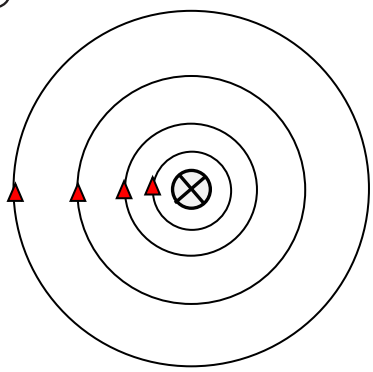
2021 Sec 4 Physics Chapter 18

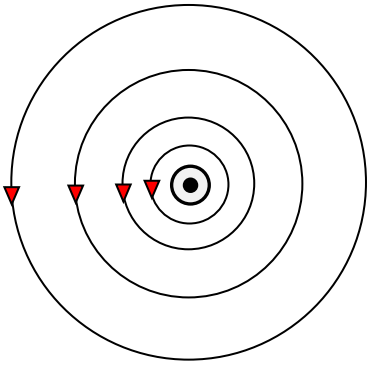
Electromagnetism- ANSWERS

18.1.1

(a)

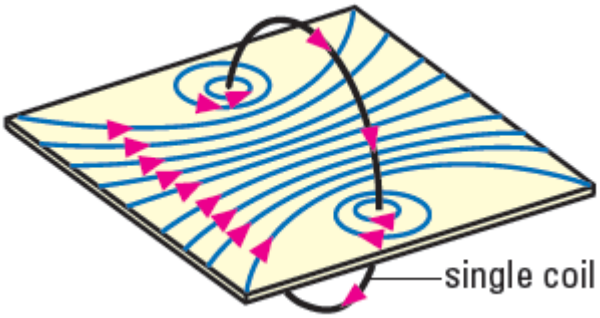


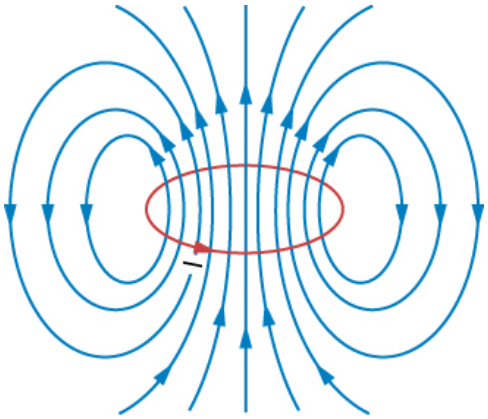
(b)



18.1.2

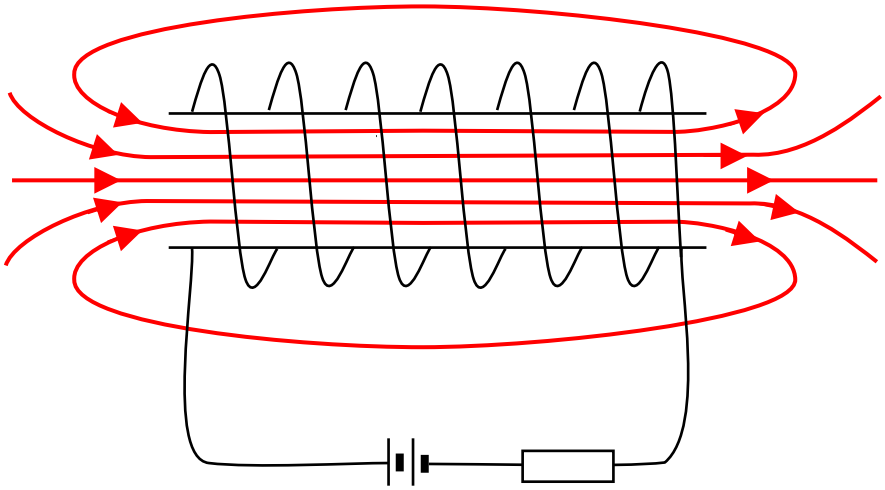
For reference:



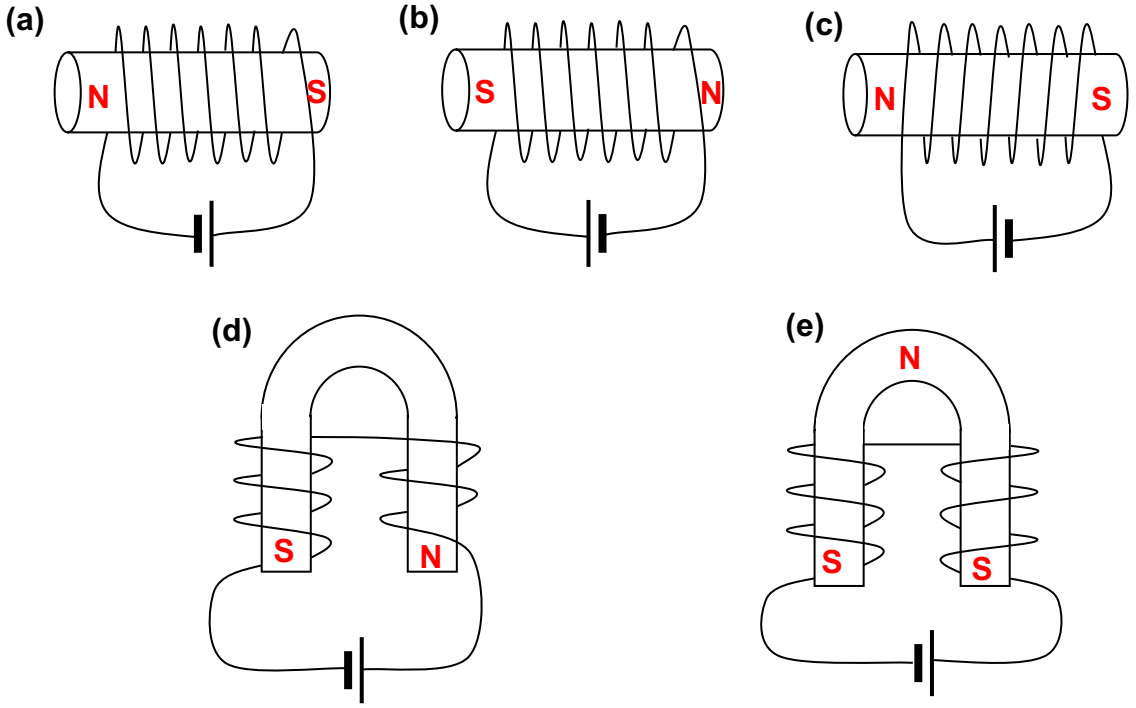


https://cnx.org/contents/A6AqGAGN@7/Magnetic-Field-of-a-Current-Loop

18.1.3



Example 18.1



Example 18.2

(a) **P:** south pole **Q:** north pole Note: spell poles, do **NOT** write "N"or "S"!

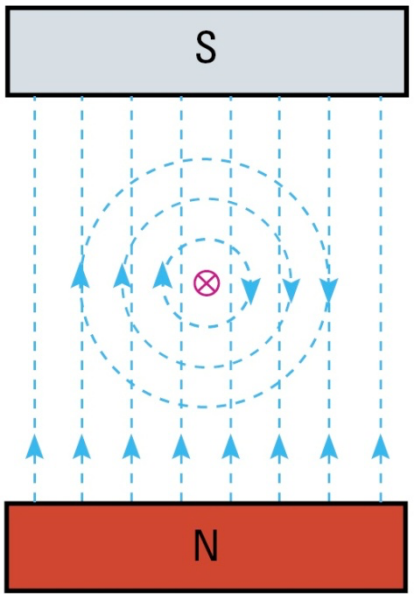
(b)

- The electromagnet is magnetised and attracts the soft iron armature, causing the hammer to strike the gong.
- As the hammer moves towards the gong, the circuit is broken and the electromagnet loses its magnetism.
- The springy metal strip pulls back the armature, connecting the contacts and closes the circuit. The cycle of the hammer striking the gong is repeated.

Example 18.3

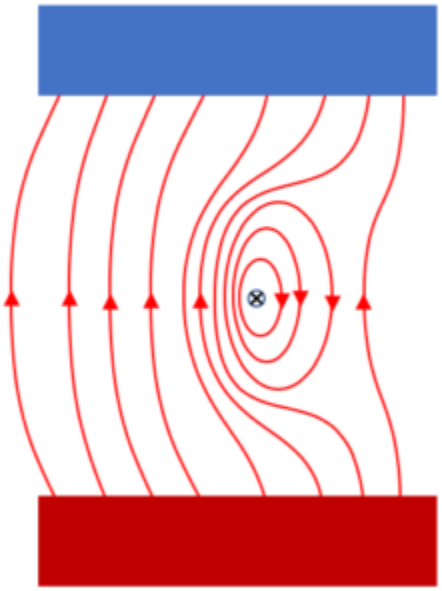
- A large current increases the strength of the electromagnet sufficiently to attract the iron catch towards it.
- The iron catch rotates about C towards the electromagnet.
- This causes the spring X to pull the springy metal upwards, break the contact and open the circuit.

Example 18.4



⊗ = wire with current flowing into the paper

Fig. 18.3(a)



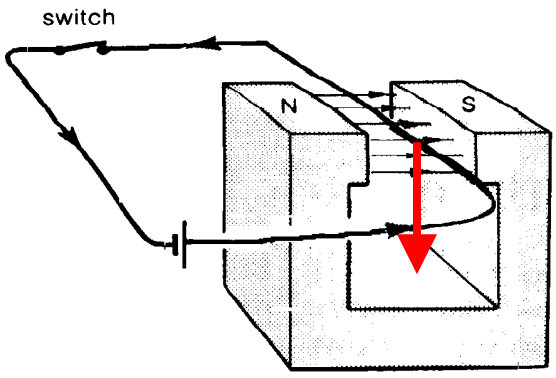
**add missing arrows in*

Fig. 18.3(b)

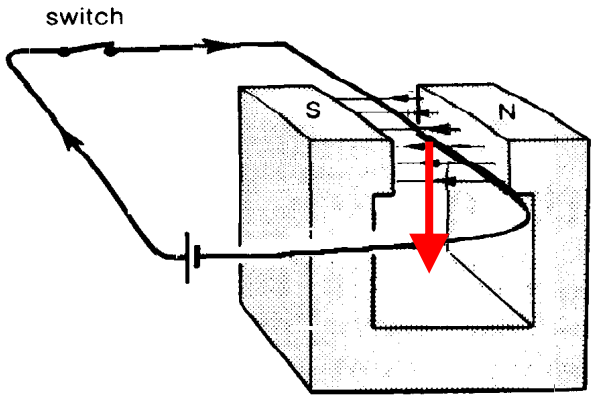
Note: field lines to be drawn with continuous lines!

Example 18.5

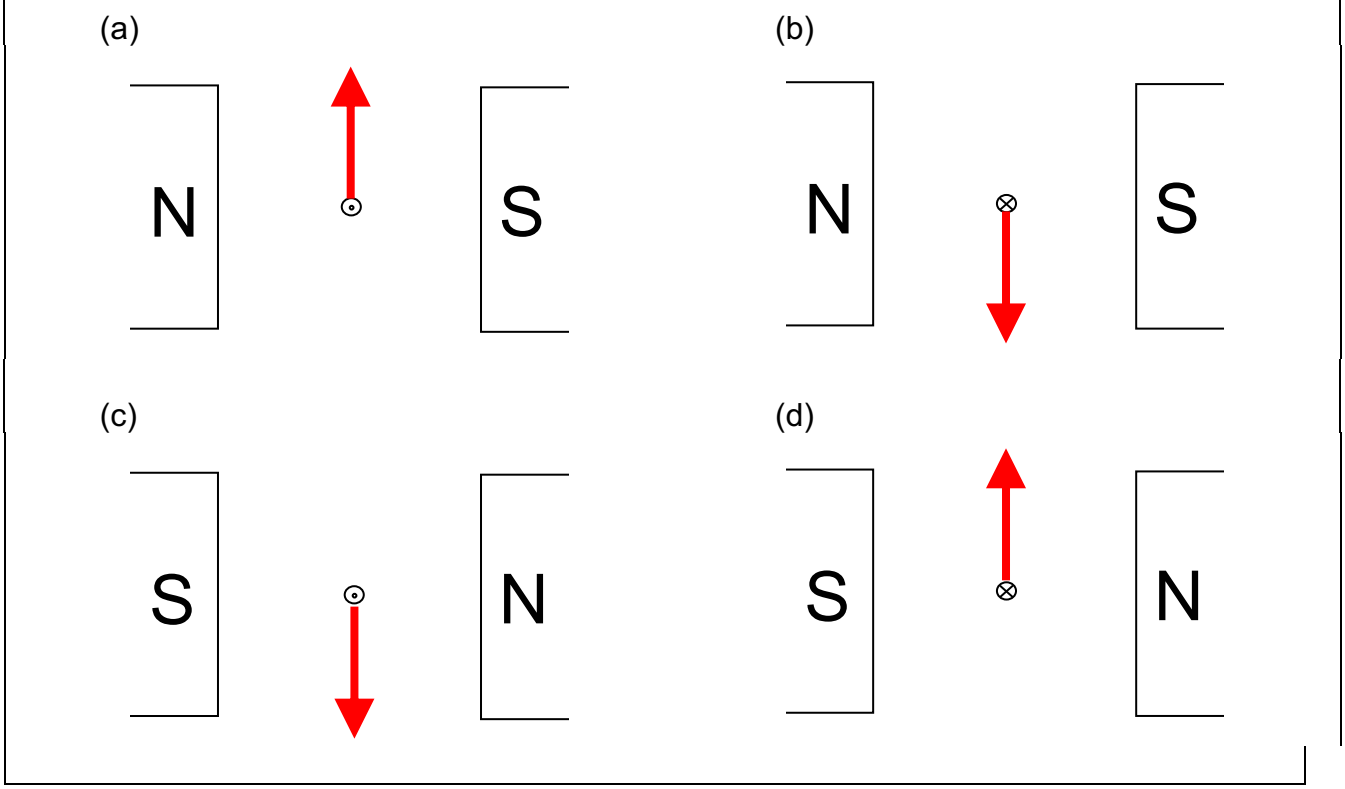
(a)



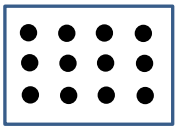
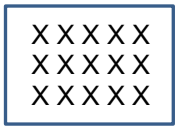
(b)



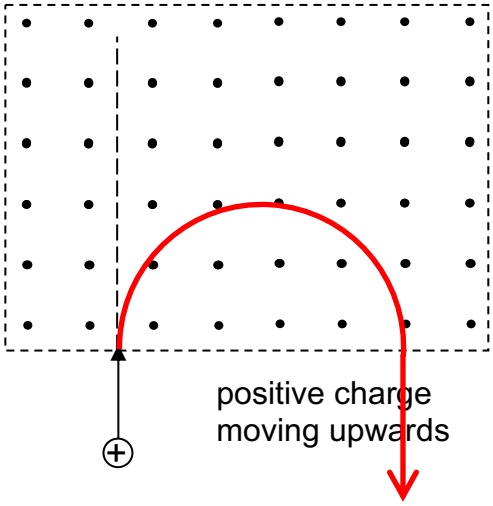
Example 18.6



18.4

	Symbols to represent physical quantity	
direction	**Current in a wire**	**Magnetic field pattern**
out of paper	Dot in a circle 	Equally spaced dots in a region 
into paper	Cross in a circle 	Equally spaced crosses in a region 

Example 18.7



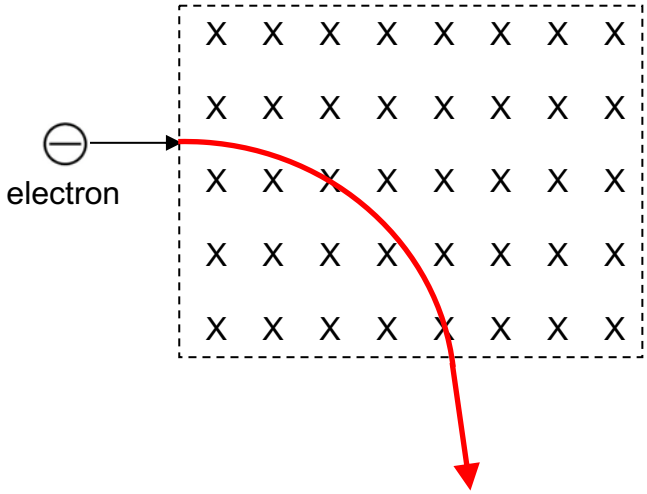
The magnetic field is out of the page and confined to the box.

Shape of path: arc of a circle in field, straight line outside field

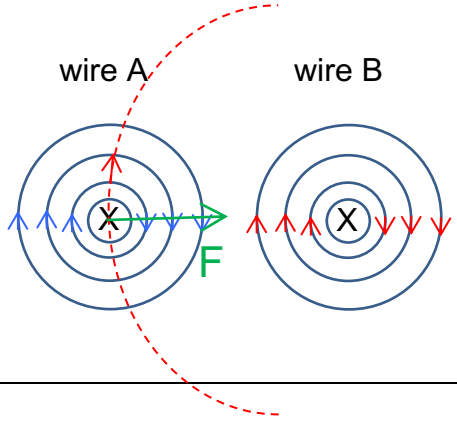
How would the resultant path change for a negatively charged particle?

The circular path will curve towards the left. It would be straight once outside the field

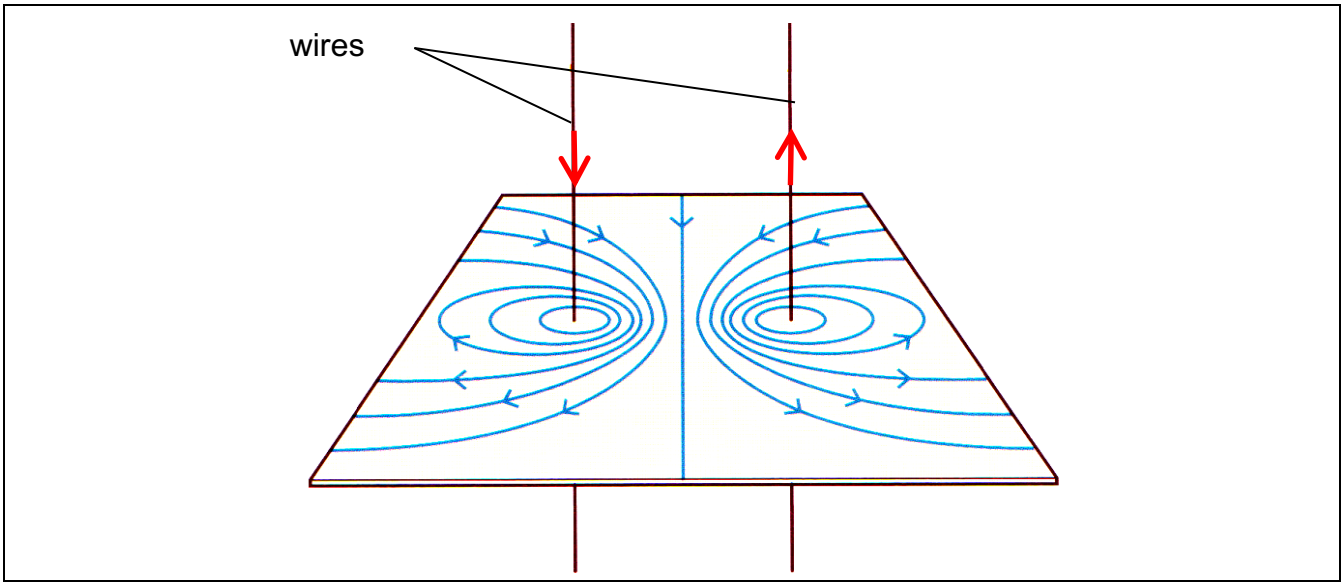
Example 18.8



18.5

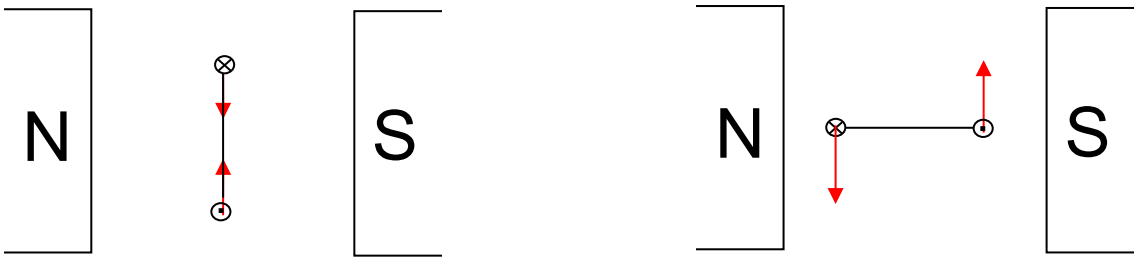


Example 18.9



Conclusion: "Like" currents attract ; "unlike" currents repel

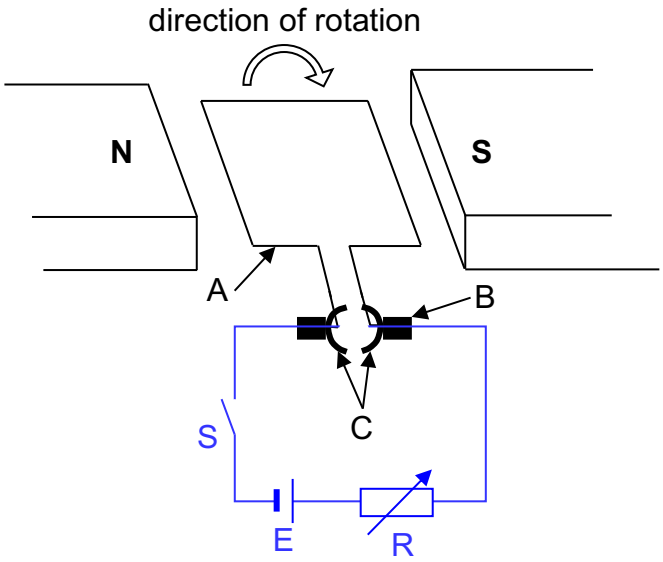
18.61



Net moment : zero
Net force : zero

Net moment : maximum
Net force : zero

Example 18.10



(a) A: rotating coil B: carbon brush C: split ring commutator

(b) ***Note****: the polarity of the cell E must be consistent with the current direction needed to give the clockwise rotation of the coil.*

(c)

- A force acts upwards on the left side of the coil and another force downwards on the right side, to give it a clockwise moment to rotate in the clockwise direction.
- When the coil passes the vertical plane, the split ring commutator swap contact with the carbon brushes. This causes the direction of current flowing in the coil to reverse and hence the forces reverse direction as well.
- Hence, the coil is able to rotate continuously in the clockwise direction.

(d)

- When the resistance of R decreases the current flows through the coil will increase (Ohm's Law).
- This will increase the speed of rotation of the motor as the forces (and hence the torque/turning moment) acting on the coil are increased.

(e)

1. Increase the number of turns in the coil
2. use a cell with a higher e.m.f. to provide a larger current through the coil

Example 18.11

(a)i) Upwards for AB and downwards for CD.

(ii) Given the directions of the magnetic field and current in each side of the coil, use Fleming's left hand rule to determine the direction of the forces.

(b)(i) Remains upwards for AB and downwards for CD.

(ii) When the coil makes a 180° turn, as the force on AB remains upwards.
Hence an opposite moment is produced which prevents the coil from rotating continuously.

Note: There is ***no*** *resultant force on the coil!*

(c) When the coil rotates until the insulated part of the wire is below and makes contact with the paper clip, the current will be cut off. However, the momentum (or inertia) of wire AB causes it to continue to rotate in the same direction.

Half a cycle later, the non-insulated part of the wire makes contact with the paper clip again. Current flows through the coil and forces and a net moment are produced to keep the coil rotating in the same direction.

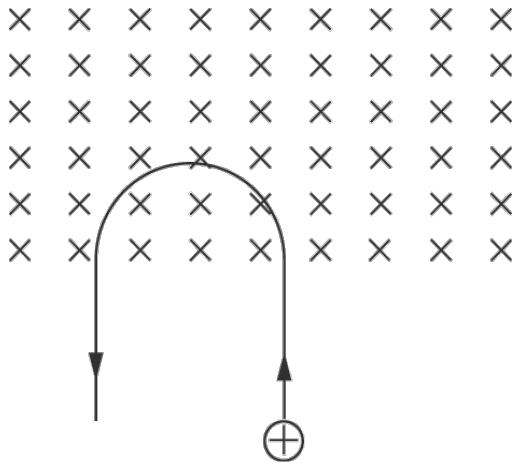
Note: The bare half of the wire does **not** act as a commutator, as current is **not** reversed every half a cycle.

Exercises

1 A **2** B **3** A **4** D **5** C

6(a) No. Because the existence of the magnetic field is due to the motion of electric charges (an electric current).

(b)



7.(a) A small current causes the soft iron core to be weakly magnetised and unable to attract the iron lever upwards. [1]

(b) A large current that exceed the rating of the circuit [1]
will cause the soft iron core to becomes strongly magnetised and be able to attract the iron lever upwards (releasing the metal rod). [1]
The tension in the spring acts to pull the metal rod to the right, separating the contacts and opening the circuit. [1]

(c) Soft iron core is no longer magnetised and does not attract the iron lever. [1]
The spring keeps the metal rod to the right and the iron lever drops to rest on top of the metal rod. Contacts remain opened. [1]

(d) By pressing the reset button, it pushes the metal rod to the left which fits back into the notch in the iron lever. This brings the contacts together again. [1]