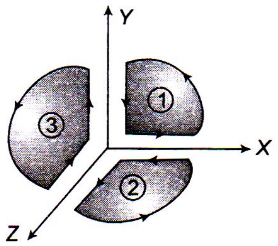
WEEKLY TEST OYM TEST - 12
SOLUTION Date 30-06-2019

[PHYSICS]

1. **(b)** The circular segments in each of the quadrants can be considered individually for calculating the magnetic magnet. Thus, segments in each of the quadrants are considered as loops individual by joining the two ends hypothetically in the same plane. When all the three segments are considered together, the contribution by hypothetical elements are cancelled.



$$M_1 = i\left(\frac{\pi a^2}{4}\right)\hat{k}$$

Similarly, $M_2 = i\left(\frac{\pi a^2}{4}\right)\hat{j}$

$$M_3 = i\left(\frac{\pi a^2}{4}\right)\hat{i}$$

So, net magnetic moment

$$\vec{M} = \vec{M}_1 + \vec{M}_2 + \vec{M}_3$$

$$\vec{M} = \frac{\pi a^2 i}{4}(\hat{i} + \hat{j} + \hat{k})$$

2. **(b)** Since $L = 2\pi r;\ r = \frac{L}{2\pi}$

Area of circle $\pi r^2 = \frac{\pi L^2}{4\pi^2} = \frac{L^2}{4\pi}$

Area of each half of circle $= \frac{L^2}{8\pi}$

Magnetic moment of each half $= \frac{L^2 i}{8\pi}$

The two magnetic moments are at right angles to each other.

Magnetic moment of the frame

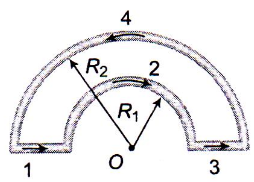
$$= \sqrt{\left(\frac{L^2 i}{8\pi}\right)^2 + \left(\frac{L^2 i}{8\pi}\right)^2} = \frac{\sqrt{2}.L^2 i}{8\pi} = \frac{L^2 i}{4\sqrt{2}\pi}$$

3. **(b)** The given shape is equivalent to the following diagram The field at O due to straight part of conductor is $B_1 = \frac{\mu_o}{4\pi}.\frac{2i}{r}\odot$. The field at O due to circular coil is $B_2 = \frac{\mu_0}{4\pi}.\frac{2\pi i}{r}\otimes$. Both fields will act in the opposite direction, hence the total field at O.

i.e., $B = B_2 - B_1 = \left(\frac{\mu_o}{4\pi}\right)\times(\pi - 1)\frac{2i}{r} = \frac{\mu_o}{4\pi}.\frac{2i}{r}(\pi - 1)$

4. **(d)** $B = \frac{\mu_0}{4\pi}\frac{(2\pi - \theta)i}{R} = \frac{\mu_0}{4\pi}\frac{\left(2\pi - \frac{\pi}{2}\right)\times i}{R} = \frac{3\mu_0 i}{8R}$

5. **(a)** In the following figure, magnetic fields at O due to sections 1, 2, 3 and 4 are considered as B_1, B_2, B_3 and B_4 respectively.



$B_1 = B_3 = 0$

$B_2 = \frac{\mu_0}{4\pi}.\frac{\pi i}{R_1}\otimes$

$B_4 = \frac{\mu_0}{4\pi}.\frac{\pi i}{R_2}\odot$ As $|B_2| > |B_4|$

So $B_{net} = B_2 - B_4 \Rightarrow B_{net} = \frac{\mu_0 i}{4}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)\otimes$

6. **(b)** $B = \frac{3}{4}\left[\frac{\mu_0 I}{2a}\right] + \frac{1}{4}\left[\frac{\mu_0 I}{2b}\right]$

$B = \frac{3\mu_0 I}{8a} + \frac{\mu_0 I}{8b}$

7. **(c)** The magnetic induction due to both semicircular parts will be in the same direction perpendicular to the paper inwards.

$\therefore B = B_1 + B_2 = \frac{\mu_0 i}{4r_1} + \frac{\mu_0 i}{4r_2} = \frac{\mu_0 i}{4}\left(\frac{r_1 + r_2}{r_1 r_2}\right) \otimes$

8. **(b)** Distance of straight conductor from

$$B = \frac{\mu_0 I \times \sqrt{2}}{2\pi r} + \frac{\mu_0 I}{2r}\frac{\pi}{2\times 2\pi}$$

Or $B = \frac{\mu_0 I}{4\pi} + \frac{2I}{r}\left[\sqrt{2}\frac{\pi}{4}\right].$

9. **(a)** $r_1 : r_2 = 1 : 2$ and $B_1 : B_2 = 1 : 3$ We know that

$$B = \frac{\mu_0}{4\pi}.\frac{2\pi ni}{r} \Rightarrow \frac{i_1}{i_2} = \frac{B_1 r_1}{B_2 r_2} = \frac{1\times 1}{3\times 2} = \frac{1}{6}$$

10. **(b)** We shall use $\oint \vec{B}.d\vec{l} = \mu_0 I$ where I is the current enclosed by loop.

Net current enclosed by path a is zero.

Net current enclosed by path c is A.

Net current enclosed by path d is 3A.

Net current enclosed by path b is 5A.

11. **(b)** Current within radius $r < R$:

$$I_{in} = I\pi r^2 = \frac{i}{\pi R^2}\pi r^2 = \frac{ir^2}{R^2}$$

for $r < R$, $\oint \vec{B}\cdot d\vec{\ell} = \mu_0 I_{in} = \frac{\mu_0 ir^2}{R^2}$ $\Rightarrow$ Parabolic

for $r > R$, $\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{\text{in}} = \mu_0 I$ $\Rightarrow$ Constant

12. **(b)** $B = \frac{\mu_0}{4\pi}\frac{2M}{x^3} = \frac{\mu_0}{4\pi}\frac{i\pi r^2}{(r/\tan\theta)^3}$

$\Rightarrow B \propto \frac{i}{r} B_1 = B_2 \Rightarrow \frac{i_1}{r_1} = \frac{i_2}{r_2} \Rightarrow \frac{i_1}{i_2} = \frac{r_1}{r_2}$

13. $B_1 = \frac{\mu_0}{4\pi} \times \frac{2\pi I}{a} \times \frac{1}{2}$ (due to semicircular part)

$B_2 = \frac{\mu_0}{4\pi} \times \frac{2I}{a}$ (due to parallel parts of currents)

These two fields are at right angles to each other.
Hence, resultant field,

$$B = \sqrt{B_1^2 + B_2^2} = \frac{\mu_{04} I}{4\pi a}\sqrt{\pi^2 + 4}$$

14.

15. Using the formula,

$$B = \frac{\mu_0 i R^2}{2(R^2 + x^2)^{3/2}}$$

we get; $54 = \frac{\mu_0 i (3)^2}{2[3^2 + 4^2]^{3/2}}$

or $\mu_0 i = \frac{54 \times 2 \times 5 \times 25}{9}$

Now, at the centre of the coil, x = 0 and

$$B = \frac{\mu_0 i}{2R} = \frac{\mu_0 i}{2 \times 3} = \frac{\mu_0 i}{6}$$

$$= \frac{54 \times 2 \times 5 \times 25}{9 \times 6} = 250$$

B = 250μ tesla

[CHEMISTRY]

24. **(a)** Adsorption of a gas on solid independent of the pressure start fast and after some time becomes slow.

25. **(c)** Liquid (Dispersed phase) + Solid (Dispersion medium) = Gel (Colloid) (e.g. Butter)

26. **(a)** Following are surface phenomena
(i) Surface tension (ii) Adsorption
Viscosity and absorption are not surface phenomena.

27. **(c)** Physical adsorption decreases with increase of temperature.

28. **(a)** Colloidal particles range between 10^{-7} and 10^{-9}m or 10^{-5} and 10^{-7} cm.

29. **(b)** Easily liquefiable gases like SO_2, NH_3, CO_2 are adsorbed to a greater extent than the elemental gases like N_2, O_2, H_2.

30. **(c)** Properties of the colloidal solution depend upon physical state of dispersed phase and mol. wt.