Magnetism Questions – OCR A Level Physics

Praneel Physics

1. Define the magnetic flux density. **(P)**

Working and Answer:

Magnetic flux density is the force per unit current per unit length on a wire at right angles to the field. $B = \frac{F}{IL}$

2. What is the unit of magnetic flux density? **(P)**

Working and Answer:

Tesla (T)

3. State the direction of the force on a current-carrying wire in a magnetic field. **(P)**

Working and Answer:

It is given by Fleming's left-hand rule.

4. What shape are the magnetic field lines around a straight current-carrying wire? **(P)**

Working and Answer:

Concentric circles centered on the wire.

5. Describe how to determine the direction of the magnetic field around a solenoid. **(PP)**

Working and Answer:

Use the right-hand grip rule: fingers follow current, thumb shows field direction.

6. State the formula for the force on a current-carrying wire in a magnetic field. **(PP)**

Working and Answer:

$$F = BIL\sin\theta$$

7. Explain what is meant by a uniform magnetic field. **(PP)**

Working and Answer:

A magnetic field with constant strength and direction, represented by parallel, equally spaced lines.

8. How does the force on a wire vary with angle in a magnetic field? **(PP)**

Working and Answer:

It is maximum when the wire is perpendicular and zero when parallel to the field.

9. A 0.20 m wire carrying 5.0 A is placed at right angles to a 0.30 T magnetic field. Calculate the force. **(PPP)**

Working and Answer:

$$F = BIL = 0.30 \times 5.0 \times 0.20 = 0.30\,\text{N}$$

10. A proton travels at 1.0×10^6 m/s perpendicular to a 0.25 T magnetic field. Calculate the magnetic force. **(PPP)**

Working and Answer:

$$F = Bqv = 0.25 \times 1.6 \times 10^{-19} \times 1.0 \times 10^6 = 4.0 \times 10^{-14}\,\text{N}$$

11. Calculate the radius of the path of a 1.0×10^{-6} C particle of mass 2.0×10^{-3} kg moving at 200 m/s in a 0.5 T field. **(PPP)**

Working and Answer:

$$r = \frac{mv}{Bq} = \frac{2.0 \times 10^{-3} \times 200}{0.5 \times 1.0 \times 10^{-6}} = 800\,\text{m}$$

12. A 15 cm wire at 60° to a 0.40 T magnetic field carries 2.5 A. Calculate the force on it. **(PPP)**

Working and Answer:

$$F = BIL\sin\theta = 0.40 \times 2.5 \times 0.15 \times \sin 60^\circ = 0.13\,\text{N}$$

13. Explain why a charged particle in a magnetic field moves in a circular path. **(PPPP)**

Working and Answer:

The magnetic force acts as a centripetal force, always perpendicular to velocity, causing circular motion:

$$F = qvB = \frac{mv^2}{r}$$

14. Describe how velocity selectors work using electric and magnetic fields. **(PPPP)**

Working and Answer:

They use perpendicular electric and magnetic fields; only particles with $v = \frac{E}{B}$ pass undeflected.

15. A particle moves in a circle of radius 0.25 m under a 0.3 T field. If its speed is 5.0×10^4 m/s and charge is 1.6×10^{-19} C, find its mass. **(PPPP)**

Working and Answer:

$$r = \frac{mv}{qB} \Rightarrow m = \frac{rqB}{v} = \frac{0.25 \times 1.6 \times 10^{-19} \times 0.3}{5.0 \times 10^4} = 2.4 \times 10^{-24}\,\text{kg}$$

16. Determine the magnetic flux through a 0.02 m^2 coil in a 0.5 T field. **(PPPP)**

Working and Answer:

$$\Phi = B \cdot A = 0.5 \times 0.02 = 0.01\,\text{Wb}$$

17. Calculate the time period of a proton in a circular path in a 0.2 T field. $q = 1.6 \times 10^{-19}\,\text{C}$, $m = 1.67 \times 10^{-27}\,\text{kg}$ **(PPPPP)**

Working and Answer:

$$T = \frac{2\pi m}{qB} = \frac{2\pi \times 1.67 \times 10^{-27}}{1.6 \times 10^{-19} \times 0.2} = 3.3 \times 10^{-7}\,\text{s}$$

18. A current loop of area 0.03 m² lies in a magnetic field of 0.6 T at an angle of 30°. Calculate the flux through the loop. **(PPPPP)**

Working and Answer:

$$\Phi = BA\cos\theta = 0.6 \times 0.03 \times \cos 30^\circ = 0.016\,\text{Wb}$$

19. A wire carries a 6.0 A current through a 0.25 T field for 0.40 m. It's at 45°. Find the force. **(PPPPP)**

Working and Answer:

$$F = BIL\sin\theta = 0.25 \times 6.0 \times 0.40 \times \sin 45^\circ = 0.42\,\text{N}$$

20. Calculate the energy gained by an electron moving in a circular path of radius 0.015 m in a 0.4 T field with speed 1.0×10^7 m/s. **(PPPPP)**

Working and Answer:

$$F = qvB = \frac{mv^2}{r} \Rightarrow m = \frac{rqB}{v} \Rightarrow KE = \frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{rqB}{v}\right)v^2 = \frac{rqBv}{2}$$
$$= \frac{0.015 \times 1.6 \times 10^{-19} \times 0.4 \times 1.0 \times 10^7}{2} = 4.8 \times 10^{-15}\,\text{J}$$