

- 5 (a) Twin core cable, consisting of a 'live' wire and a 'neutral' wire, is commonly used for wiring applications. Current is supplied via the 'live' wire from an electrical power source to the appliance. Current then flows via the 'neutral' wire back to the electrical power source.

The twin core cable shown in Fig. 5.1 consists of two thin wires whose centres are 5.0 mm apart. Each wire carries a current of 0.25 A.

Permeability of the insulating material, $\mu = 1.3 \times 10^{-6} \text{ H m}^{-1}$.

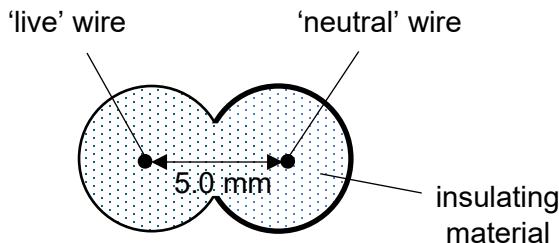


Fig. 5.1

- (i) State whether the force between the wires is attractive or repulsive.

..... [1]
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- (ii) Calculate the magnitude of the force per unit length on each wire.

force per unit length = N m⁻¹ [3]
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- (b) A railgun is a device typically designed as a weapon that uses electromagnetic force to launch high speed projectiles. A simplified model of a railgun is shown in Fig. 5.2. Fig. 5.2 shows the top view of a pair of smooth horizontal metal rails connected across a 2.0 V battery of negligible internal resistance. The metal rails have negligible resistance. A copper rod XY of resistance $3.04 \text{ m}\Omega$ is resting on the rails. The rails and the rod lie in a horizontal plane and a uniform vertical magnetic field of flux density 24 mT is applied out of the page.

When the switch is closed, a magnetic force acts on XY which causes it to start moving towards the right. At time t s after the switch is closed, XY has a velocity $v \text{ m s}^{-1}$.

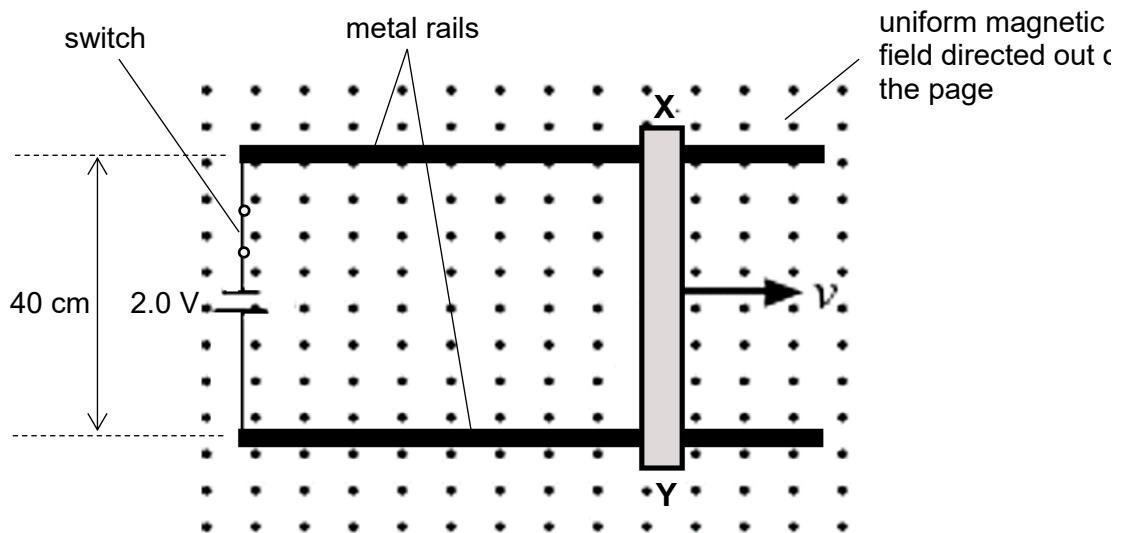


Fig. 5.2

- (i) As the rod moves to the right, there is an induced e.m.f across rod XY. Use Lenz's law to explain why the **induced** electric potential at X is lower compared to Y.

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[2]
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- (ii) Show that the current, in amperes, in the closed circuit at time t is given by $(660 - 3.2v)$.

[2]
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- (iii) Show that after some time rod XY will slide with constant velocity. Determine this velocity.

Explain your working.

velocity = m s⁻¹ [4]