Raffles Institution
Year 5-6 Physics Department

2025 Year 6 H2 Physics Remedial
Chapter 16: Electromagnetism

1 **(a)** Fig. 1.1 shows two identical straight wires of length *L* placed normal to this page with current in wire X flowing into the page and current in wire Y flowing out of the page. The two wires are positioned 0.10 m apart.

Fig. 1.1

(i) Sketch and label the directions of the magnetic field lines in Fig. 1.1 assuming that both currents in wire X and Y are of the same magnitude. [2]

(ii) Indicate, in Fig. 1.1, the direction of the magnetic force *F* on wire X and wire Y. [1]

(iii) A current of 5.0 A now flows in wire X and a current of 3.0 A flows in wire Y. You may assume that at a distance, *d*, from a straight wire with a current, *I*, flowing through it, the magnetic flux density, $B = \frac{\mu_o I}{2\pi d}$.

1. Calculate the magnetic flux density at wire X due to wire Y. [1]

2. Calculate the magnetic flux density at wire Y due to wire X. [1]

3. Hence show quantitatively that the force *F* experienced by each wire is equal in magnitude. [3]

(b) Wire Y is placed in the region between the poles of a strong magnet.

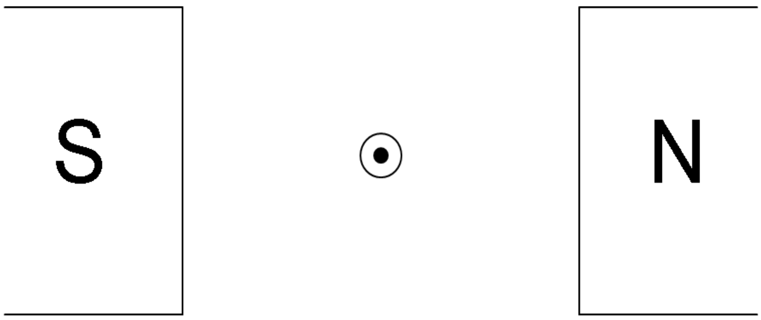


Fig. 1.2

(i) Sketch in Fig. 1.2 the resultant magnetic field in the region between the poles of a magnet. [2]

(ii) State the direction of the magnetic force acting on wire Y. [1]

2 **(a)** A large horseshoe magnet produces a uniform magnetic field of flux density *B* between its poles. Outside the region of the poles, the flux density is zero. The magnet is placed on a top-pan balance and the wire XY is situated between its poles, as shown in Fig. 2.

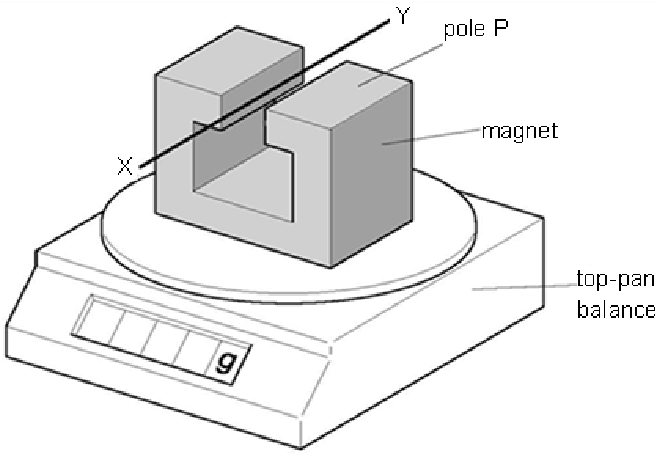


Fig. 2

The wire XY is horizontal and normal to the magnetic field. The length of wire between the poles is 4.4 cm. A direct current of magnitude 2.6 A is passed through the wire in the direction from X to Y. The reading on the top-pan balance increases by 2.3 g.

(i) State and explain the polarity of the pole P of the magnet. [3]

(ii) Calculate the flux density between the poles. [2]

(b) A charged particle may experience a force in an electric field and in a magnetic field. State two differences between the forces experienced in these two types of fields. [2]

[AJC/Prelims 2014/P2/3]

3 Fig. 3 below shows a current balance. The wire frame AXYC is balanced on two knife edges through which a current from a battery can be passed through. The wire frame is horizontal when there is no current. A magnetic force acts on the wire frame when a 3.0 A current flows through.

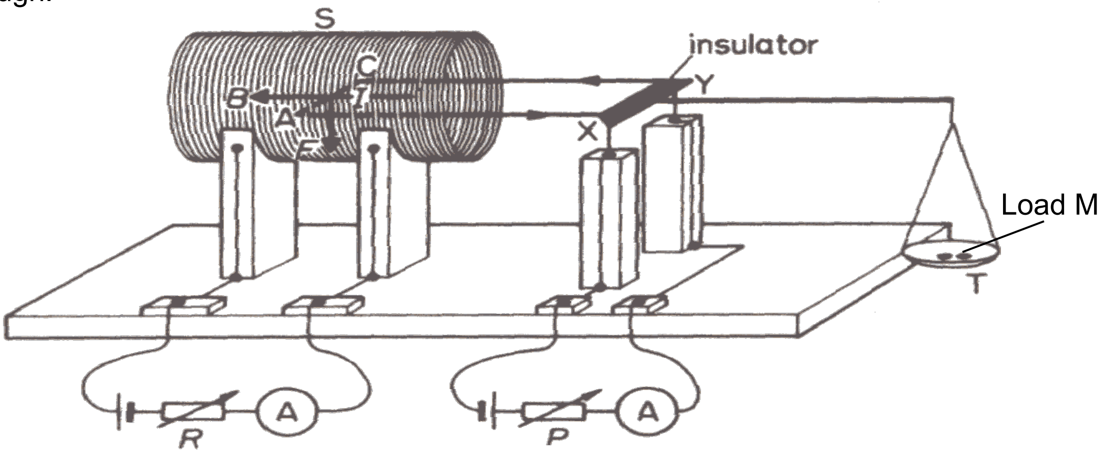


Fig. 3

(a) Explain why the current in AC causes a turning effect.

[3]

(b) Explain why the current in AX and CY do not contribute to the turning effect.

[1]

(c) A 0.030 kg load M, is needed on the right hand side to restore the frame to its horizontal position again. The length of AX is 60.0 cm and AC is 20.0 cm. The horizontal distance between load M and XY is 40.0 cm. Calculate the magnetic flux density in the solenoid.

[3]

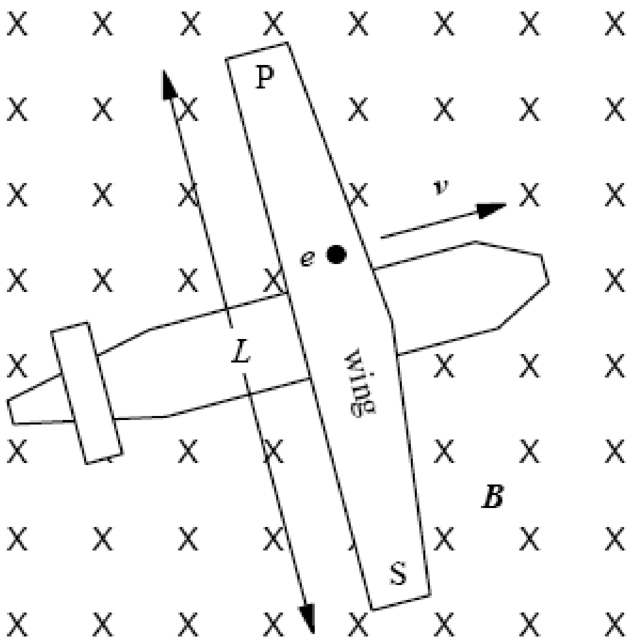
[HCI/Prelims 2014/P2/5]

4 A wire with length L and cross-sectional area A, carries a current I. When placed perpendicularly in a region of uniform magnetic flux density B, it experiences a magnetic force F.

Show that the force, F_e experienced by individual electrons moving within the wire with drift velocity, v_d is equal to Bev_d.

[3]

5 A jet aeroplane is flying with velocity $\boldsymbol{v}$ at right angles to the Earth's magnetic field $\boldsymbol{B}$ near the North pole of the Earth, as shown in the plan view below. The plane's wingspan (distance between wingtips) is L. The wingtips are labelled P (port) and S (starboard).



(a) Consider an electron of charge magnitude e in the metal wing of the plane at the point shown by a dot in the figure.

(i) Draw a vector on the diagram to represent the magnetic force that this electron will experience due to its motion in the magnetic field. Label the force as F.

[1]

(ii) Hence explain why an electric field will be formed across the wing, and draw a vector in the diagram to show its direction. Label the field as E.

[2]

(b) While the plane is flying steadily in the magnetic field, the electrons in the wing experience the magnetic force in a(i) but do not move along the wing; such motion is opposed by the *electric* field in a(ii) arising in the wing.

(i) Explain why the electric force on the electron is **exactly** equal to the magnetic force, in this situation.

[2]

(ii) If the plane is flying at a speed of 720 km h^{-1} and the magnetic flux density of the earth B is 5.0 x 10^{-5} T, calculate the electric field that will be set up in the wings of the aeroplane..

[2]

[VJC/Prelims 2014/P3/3]