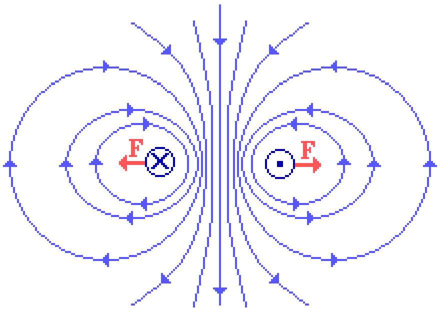
Raffles Institution
Year 5-6 Physics Department

2025 Year 6 H2 Physics Remedial
Chapter 16: Electromagnetism

Suggested Solutions

1 (a) (i)



Opposite direction

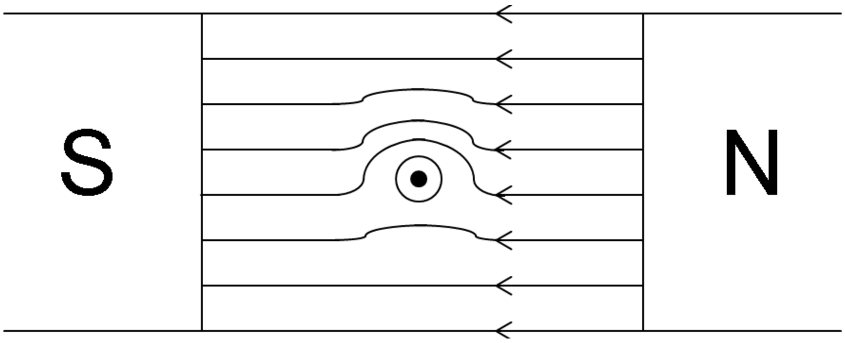
(ii) Magnetic force F on wire X and wire Y as indicated.

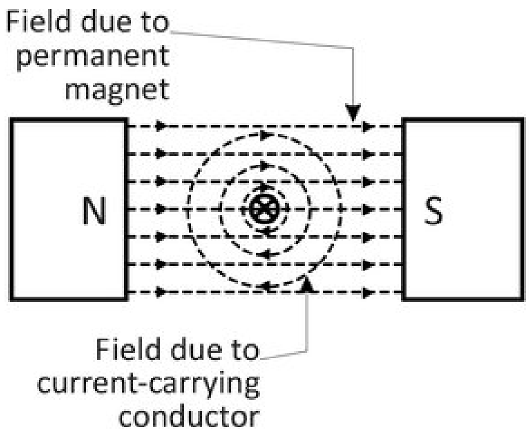
(iii) 1. $B_{X\ due\ to\ Y} = [(4\pi \times 10^{-7})(3.0)] / [2\pi\ (0.10)]$
$= 6.0 \times 10^{-6}$ T

2. $B_{Y\ due\ to\ X} = [(4\pi \times 10^{-7})(5.0)] / [2\pi\ (0.10)]$
$= 1.0 \times 10^{-5}$ T

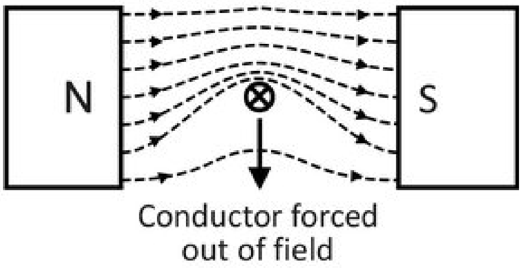
3. Using magnetic force, $F = BIL\sin\theta$,
Magnetic force on wire X, $F_x = (6.0 \times 10^{-6})(5.0)L\sin 90^o$
$= (3.0 \times 10^{-5})L$
Magnetic force on wire Y, $F_Y = (1.0 \times 10^{-5})(3.0)L\sin 90^o$
$= (3.0 \times 10^{-5})L$
Since the two wires are equal in lengths, F_x and F_Y are equal in magnitude.

(b) (i)





(a) Individual Fields



(b) Combined Fields Causing Force on Conductor

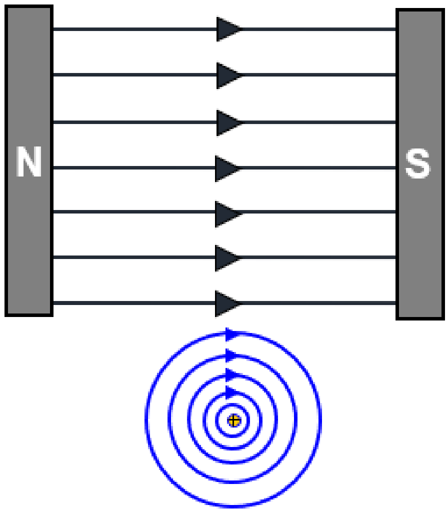
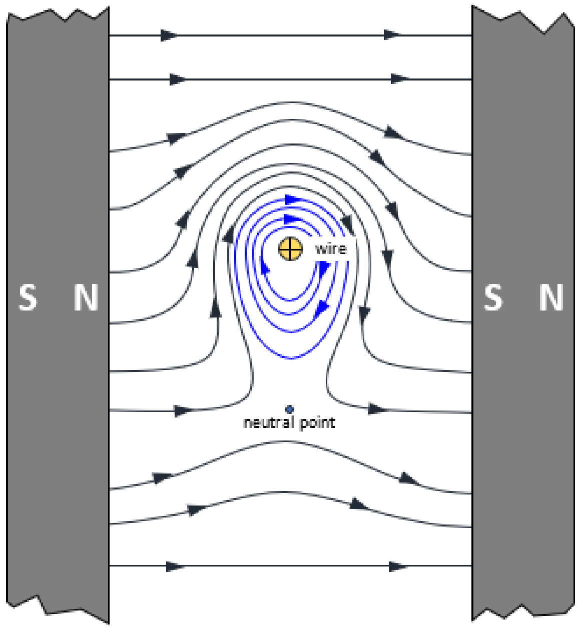


Figure 1, 2 and 3



(ii) Vertically downwards.

2 **(a)** **(i)** As seen from **the increased balance reading**, there is a **downward force on the magnet** due to current-carrying wire.
By Newton's third law, there is **an upward force on the wire** by the magnet.
By Fleming's left hand rule, pole P is a **North** pole

(ii) Consider the forces on the magnet:
$N = BIL$
where N is the increase in contact force between the magnet and the top-pan balance caused by the current passing through the wire in a magnetic field
$(2.3 \times 10^{-3})(9.81) = B(2.6)(4.4 \times 10^{-2})$
$B = 0.20$ T

(b) In an electric field, the force on a moving charged particle acts **along the direction** of the electric field while the magnetic force acts **perpendicular to its motion and the magnetic field**.

Either:

In an electric field, a stationary charged particle will experience an electric force but will not experience a magnetic force in a magnetic field.

Or:

In an electric field, a charged particle moving parallel to the electric field will experience a force which causes it to accelerate or decelerate but a charged particle moving parallel to the magnetic field will not experience a force and will move with constant speed.

3 **(a)** The current in AC flows in a direction perpendicular to the solenoid's magnetic field, which acts along the axis of the solenoid. A magnetic force will act on AC and its direction is downwards according to Fleming's Left Hand Rule. This force will have a turning effect about the pivot along XY as its line of action is some distance away.

(b) The directions of the currents in AX and CY are anti-parallel and parallel respectively to that of the magnetic flux density of the solenoid. Hence no force will be induced on AX and CY.

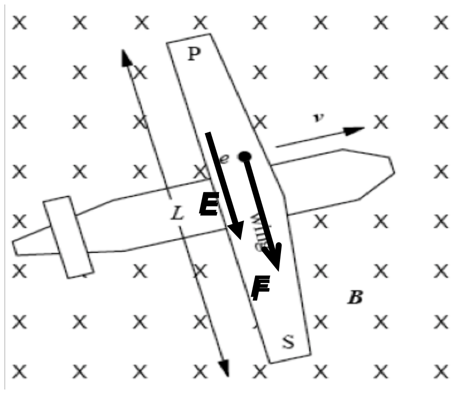
(c) By the principle of moments, taking moments about XY:
anti-clockwise moment = clockwise moment

$$(BIL)(60) = (mg)(40)$$
$$B = \frac{(0.030)(9.81)(40)}{(3.0)(0.200)(60)}$$
$$= 0.327 \text{ T}$$

4

$$F = BIL$$
$$= B\,nev_d A\,L \qquad (\because I = nev_d A \text{, where } n \text{ is number of electrons per unit volume})$$
$$= BNev_d \qquad (\text{where } N \text{ is number of electrons in wire})$$
$$F_e = \frac{F}{N} = Bev_d \qquad (\text{proven})$$

5 (a) (i)



(ii) As the plane moves, the electrons will experience a force *F* in the direction shown in (i). Electrons will accumulate at side S, leaving behind positive charge at P. A potential difference is now set up with side P being higher potential than S. Hence an electric field is set up in the direction P to S.

(b) (i) Because of the electric field *E* in a(ii), the electron will now experience an electric force F_E directed from S to P. When the electric force F_E equals in magnitude to the magnetic force *F* in a(i), then the electron does not move along the wing.

(ii)

$$eE = Bev$$
$$E = Bv$$
$$= 5.0 \times 10^{-5}(720 \times 10^3/3600)$$
$$= 1.0 \times 10^{-2} \text{ V m}^{-1}$$

Take note:

For charged particle moving in a magnetic field,

It is wrong to state: "Centripetal force equals magnetic force…"

Correct way to state: "Magnetic force <u>provides</u> the centripetal force…"

Only then can you proceed with the equation $mv^2/r = Bqv$… and so on.