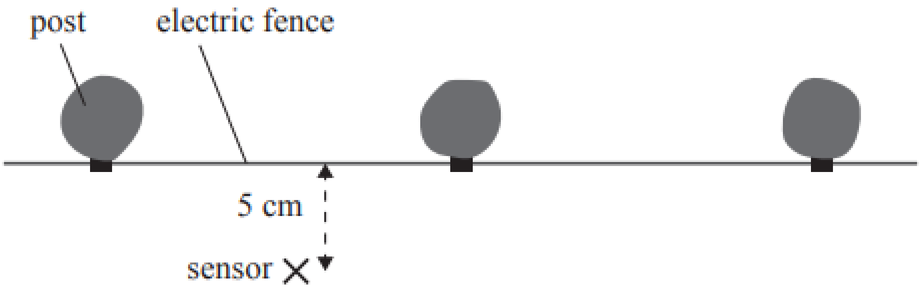
Electromagnestism

2020:3

(a) Bringing a compass close to a magnet will move the needle of the compass in the direction of the magnetic field. Draw the direction of the plotting compasses with arrows to represent the needle of the compass while in the positions shown below.



(b) Electric fences are used extensively around New Zealand to keep livestock in their paddocks. An electric fence sends pulses of current through the wire. The wire is attached to the post using a plastic clip, as shown. When the current flows through a wire, it creates a magnetic field. When a sensor was placed 5 cm from the wire, it was found to have a magnetic field strength of 80 nanotesla (8.0×10^{-8} T)

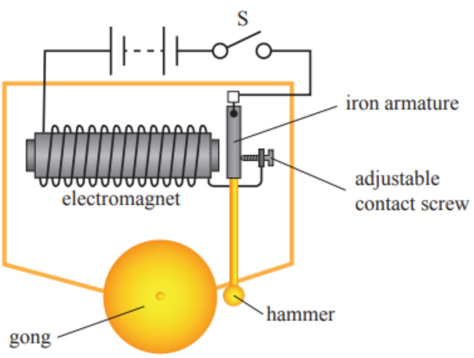


(i) Calculate the current in the wire.

(ii) A typical electric fence has a current of 30 mA (30×10^{-3} A).
Explain whether you would need to increase, decrease, or keep the same voltage so the current is that of a typical electric fence.

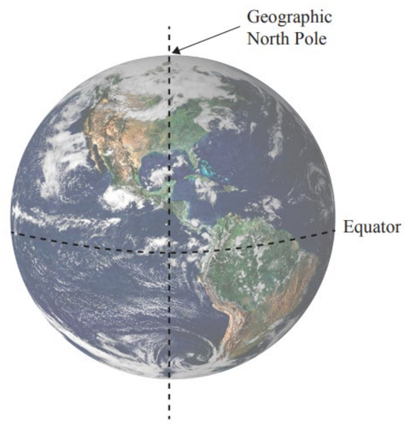
(c) Explain why the clip that attaches the wire to the post is made from plastic, and what might happen if the wire was attached directly onto the wooden fence post.

(d) The schematic diagram below shows the circuit of an electric bell. The electric bell makes a repetitive sound by the hammer continually hitting the gong.
Explain the process that causes the hammer to continually hit the gong when the switch is closed.



2019:3

(a) Use the diagram to draw the shape of the Earth's magnetic field, including arrows to show the direction of the magnetic field.



(b) Describe TWO differences between the Earth's magnetic field near the Geographic North Pole and the Earth's magnetic field near the Equator.

(c) A current-carrying wire, wire A, is shown below. The diagram below shows a cross-section of wire A, with current flowing "into the page".

(i) Complete the diagram to show the shape and direction of the magnetic field near wire A, due to the current in the wire.

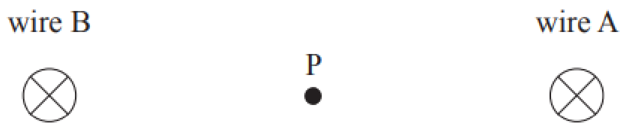
(ii) Wire A has a constant current of 0.20 A flowing through it. At point P, the magnetic field due to the current in the wire is 8.0 × 10–7 T. Calculate the distance, d, between point P and wire A.

(d) A second wire, wire B, is located on the opposite side of point P, as shown below. Wire B carries a different current to wire A.
At point P, the magnetic field strength due to the current in wire A is 8.0×10^{-7} T, and the magnetic field strength due to the current in wire B is 6.5×10^{-6} T.

Calculate the strength and direction of the combined magnetic field at point P.
As part of your answer you should:

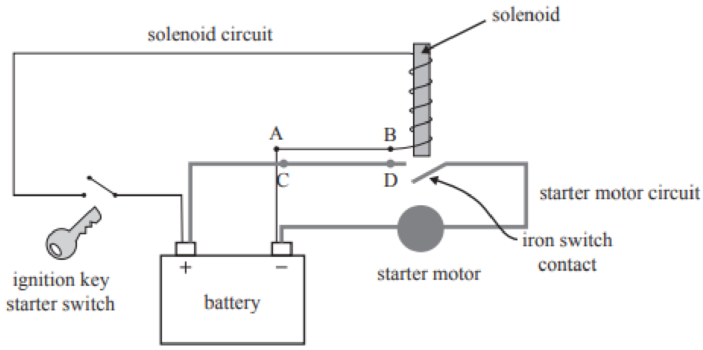
- compare the strength and direction of the magnetic field produced by wire A and the magnetic field produced by wire B, at point P
- explain how these two magnetic fields determine the strength and direction of the combined magnetic field at point P
- calculate the strength, and state the direction of the combined magnetic field at point P.

You may use the diagram below to show the interactions of the two magnetic fields.



2018:3

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.



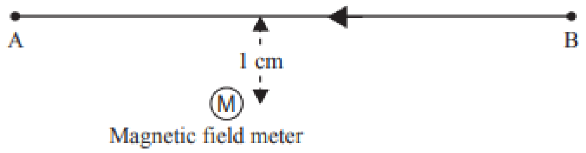
(a) (i) On the diagram above, label the magnetic south pole on the solenoid when the ignition switch is closed.

(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.

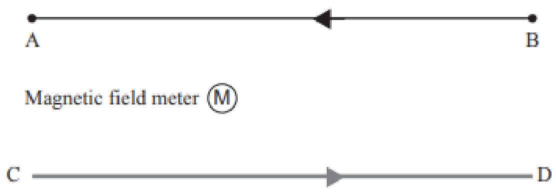
(c) Below is section AB of the solenoid circuit. Draw the direction of the magnetic field produced by section AB, both above and below the wire, when the current is flowing in the solenoid circuit.

(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 (4.0×10^{-5} T) at a distance of 1.0 cm from the wire.
Calculate the current in section AB of solenoid circuit.

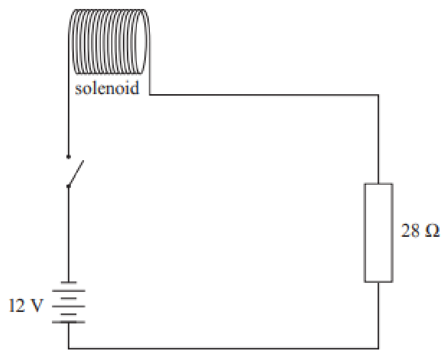
(ii) When the starter motor is operating, current also flows through the wire CD in the starter motor circuit. The wire CD is below the magnetic field meter, as shown. The current in CD flows in the opposite direction to the current in AB, as shown below. Explain how the current through the wire CD affects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



2017:3

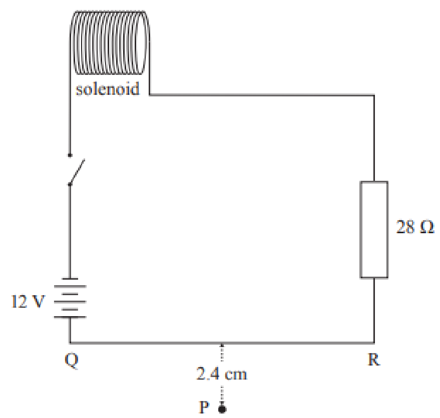
A magnetic door lock consists of a solenoid attached to the door frame and a plate attached to the door. A simplified diagram of the solenoid circuit is shown below.

(a) When the switch is closed, current flows through the solenoid, which produces a magnetic field. On the diagram above sketch the shape and direction of the magnetic field produced by the solenoid. Label the north and south poles of the solenoid.



(b) The resistance of the solenoid is negligible in this circuit. Show that when the switch is closed, the current in the circuit is 0.43 A.

(c) Point P is far enough away from the solenoid that the magnetic field from the solenoid is insignificant. However there is still a magnetic field, due to the current along the wire between Q and R.



Calculate the size and state the direction of the magnetic field at point P, due to the current in the wire between points Q and R.

(d) When used in a door lock, the solenoid has a core and the door plate is near the end of the solenoid. The door plate and solenoid core are made of the same material.
Explain how the door can be locked using this system.
In your answer you should:

- state whether opening or closing the switch locks the door
- describe how doing this locks the door
- name a suitable material for both the door plate and solenoid core, and explain why this material is suitable.