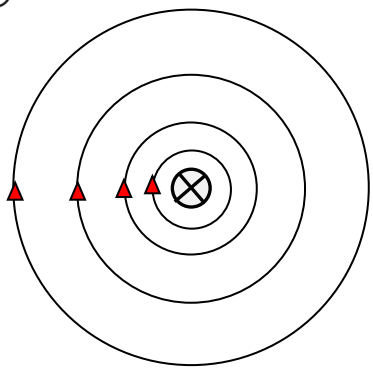
2026 Sec 4 Physics Chapter 18

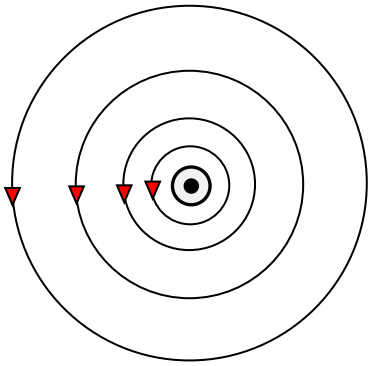
Electromagnetism- ANSWERS

Example 1

(a) (i)



(a)(ii)

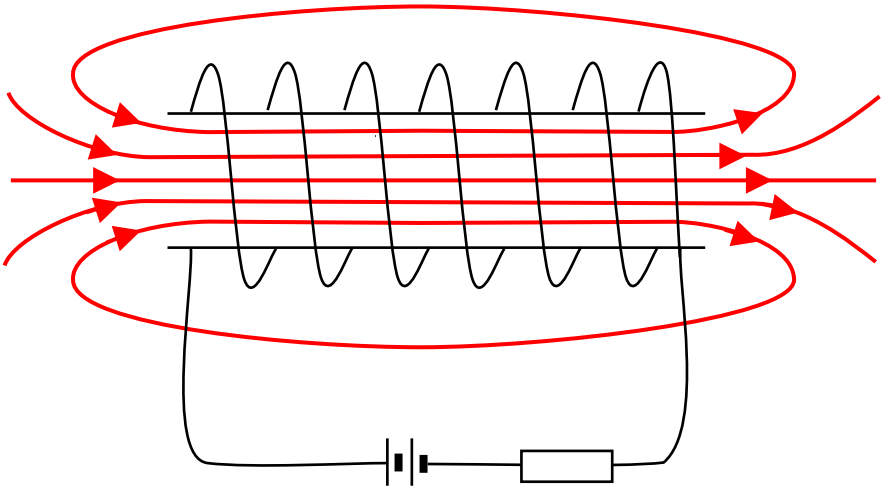


(b) The spacing between the field lines increases as the field lines are further from the wire. This is because the field is weaker further from the wire.

(c) Similarity: The field pattern remains as concentric rings around the wire OR the spacing between the concentric rings increases as the distance of the field lines from the wire increases.
Difference: The spacing between the field lines become smaller as current increases.

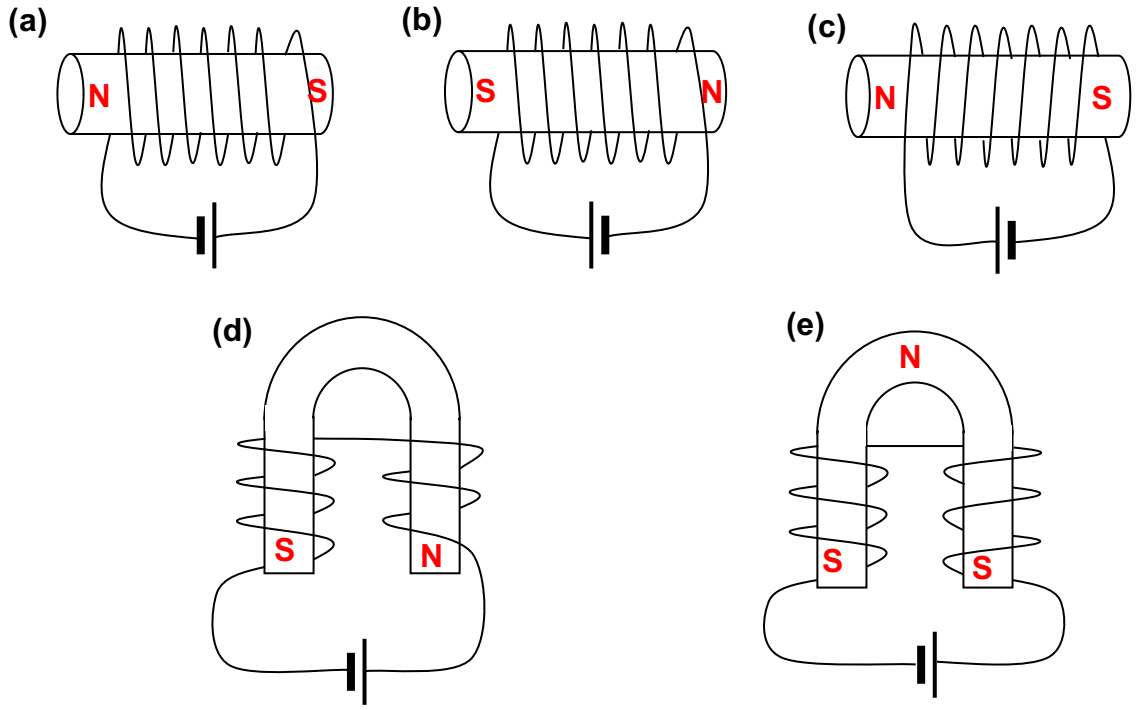
Example 2

(a)



(b) The direction outside the solenoid is from right to left but it is from left to right inside the solenoid.

Example 3



Example 4

(a) P: South Q: North

(b)

- The soft iron cores are magnetised and attract 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 spring pulls back the armature, connecting the contacts and closes the circuit. The cycle of the hammer striking the gong is repeated.

Example 5

1. Under normal conditions, when the switch is turned on, current flows through the solenoid.
2. When the current is below the limit, the magnetic field of the solenoid is weak and does not attract the iron bolt.
3. The solenoid and iron bolt are not in contact. The current flows normally through the circuit.
4. A surge in current occurs when there is a fault.
5. If the surge in current exceeds the limit. The solenoid becomes an electromagnet that is strong enough to attract the iron bolt.
6. As a result, the plastic plunger is free to move upward as the spring around the plunger extends. This action opens the circuit and cuts the flow of current to the home appliances as well as the solenoid

3 (a) the force increases

(b) the direction of the force is reversed

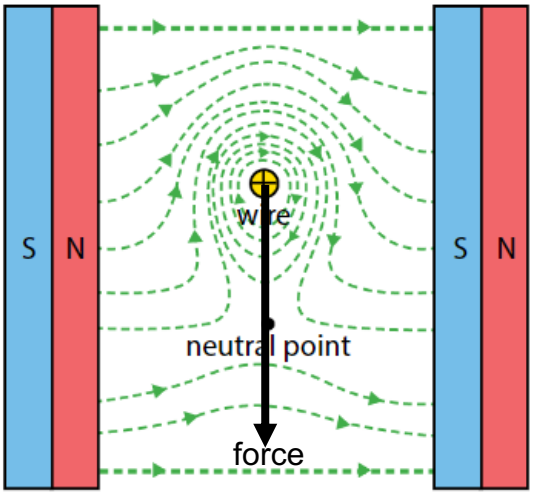
(c) the direction of the force is reversed

Example 6

(a) same direction, opposite direction

(b) stronger, weaker

(c)

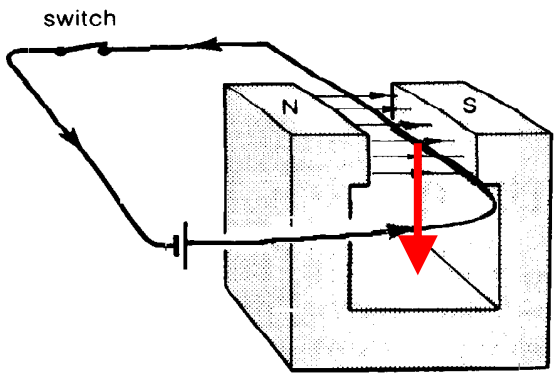


(b) Magnetic field after interaction

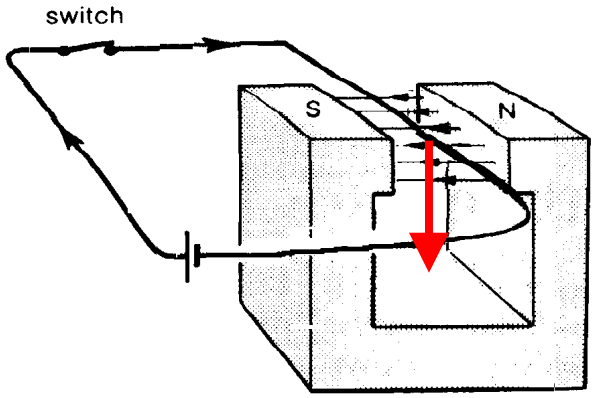
Fig. 6

Example 7

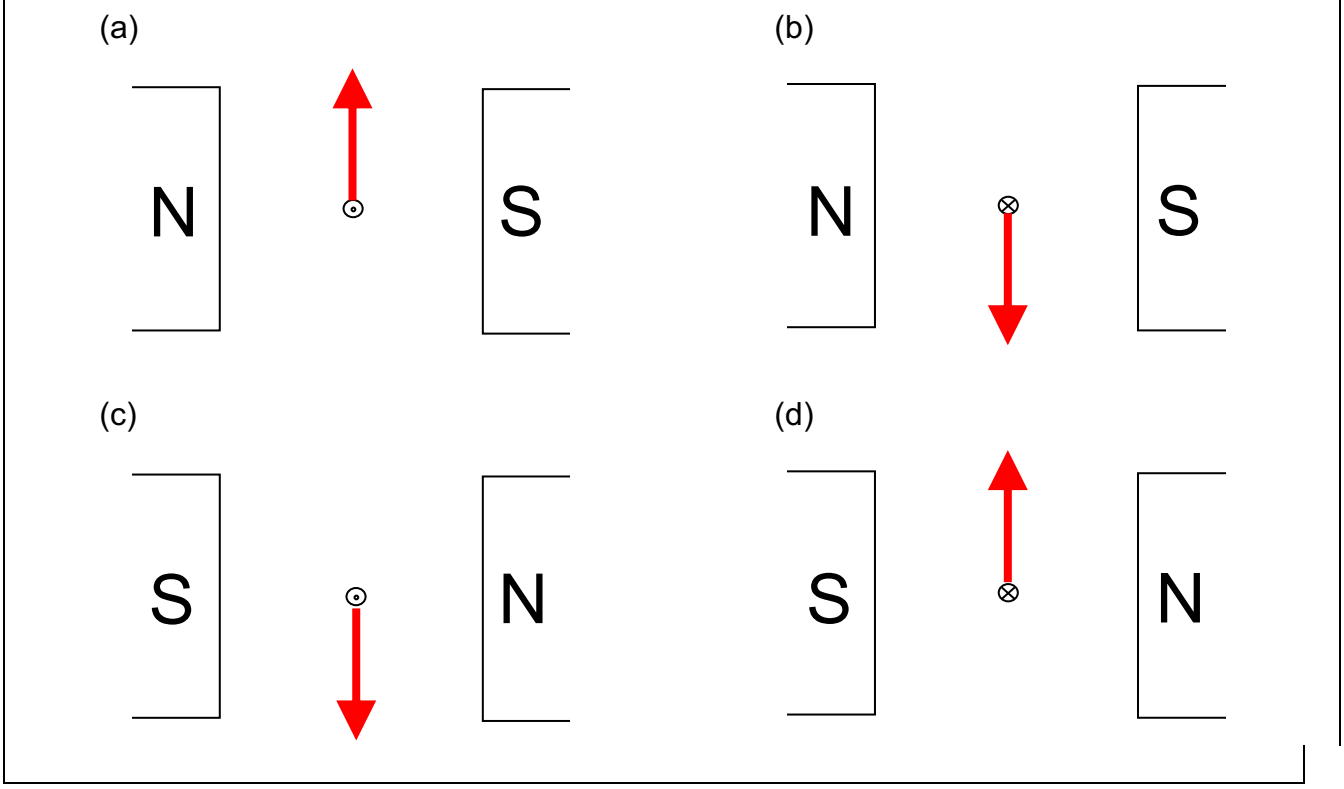
(a)



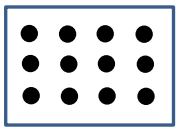
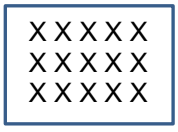
(b)



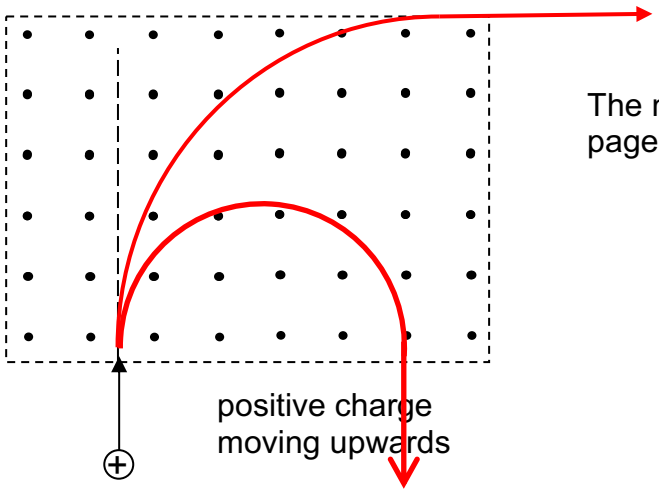
Example 8



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 9



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

(b) Describe the shape of the path or trajectory taken by the positive charge in the field and its path when it leaves the field.

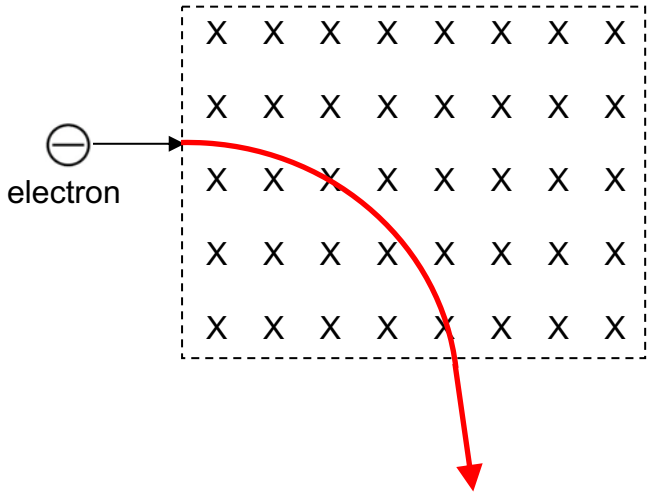
Shape of path: arc of a circle within the field, straight line outside field

(c) Describe the path or trajectory taken if the particle is negatively charged.

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

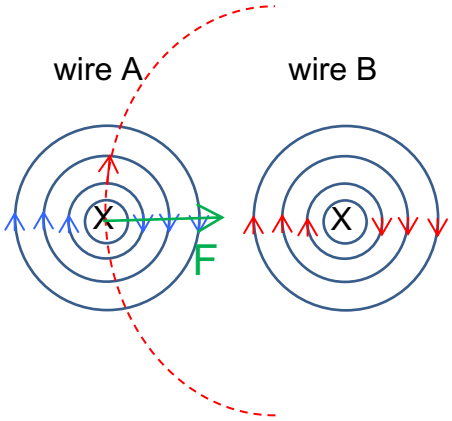
[two possible paths (arcs) with different radii are shown]

Example 10

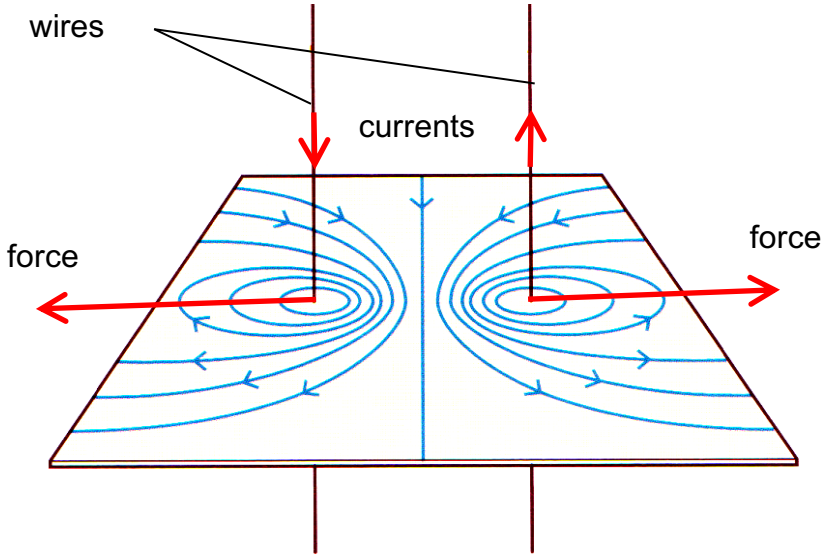


Extension

I

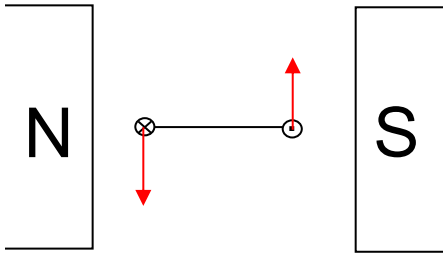
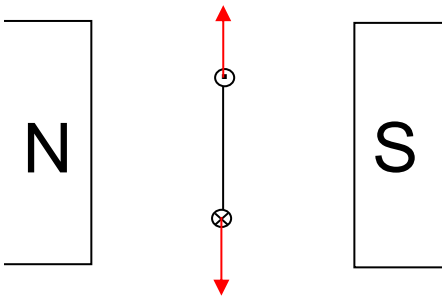
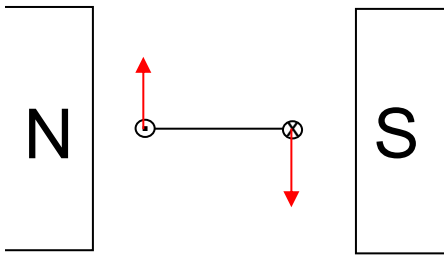
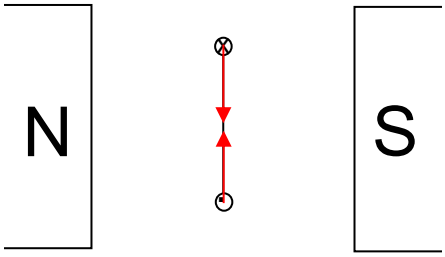


II The field between the wires is stronger than beyond the wires. The mutual repulsion between the closer field lines of the stronger field is greater than for the weaker field. There is a net force acting from the strong to the weak field.

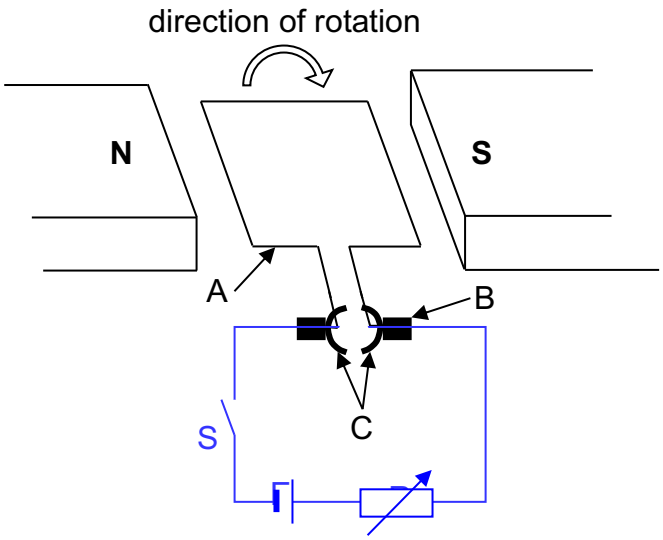


Conclusion: "Like" currents attract ; "unlike" currents repel

5.1 Force on a current-carrying coil (in a magnetic field)

Initial orientation: **the plane of the coil is horizontal**	**After 90° acw rotation:** **the plane of the coil is vertical**
 Net force: zero Net moment: maximum Direction of moment: anti-clockwise	 Net force: zero Net moment: zero Direction of moment: not applicable
After 180° acw rotation: **the plane of the coil is horizontal**	**After 270° acw:** **the plane of the coil is vertical**
 Net force: zero Net moment: maximum Direction of moment: clockwise	 Net force: zero Net moment: zero Direction of moment: not applicable

Example 11



(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 through the coil increases (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 12

(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 190° 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.

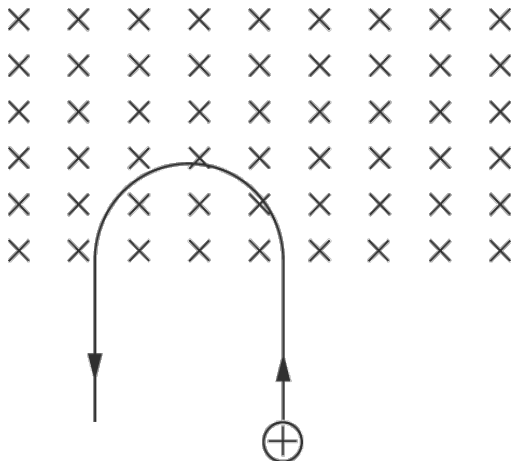
Note: The bare half of the wire does **not** act as a commutator, as current is **not** reversed every half a cycle.

Exercises

1 A **2** B **3** B **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 large current that exceed the rating of the circuit will cause the soft iron core to becomes strongly magnetised and be able to attract the iron lever upwards (releasing the metal rod).
The tension in the spring acts to pull the metal rod to the right, separating the contacts and opening the circuit.

(b) Soft iron core is no longer magnetised and does not attract the iron lever.
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.

(c) 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.