TOPIC: MAGNETIC FIELD (ANSWER KEY)

1.	A	2.	D	3.	A	4.	C	5.	B
6.	C	7.	B	8.	B	9.	C	10.	B
11.	A	12.	C	13.	A	14.	D	15.	C
16.	C	17.	C	18.	B	19.	A	20.	B
21.	A,C,D	22.	A,B,C	23.	C	24.	A	25.	A
26.	B	27.	B	28.	C	29.	(6)	30.	(8)
31.	(2)	32.	(2)	33.	(4)	34.	(5)	35.	(6)

SOLUTIONS

1. (A)

$\vec{F} = q(\vec{V} \times \vec{B})$

2. (D)

Magnetic force always acts perpendicular to the velocity vector, so it can only change the direction but not magnitude.

3. (A)

Magnetic flux = $\vec{B}.\vec{A}$

4. (C)

$r = \frac{mv}{qB}$

5. (B)

$\vec{F} = I\vec{l} \times \vec{B}$

6. (C)

Pitch $= \frac{2\pi m}{qB} v_{parallel}$

$= \frac{2 \times 3.14 \times 1.67 \times 10^{-27}}{1.6 \times 10^{-19} \times 8.35 \times 10^{-2}} (2 \times 10^5)$

= 0.157 m

7. (B)

Area vector of both the loops are in opposite direction.

8. (B)

$F = \int (id\vec{l} \times \vec{B}) = iB|\overrightarrow{AC}| = i_0 B_0 l$

9. (C)

Using formulae B = $\frac{\mu_0}{4\pi}\frac{I}{r}(\sin\alpha + \sin\beta)$

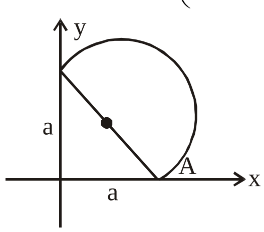
We get $\frac{\mu_0 I}{4\pi d}(1 - \cos\theta)$.

10. (B)

$r = \frac{\sqrt{2}a}{2} = \frac{a}{\sqrt{2}}$

Total area = $\frac{\pi r^2}{2} + \frac{1}{2} \times a \times a = \frac{\pi a^2}{4} + \frac{a^2}{2}$

Magnetic moment of the loop is $= I\left(\frac{\pi a^2}{4} + \frac{a^2}{2}\right)$.



11. **(A)**

$$M = (I\ area) = \left(2 \times \pi \times \frac{1}{4}\right) \times 10 = 5\pi$$

$$W = MB\ \left(1 - \frac{1}{2}\right) = 5\pi \times 4\left(\frac{1}{2}\right) = 10\pi\ J$$

12. **(C)**

B is independent of ‘x’ for large number of wires.

13. **(A)**

$F = i.2b.B$

$m\ \alpha = 2ibB$

$$\alpha = \frac{2ibB}{m}.$$

14. **(D)**

$$B = \frac{\mu_0 i}{2r} - \frac{\mu_0 i}{2(2r)} + \frac{\mu_0 i}{2(2^2 r)}.......\infty$$

$$B = \frac{\mu_0 i}{2r}\left[1 - \frac{1}{2} + \frac{1}{2^2} - \frac{1}{2^3} + ...\infty\right]$$

$$B = \frac{\mu_0 i}{2r}\left[\frac{1}{1 - \left(-\frac{1}{2}\right)}\right]$$

$$B = \frac{\mu_0 i}{3r}.$$

15. **(C)**

$$i = 2R\left(-\hat{j}\right) \times \frac{B_0}{\sqrt{2}}\left(\hat{i} + \hat{j}\right)$$

$$= \sqrt{2}\ IRB_0\hat{k}$$

16. **(C)**

Very early, the velocity imparted to the electron by the electric field will be in the –ve direction and the force due to magnetic field in the +ve *x*-direction.

17. **(C)**

Use Ampere’s circuital law. With OPQRO as the Amperean circuit, only one-fourth of the current i can be considered to be .... the surface OPQRO.

18. **(B)**

Magnetic fields due to opposite wires will be cancelled out.

19. **(A)**

$$\vec{F} = I\left(\vec{l} \times \vec{B}\right) = 60\hat{i}\ N$$

20. **(C)**

The field is uniform for the dipole.

21. **(A,C,D)**

$W = qV$, therefore K.E. will become two times, and radius √2 times;

Angular velocity, however, will not change because time period remains unchanged.

22. **(A, B, C)**

$\vec{F} = I(\vec{l} \times \vec{B})$, Here $\vec{l}$ is $\lambda\hat{i}$.

23. **(C)**

$\alpha = \beta = 0$

24. **(A)**

B due to ED = B due to EF

Similarly B due to BC = B due to AB

In all the cases, $\alpha = 45^\circ$ and $\beta = 0^\circ$

$$B_{ED} = \frac{\mu_0 I}{4\pi(a)}(\sin 45^\circ)$$

$$B_{BC} = \frac{\mu_0 I}{4\pi(2a)}(\sin 45^\circ)$$

25. **(A)**

Magnetic field at C is due to only AB wire.

Similarly, magnetic field at A is due to only BC wire.

26. **(A)**

$$\vec{B} = \frac{\mu_0 I R^2}{(R^2 + x^2)^{3/2}} = \mu_0 I \sin^3\theta\sqrt{R}$$

22. **(B)**

$$B_{\text{larger coil}} : B_{\text{smaller coil}} = \sqrt{\frac{\text{Radius of larger coil}}{\text{Radius of smaller coil}}}$$

$$= \sqrt{\frac{\text{Distance of larger coil}}{\text{Distance of smaller coil}}} = \sqrt{\frac{4}{1}} = 2$$

23. **(C)**

The field due to the large coil is double that of the smaller coil. When the two coils are on the same side, fields add; when they are on opposite sides of point P, the fields subtract.

29. **(6)**

$\vec{F} = i(\vec{l} \times \vec{B})$

30. **(8)**

$\vec{F}.\vec{B} = 0$ (in case of magnetic force) $\Rightarrow \vec{a}.\vec{B} = 0$

31. **(2)**

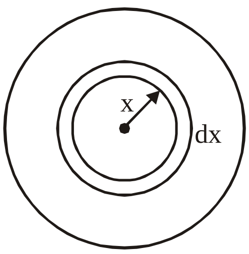
$$qE = qvB \Rightarrow B = \frac{E}{v} = 10$$

32. **(2)**

$$E = \frac{x}{2}\frac{dB}{dt}$$

$$E = \frac{3Kxt^2}{2}$$

$$d\tau = \frac{3Kxt^2}{2} \times \frac{2\pi x dx}{\pi r^2} q.x$$



$$\tau = \frac{3Kt^2 q}{r^2}\int_0^r x^3 dx$$

$$\tau = \frac{3Kq.t^2}{4}.r^2 \qquad \ldots(i)$$

torque due to friction force

$$d\tau = \mu dmgx$$

$$\tau = 2\mu g\frac{qm}{r^2}\int_0^r x^2 dx = \frac{2}{3}\mu mgr \qquad \ldots(ii)$$

$$\frac{3Kq.t^2 r^2}{4} = \frac{2}{3}\mu mgr$$

$$t = \sqrt{\frac{8\mu mg}{9Kqr}}.$$

= 2 seconds.

33. (4)

$$mg\frac{l}{2} = \mu B$$

$$B = \frac{mgl}{2\mu} = \frac{mgl}{2Il^2}$$

34. (5)

Impulse $= \int F.dt = \int ilB.dt = qlB$

$$v = \frac{qlB}{m} \qquad \therefore h = \frac{q^2 l^2 B^2}{2gm^2}$$

$$\Rightarrow \quad 3 = \frac{3k(0.2)^2(0.1)^2}{2\times 10\times(10^{-2})^2} \quad \Rightarrow \quad k = 5$$

35. (6)

Wire PQ begins to slide when magnetic force is just equal to the force of friction, i.e., $\mu mg = ilB\sin\theta$ ($\theta = 90^o$)

Here, $i = \frac{E}{R} = \frac{6}{20} = 0.3A$

$$\mu = \frac{ilb}{mg}$$

$$= \frac{(0.3)(4.9\times 10^{-2})(0.8)}{(10\times 10^{-3})(9.8)} = 0.12$$

So, $50\times 0.12 = 6$