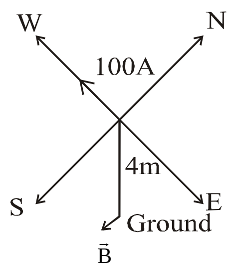
SOLUTION
MOVING CHARGES AND MAGNETISM

EXERCISE-I (MHT CET LEVEL)

Q.1 (3) The magnetic field is

$$B = \frac{\mu_0}{4\pi}\frac{2I}{r} = 10^{-7} \times \frac{2 \times 100}{4} = 5 \times 10^{-6} T$$



According to right hand palm rule, the magnetic field is directed towards south.

Q.2 (2) The magnetic field at C due to first conductor is

$B_1 = \frac{\mu_0}{2\pi}\frac{I}{3d/2}$ (since, point C is separated by $d + \frac{d}{2} = \frac{3d}{2}$ from 1 st conductor) . The direction of field is perpendicular to the and directed outwards. plane of paper and directed outwards.
The magnetic field at C due to second conductor is

$B_2 = \frac{\mu_0}{2\pi}\frac{10}{d/2}$ (since, point C is separated by $\frac{d}{2}$ from 2 nd conductor) The direction of field is perpendicular to the and directed inwards. plane of paper since, direction of B_1 and B_2 at point C is in opposite direction and the magnetic field at C is zero, therefore,

$$B_1 = B_2$$

$$\frac{\mu_0}{2\pi}\frac{I}{3d/2} = \frac{\mu_0}{2\pi}\frac{10}{d/2}$$

On solving 1=30.0 A

Q.3 (3) When a charge particle is allowed to move in a uniform magnetic field, then it describes spiral of circular path

Centripetal force, $\frac{mv^2}{R} = qvB$

$$\therefore\ v = \left(\frac{qB}{R}R\right)$$

Hence, $\sqrt{\frac{2qV}{m}} = \left(\frac{qB}{R}\right)R \left[\because V = \sqrt{\frac{2qV}{m}}\right]$

$$\Rightarrow R = \left(\frac{2mV}{q}\right)^{1/2} \times \frac{1}{B}$$

or, $m \propto R^2$

or, $\frac{m_1}{m_2} = \left(\frac{R_1}{R_2}\right)^2$

Q.4 (2) $\vec{B_0} = \vec{B_1} + \vec{B_2} + \vec{B_3}$

Here, $\vec{B_1}$ & $\vec{B_3}$ are due to straight wires

& $\vec{B_2}$ is due to semi-circular wire.

$$\vec{B_1} = \vec{B_3} = \frac{\mu_0}{4\pi}.\frac{2I}{R}\left(-\hat{K}\right) = \quad \vec{B_2} = \frac{\mu_0}{4\pi}.\frac{\pi I}{R}\left(-\hat{i}\right)$$

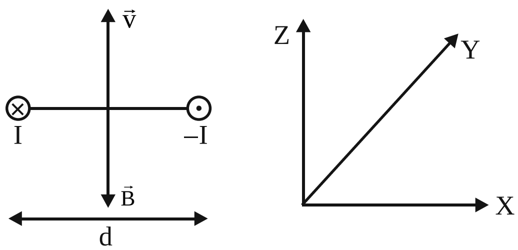
Q.5 (2)	**Q.6** (3)	**Q.7** (1)	**Q.8** (3)	**Q.9** (4)
Q.10 (3)	**Q.11** (3)	**Q.12** (3)	**Q.13** (4)	**Q.14** (2)
Q.15 (1)	**Q.16** (1)	**Q.17** (2)	**Q.18** (2)	**Q.19** (2)
Q.20 (3)	**Q.21** (1)	**Q.22** (3)	**Q.23** (4)	**Q.24** (3)

Q.25 (2)
Since, the radius of circular path of a charged particle in magnetic field is $\frac{mv}{qB} = \frac{\rho}{qB}$ Now, the radius of circular path of charged particle of given momentum ρ and magnetic field B is given by $r\alpha\frac{1}{q}$ But charge on both charged particles protons and deuterons is same. Therfore,

$$\Rightarrow \frac{r_\rho}{r_D} = \frac{q_D}{q_\rho} = \frac{1}{1}$$

Q.26 (2)
When a charged particle enters a magnetic field at a direction perpendicular to the direction of motion, the path of the motion is circular. In circular motion the direction of velocity changes at every point (the magnitude remains constant). Therefore, the tangential momentum will change at every point. But kinetic energy will remain constant as it is given by $\frac{1}{2}mv^2$ and v^2 is the square of the magnitude of velocity which does not change.

Q.27 (4) Net magnetic field due to the wires will be downward as shown below in the figure. Since angle between $\vec{v}$ and $\vec{B}$ is 180°.

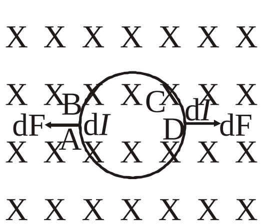


Therefore, mahnetic force $\vec{F}_m = q(\vec{v}\times\vec{B}) = 0$

Q.28 (4) Power $= \frac{\text{work done}}{\text{time}}$
As no work is done by magnetic force on the charged particle because magnetic force is perpendicular to velocity, hence power delivered is zero.

Q.29 (2) **Q.30** (1) **Q.31** (4) **Q.32** (1) **Q.33** (2)
Q.34 (1) **Q.35** (3) **Q.36** (1) **Q.37** (4) **Q.38** (1)
Q.39 (4) **Q.40** (4) **Q.41** (1)

Q.42 (3) The magnetic field is perpendicular to the plane of the paper. Let us consider two diametrically opposite elements. By Fleming's Left hand rule on element AB the direction of force will be Leftwards and the magnitude will be dF = IdI B sin90° = IdIB



On element CD, the direction of force will be towards right on the papper and the magnitude will be dF = IdIB.

Q.43 (2)
$F = Bi\ell = 2\times1.2\times0.5 = 1.2N$

Q.44 (2) **Q.45** (3) **Q.46** (2) **Q.47** (1) **Q.48** (2)
Q.49 (3) **Q.50** (4)

Q.51 (3) Torque, $\tau = \vec{M}\times\vec{B}$

Q.52 (3)

EXERCISE-II (NEET LEVEL)

Q.1 (4) $dB = \frac{\mu_0}{4\pi}\cdot\frac{idl\sin\theta}{r^2} \Rightarrow d\vec{B} = \frac{\mu_0}{4\pi}.\frac{i(d\vec{l}\times\vec{r})}{r^3}$

Q.2 (2) $i = \frac{q}{T} = \frac{2\times1.6\times10^{-19}}{2} = 1.6\times10^{-19}A$

$\therefore\ B = \frac{\mu_0 i}{2r} = \frac{\mu_0\times1.6\times10^{-19}}{2\times0.8} = \mu_0\times10^{-19}$

Q.3 (3) Field at the centre of a circular coil of radius r is

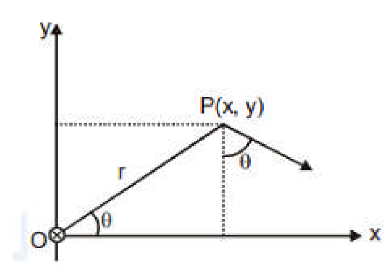
$B = \frac{\mu_0 I}{2r}$

Q.4 (3) $B_{OD} = 0, B_{OB} = 0$

$$B_{AB} = \frac{\mu_0 I}{4\pi a\sqrt{2}}\left[\cos45^o\left(-\hat{i}\right)+\cos45^o\,\hat{k}\right]$$

$$= \frac{\mu_0 I}{8\pi a}\left(-\hat{i}+\hat{k}\right)$$

Q.5 (1) The wire carries a current I in the negative z-direction. We have to consider the magnetic vector field $\vec{B}$ at (x, y) in the z = 0 plane.



Magnetic field $\vec{B}$ is perpendicular to OP.

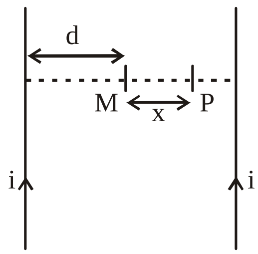
$\therefore \vec{B} = B\sin\theta\hat{i} - B\cos\theta\hat{j}$

$\sin\theta = \frac{y}{r}, \cos\theta = \frac{x}{r} B = \frac{\mu_0 I}{2\pi r}$

$$\therefore \vec{B} = \frac{\mu_0 I}{2\pi r^2}\left(y\hat{i} - x\hat{j}\right)$$

or $$\vec{B} = \frac{\mu_0 I\left(y\hat{i} - x\hat{j}\right)}{2\pi r^2\left(x^2 + y^2\right)}.$$

Q.6 (2) The magnetic field due to two wires at P



$$B_1 = \frac{\mu_0 i}{2\pi\left(d + x\right)}; B_2 = \frac{\mu_0 i}{2\pi\left(d - x\right)}$$

Both the magnetic fields act in opposite direction.

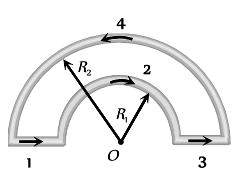
$$\therefore B = B_2 - B_1 = \frac{\mu_0 i}{2\pi}\left[\frac{1}{d - x} - \frac{1}{d + x0}\right]$$

$$= \frac{\mu_0 i}{2\pi}\left[\frac{d + x - d + x}{d^2 - x^2}\right] = \frac{\mu_0 ix}{\pi\left(d^2 - x^2\right)}$$

Q.7 (4)

Q.8 (2)

Q.9 (1) 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.



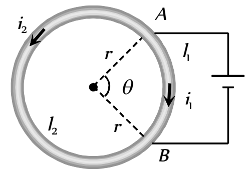
$$B_1 = B_3 = 0$$

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

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

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

Q.10 (4) Directions of currents in two parts are different, so directions of magnetic fields due to these currents are opposite. Also applying Ohm's law across AB



$$i_1R_1 = i_2R_2 \Rightarrow i_1l_2 = i_2l_2$$

$$\left(\because R = \rho\frac{l}{A}\right)$$

Also $B_1 = \frac{\mu_0}{4\pi}\times\frac{i_1l_1}{r^2}$ and $B_2 = \frac{\mu_0}{4\pi}\times\frac{i_2l_2}{r^2}$

$(\because l = r\theta)$

$$\therefore \frac{B_2}{B_1} = \frac{i_1l_1}{i_2l_2} = 1$$

Hence, two field induction's are equal but of opposite direction. So, resultant magnetic induction at the centre is zero and is independent of θ.

Q.11 (1) Magnetic field due to one side of the square at centre *O*

$$B_1 = \frac{\mu_0}{4\pi}\cdot\frac{2i\sin 45^o}{a/2} \Rightarrow B_1 = \frac{\mu_0}{4\pi}\cdot\frac{2\sqrt{2}i}{a}$$

Hence magnetic field at centre due to all side

$$B = 4B_1 = \frac{\mu_0(2\sqrt{2}i)}{\pi a}$$

Magnetic field due to *n* turns

$$B_{net} = nB = \frac{\mu_0 2\sqrt{2}ni}{\pi a} = \frac{\mu_0 2\sqrt{2}ni}{\pi(2l)} = \frac{\sqrt{2}\mu_0 ni}{\pi l} \quad (\because a = 2l)$$

Q.12 (2) Here, $i_{ps} = 3i_{QR}$

$\Rightarrow B_{ps} = 3B_{QR}$ (at the center)

$\Rightarrow B_{ps} = B_{PQRS} = 3P_{QR}$

Now, $B_{Centre} = B_{PS} - B_{PQRS}$

(as the two are opposite in direction)

= 0 = (from eq^n (1)

Q.13 (2) Because for inside the pipe $i = 0$

$$\therefore B = \frac{\mu_0 i}{2\pi r} = 0$$

Q.14 (1) $B = \mu_0 ni \Rightarrow i = \frac{B}{\mu_0 n} = \frac{20\times 10^{-3}}{4\pi\times 10^{-7}\times 20\times 100}$

= 7.9 amp = 8 amp

Q.15 (3) The magnetic field in the solenoid along its axis (i)

At an internal point = μ_0 ni

$= 4\pi \times 10^{-7} \times 5000 \times 4 = 25.1 \times 10^{-3}$ Wb /m^2

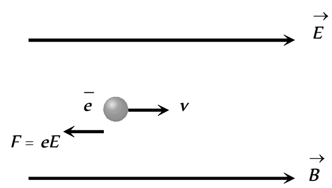
(Here n = 50 turns/ cm = 5000 turns / m)

(ii) At one end

$$B_{end} = \frac{1}{2}B_{in}\frac{\mu_0 ni}{2} = \frac{25.1\times10^{-3}}{2} = 12.6\times10^{-3}\ \text{Wb/m}^2$$

Q.16 (2) Magnetic field at the centre of solenoid (2)= $\mu_0 ni$
Where *n* = Number of *turns* /*meter*
$\therefore B = 4\pi\times10^{-7}\times4250\times5 = 2.7\times10^{-2}\ \text{Wb/m}^2$

Q.17 (4) Since electron is moving is parallel to the magnetic field, hence magnetic force on it $F_m = 0$..



Q.18 (4)

Q.19 (4)

Q.20 (3)

Q.21 (3)

Q.22 (3)

Q.23 (2) $r = \frac{p}{qB} \Rightarrow r \propto p$

Q.24 (2) $B = \frac{mv}{qr} = \frac{9\times10^{-31}\times10^{6}}{1.6\times10^{-19}\times0.1} = 5.6\times10^{-5}T$

Q.25 (4) Due to perpendicular component of velocity particle performs circular motion & it moves forward due to parallel component due to parallel component. resulting into helical path.

Q.26 (2) This is according to the cross product $\vec{F} = q(\vec{v}\times\vec{B})$ otherwise can be evaluated by the left-hand rule of Fleming.

Q.27 (1) $F = ma = qvB \Rightarrow$
$a = \frac{qvB}{m} = \frac{1.6\times10^{-19}\times2\times3.4\times10^{7}}{1.67\times10^{-27}}$
$= 6.5\times10^{15} m/sec^2$

Q.28 (4) $r = \frac{\sqrt{2mK}}{qB} \Rightarrow K \propto \frac{q^2}{m}$

$$\Rightarrow \frac{K_P}{K_d} = \left(\frac{q_p}{q_d}\right)\times\frac{m_d}{m_p} = \left(\frac{1}{1}\right)^2\times\frac{2}{1} = \frac{2}{1}$$

$\Rightarrow K_p = 2\times50 = 100$ keV.

Q.29 (1) Lorentz force is given by
$\vec{F} = \vec{F}_e + \vec{F}_m = q\vec{E} + q(\vec{v}\times\vec{B}) = q[\vec{E} + (\vec{v}\times\vec{B})]$

Q.30 (2) $r = \frac{\sqrt{2mK}}{qB}$ i.e. $r \propto \frac{\sqrt{m}}{q}$
Here kinetic energy *K* and *B* are same.
$\therefore \frac{r_e}{r_p} = \sqrt{\frac{m_e}{m_p}}\times\frac{q_p}{q_e} \Rightarrow \frac{r_e}{r_p}\sqrt{\frac{m_e}{m_p}}$ $(\because q_e = q_p)$
Since $m_e < m_p$, therefore $r_e < r_p$

Q.31 (3) $r = \frac{1}{B}\sqrt{\frac{2mV}{q}} \Rightarrow r \propto \sqrt{\frac{m}{p}} \Rightarrow \frac{r_x}{r_y} = \sqrt{\frac{m_x}{q_x}\times\frac{q_y}{m_y}}$

$\Rightarrow \frac{R_1}{R_2} = \sqrt{\frac{m_x}{m_y}\times\frac{2}{1}} \Rightarrow \frac{m_x}{m_y} = \frac{R_1^2}{2R_2^2}$

Q.32 (4) The component of velocity perpendicular to *H* will make the motion circular while that parallel to *H* will make it move along a straight line. The two together will make the motion helical.

Q.33 (4) Magnetic field produced by wire at the location of charge is perpendicular to the paper inwards. Hence by applying Fleming's left hand rule, force is directed along *OY*.

Q.34 (1) $F = \frac{\mu_0}{4\pi}\frac{2\times i_1 i_2}{a} = \frac{10^{-7}\times2\times5\times5}{0.1} = 5\times10^{-5}N/m$

Q.35 (4)

Q.36 (4)

Q.37 (1) The magnetic moment of current carrying loop
$M = niA = ni(\pi r^2)$
Hence the work done in rotating it through 180°
$w = MB(1-\cos\theta) = 2MB = 2(ni\pi r^2)B$
$= 2\times(50\times2\times3.14\times16\times10^{-4})\times0.1 = 0.1\ J$

Q.38 (2)

Q.39 (2)

Q.40 (2)

Q.41 (Bouns)

Q.42 (4)

Q.43 (2)

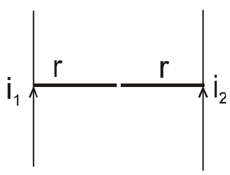
EXERCISE-III (JEE MAIN LEVEL)

Q.1 (3) Charge the rest produces only electric field but charge in motion produces both electric and magnetic field.

Q.2 (3) $i_1 > i_2$

$$\frac{\mu_0}{2r}(i_1 - i_2) = 20$$

$$\frac{\mu_0}{2r}(i_1 + i_2) = 30$$

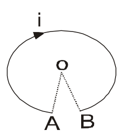


$$\frac{i_1 + i_2}{i_1 - i_2} = \frac{3}{2} \Rightarrow \frac{i_1}{i_2} = \frac{5}{1}$$

Q.3 (1) $B = \frac{\mu_0 i}{4\pi R'}(2\pi - \theta)$

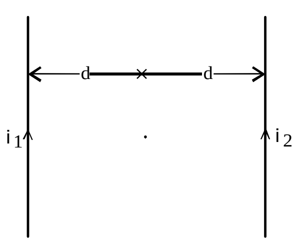
where; $(2\pi - \theta)R' = 2\pi R$

$$R' = \frac{2\pi R}{2\pi - \theta}$$



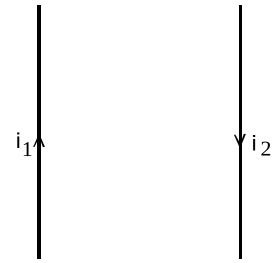
$$B = \frac{\mu_0 i}{2R}\left(\frac{2\pi - \theta}{2\pi}\right)^2$$

Q.4 (3)



$$B_{net} = \frac{\mu_0 (i_1 - i_2)}{2\pi d} = 10\,\mu T$$

.....(1)

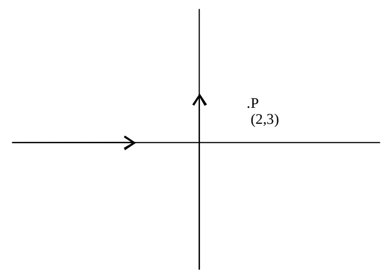


$$\vec{B} = \frac{\mu_0 (i_1 + i_2)}{2\pi d} = 30\,\mu T$$

....(2)

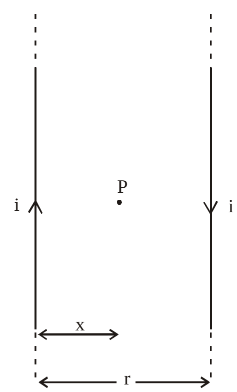
from (1) & (2) $\frac{i_1}{i_2} = 2$

Q.5 (3)



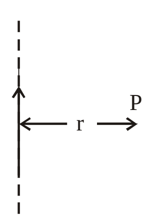
$$B_{net} = \frac{\mu_0 I}{2\pi(2)} - \frac{\mu_0 I}{2\pi(3)}, \quad B_{net} = \frac{\mu_0 I}{12\pi} \otimes$$

Q.6 (2)



At point P $\frac{\mu_0 i}{2\pi}\left[\frac{1}{x} + \frac{1}{r - x}\right]$

Q.7 (2)



$$B = \frac{\mu_0 i}{2\pi r}$$

Now, $\frac{B_1}{B_2} = \frac{r_2}{r_1} = \frac{4}{3}$

Q.8 (1) $B \propto \frac{1}{r^3}$

$\frac{B_1}{B_2} = \left(\frac{3x}{x}\right)^3 = \frac{27}{1}$

Q.9 (4) $B = \mu_0 \mu_r ni$

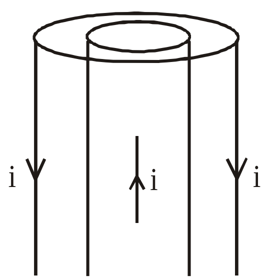
$= 10^{-7} \times 4\pi \times 4000 \times 1000 \times 5$

$= 8\pi$ T

$= 25.12$ T

Q.10 (1)

Q.11 (1)



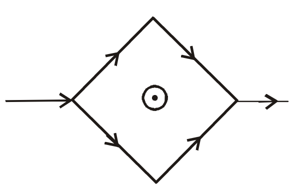
Inside the conductor magnetic field due to both have same direction so we add them.
Out side the conductor magnetic field due to both have opposite direction. so we subtract them.

Q.12 (2) $F = qVB$

$F_{Min} = q_{Min} VB$

As from the given options Li^{++} has maximum charge.

Q.13 (4)



Q.14 (1) $R = \frac{mv}{qB}$

$q \times 12 \times 10^3 = \frac{1}{2}\, m\,(10^6)^2$

$\frac{m}{q} = 24 \times 10^{-9}$

$\Rightarrow R = \frac{24 \times 10^{-9} \times 10^6}{0.2} = 12$ cm

Q.15 (2) $R \propto \frac{m}{q}$

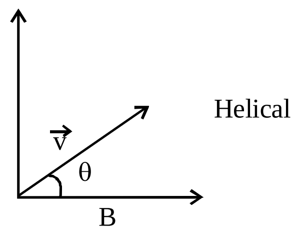
$R_p : R_e : R_\alpha = \frac{m_p}{q} : \frac{m_e}{q} : \frac{4m_p}{2q}$.

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

α-particle has maximum R, so the path followed is B.

Q.16 (2) A particle starting from rest moves in direction of electric field. As both electric & magnetic field are parallel. Hence $\vec{v}$ and $\vec{B}$ are also parallel. Hence there is on force on particle.

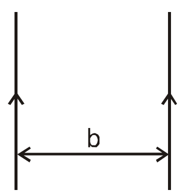
Q.17 (3) Path of particle will be helical



Q.18 (2) $R = \frac{mv}{qB}$

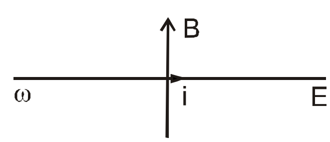
$R \propto v$

Q.19 (2)



$F = \frac{\mu_0}{4\pi} \cdot \frac{2i^2}{b} = \frac{\mu_0 i^2}{2\pi b}$

Q.20 (3)



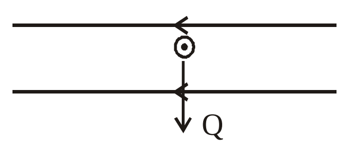
$F = BiL$

$= 10^{-4} \times 10 \times 1 = 10^{-3}$ N

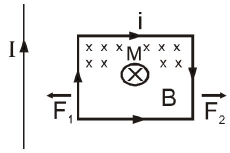
Q.21 (2)

By formula $F = i\left(\vec{\ell} \times \vec{B}\right)$

direction of ℓ in direction of i.



Q.22 (3) $\vec{M}\times\vec{B}=0$
$\tau = 0$



Loop will Not rotate
$F_1 > F_2$
So loop move towards the wire

Q.23 (2) $i = qf$

$= \dfrac{qv}{2\pi r}$

$T = \dfrac{2\pi r}{v}$

$M.M. = i\pi r^2 = \dfrac{qvr}{2}$

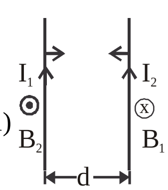
Q.24 (2) Torque on a current carrying loop is given by $\vec{\tau} = \vec{M}\times\vec{B}$
Hence $\vec{\tau}$ does not depend on shape of loop.

EXERCISE-IV

NUMERICAL VALUE BASED

Q.1 [0.16 N]
Q.2 [19.3 mm]
Q.3 [19.5 A]
Q.4 [1.18 $\hat{k}$ N-m]
Q.5 [0.64 N]
Q.6 [7.14]
Q.7 [30°]
Q.8 [0001]
Q.9 [0.25]
Q.10 [0001]

Q.11 (1)



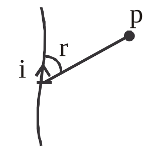
$f = \dfrac{\mu_0}{4\pi}\cdot\dfrac{2I_1I_2}{d}$

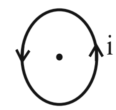
$F_1 = B_2 I_1 l$

$F_e = \dfrac{kq_1q_2}{r^2}$

Q.12 (1)

$B = \dfrac{\mu_0}{4\pi}\cdot\dfrac{idl\sin\theta}{r^2}$





$B = \dfrac{\mu_0}{4\pi}\cdot\dfrac{2\pi i}{r} = \dfrac{\mu_0 i}{2r}$

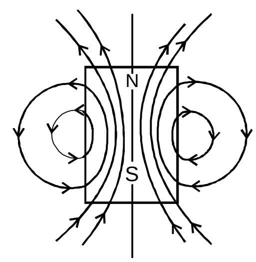
Q.13 (1) $F = q\,vB\sin\theta$
$\theta = 90^\circ, F = qvB$

$\dfrac{mv^2}{r} = qvB \Rightarrow r = \dfrac{mv}{qB}$

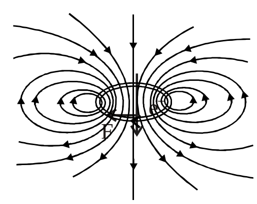
Momentum $P_e = P_p$
$M_e v_e = M_p v_p = P$

$r_e = \dfrac{P_e}{qB}, r_p = \dfrac{P_p}{qB}$

Q.14 (1)

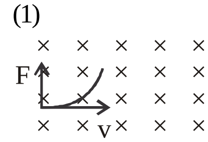


Bar-magnet



Solenoid

Q.15 (1)

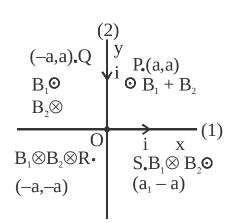


$F = qvB\sin\theta$
$\theta = 90^\circ \Rightarrow F_{max} = qvB$
$\theta = 0^\circ \Rightarrow F_{min} = 0$

$T = \dfrac{2\pi m}{qB}, K.E = \dfrac{q^2B^2r^2}{2M}$

Q.16 (2)

(–a,a).Q



$B_1 = \frac{\mu_0 i}{2\pi a}$, at point 'P

$B_2 = \frac{\mu_0 i}{2\pi a} B_{net} = \frac{\mu_0 i}{2\pi a} \times 2\hat{k}$

at point Q ,S $B_{net} = 0$

at R $B = \frac{\mu_0 i}{2\pi a} \times 2(-\hat{k})$

PREVIOUS YEAR'S

MHT CET

Q.1 (1)	**Q.2** (3)	**Q.3** (2)	**Q.4** (3)	**Q.5** (1)
Q.6 (3)	**Q.7** (1)	**Q.8** (4)	**Q.9** (2)	**Q.10** (1)
Q.11 (3)	**Q.12** (1)	**Q.13** (2)	**Q.14** (3)	**Q.15** (4)
Q.16 (4)	**Q.17** (3)	**Q.18** (2)	**Q.19** (4)	**Q.20** (1)
Q.21 (2)	**Q.22** (3)	**Q.23** (3)	**Q.24** (4)	**Q.25** (4)
Q.26 (2)	**Q.27** (2)	**Q.28** (1)	**Q.29** (3)	**Q.30** (2)
Q.31 (3)	**Q.32** (4)	**Q.33** (2)	**Q.34** (3)	**Q.35** (3)
Q.36 (3)	**Q.37** (3)	**Q.38** (2)	**Q.39** (4)	**Q.40** (1)
Q.41 (4)	**Q.42** (Bonus)	**Q.43** (3)	**Q.44** (1)	**Q.45** (3)
Q.46 (3)	**Q.47** (1)	**Q.48** (2)	**Q.49** (1)	**Q.50** (3)
Q.51 (1)	**Q.52** (4)	**Q.53** (2)	**Q.54** (1)	**Q.55** (3)
Q.56 (2)	**Q.57** (3)			

Q.58 (2) According to the question,

Magnetic field at centre of coil A = Magnetic field at centre of coil B

$\frac{\mu_0 I_1}{2(2r)} = \frac{\mu_0 I_2}{2r} \quad \Rightarrow \frac{I_1}{I_2} = 2$

We know, $R = \rho\left(\frac{I}{A}\right)$, where ρ is resistivity,I is length and A is area of cross - section.

$\Rightarrow \quad I_1 = \frac{V_1}{R_1} = \frac{V_1}{\rho\left(\frac{I_1}{A}\right)} \quad \Rightarrow \quad \frac{V_1}{I_1} = \rho.\frac{I_1}{A}$

and $\quad I_2 = \frac{V_2}{R_2} = \frac{V_2}{\rho.\left(\frac{I_2}{A}\right)} \quad \Rightarrow \quad \frac{V_2}{I_2} = \rho.\frac{I_2}{A}$

From Eqs. (ii) and (iii), we get

$\frac{V_1}{I_1} \times \frac{I_2}{V_2} = \frac{I_1}{I_2} = \frac{2\pi r_1}{2\pi r_2} \Rightarrow \frac{V_1}{V_2}.\frac{I_2}{I_1} = \frac{r_1}{r_2} \Rightarrow \frac{V_1}{V_2}.\frac{I_2}{I_1} = \frac{2r}{r}$

$\Rightarrow \frac{V_1}{V_2} = 2\frac{I_1}{I_2} = 2 \times 2$

[from Eq. (i)]

$\Rightarrow \frac{V_1}{V_2} = \frac{4}{1} = 4:1$

Q.59 (3)

In given case, the magnetic moment of the pieces get halved.

i.e., $M_1' = M_2' = \frac{M_1}{2}$

The magnetic moment of given arrangment

$M_2 = \sqrt{(M_1')^2 + (M_2')^2}$

$M_2 = \sqrt{\left(\frac{M_1}{2}\right)^2 + \left(\frac{M_1}{2}\right)^2} = \frac{M_1}{\sqrt{2}}$

$\Rightarrow \frac{M_1}{M_2} = \sqrt{2}$

Q.60 (2)

The coefficient of mutual induction is given by

$M = \frac{\mu_0 N_1 N_2 A}{I} \qquad$ ....(i)

where, μ_0 is the permeability of free space,

N_1 is the number of turns in primary coil,

N_2 is the number of turns in secondary coil,

A is the common area of cross- section

and l is the length of coils.

Thus, for toroid the Eq. (i) is given as

$M = \frac{\mu_0 N.N.\pi R^2}{2\pi r} = \frac{\mu_0 N^2 R^2}{2r} \left[\begin{array}{l}\because N_1 = N_2 = N \\ A = \pi R^2, l = 2\pi r\end{array}\right]$

Where, R is the major radius

and r is the minor radius.

Q.61 (2)

The magnetic field at the centre of coils is

$B = \frac{\mu_0 I}{2r}$

where, r = radius of the coil.

Let L be the length of wire, then

$L = 2\pi r \Rightarrow 2r = \frac{L}{\pi}$

From Eq. (i), we get

$B = \frac{\mu_0 I\pi}{L}$

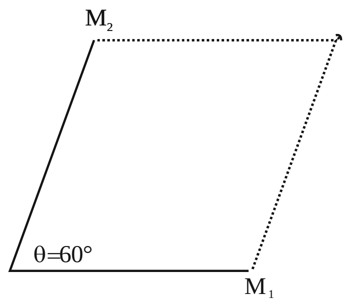
For a loop of n turns. L = 2πnr'

$\Rightarrow 2r' = \frac{L}{n\pi}$

And current, I'= nI

$\therefore B' = \frac{\mu_0 I'}{2r'} = \frac{\mu_0 n^2 I\pi}{L/n\pi} = n^2 B$ [from Eq. (ii)]

Q.62 (3) Here, $M_1 = 4\,A\text{-}m^2$
$M_2 = 5\,A\text{-}m^2$



According to parallelogram law of vector addition, resultant dipole moment M

$$M = \sqrt{M_1^2 + M_2^2 + 2M_1M_2\cos 60^\circ}$$

$$= \sqrt{4^2 + 5^2 + 2\times 4\times 5\times \cos 60^\circ}$$

$$= \sqrt{61}\,A\,m^2$$

Q.63 (2) We know that, radius of circular path in magnetic field B,

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

...(i)

When a charge q is accelerated by V volts, it acquires a kinetic energy, $E_K = qV$

$\because$ momentum $p = \sqrt{2mE_k} = \sqrt{2mqV}$

$\Rightarrow \quad mv = \sqrt{2mqV}$ ...(ii)

From Eq. (i) and (ii), we get

$$r = \sqrt{\frac{2mqV}{Bq}} = \sqrt{\frac{2mV}{qB^2}}$$

Thus, $\frac{r_\alpha}{r_p} = \sqrt{\frac{m_\alpha}{m_p}}\sqrt{\frac{q_p}{q_\alpha}} = \sqrt{\frac{4m_p}{q_\alpha}}.\sqrt{\frac{q_p}{2q_p}} = \sqrt{2}$

$\Rightarrow r_\alpha = \sqrt{2}r_p = \sqrt{2}\times\sqrt{2} = 2\text{cm}$

Q.64 (2) The inductance of a solenoid is given by

$$L = \frac{\mu_0 N^2 A}{I} = \mu_0\left(\frac{N}{I}\right)^2 \times I \times \pi \times \frac{d^2}{4}$$

$\therefore$ Inductance per unit length

$$\frac{L}{I} = \frac{\mu_0 \pi n^2 d^2}{4} \quad \left(\because \frac{N}{I} = n\right)$$

Q.65 (2) The magnetic field at the centre of a current carrying circular coil is given by

$$B = \frac{\mu_0 i}{2r} \quad \text{..........(i)}$$

Also, area of coil, $A = \pi r^2$

$\Rightarrow \quad r = \sqrt{A/\pi}$

Putting this in Eq.(i), we get

$$B = \frac{\mu_0 i\sqrt{\pi}}{2\sqrt{A}} \Rightarrow i = \frac{2B\sqrt{A}}{\mu_0\sqrt{\pi}}$$

The magnetic moment of coil is given by

$$M = NiA = \frac{2B\sqrt{A}}{\mu_0\sqrt{\pi}}\times A$$

$(\because N = 1)$

$$= \frac{2BA^{3/2}}{\mu_0 \pi^{1/2}}$$

Q.66 (1) The magnetic induction due to an arc of angle θ is given by

$$B = \frac{\mu_0}{4\pi}\left(\frac{I}{a}\right)\theta$$

Fow wires AO, DE and FG , angle θ is 0°, so they do not contribute to magnetic field induction. The arc CD of radius R_1 and arc EF of radius R_2, both subtend angle of 90° the centre O. So, total magnetic induction at O,

$$B = \frac{\mu_0 I}{4\pi R_1}.\frac{\pi}{2} + \frac{\mu_0 I}{4\pi R_2}.\frac{\pi}{2} = \frac{\mu_0 I}{4\pi}\frac{\pi}{2}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$= \frac{\mu_0 I}{8}\left(\frac{R_1 + R_2}{R_1 R_2}\right)$$

Q.67 (1) Given, $R = 200\Omega, R_L = 400\Omega$
$N = 1000, d = 20\text{ mm} = 20\times 10^{-3}\text{m}$
$B_2 = 0.012\text{ T}$ and $B_1 = 0$

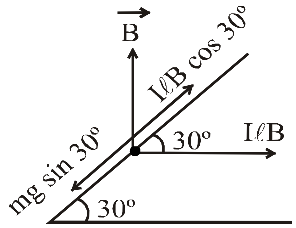
$$\therefore \quad q = \frac{\Delta\phi}{R} = \frac{N\pi\left(\frac{d^2}{4}\right)(B_2 - B_1)}{R_{eq}}$$

$$= \frac{1000\times\pi\times 10^{-4}\times(0.012 - 0)}{(200 + 400)}$$

$= 6.3\times 10^{-6}\text{C}$
$= 6.3\,\mu\text{C}$

NEET/AIPMT

Q.1 (4)



For equilibrium,

mg sin 30° = I ℓ B cos 30°

$$I = \frac{mg}{\ell B}\tan 30°$$

$$= \frac{0.5\times 9.8}{0.25\times\sqrt{3}} = 11.32A$$

Q.2 (3)
The energy provided by current source will be converted into potential energy of the rod.

Q.3 (1)
For 1 division,

$$\text{Current} = \frac{1}{5}\text{ mA}$$

$$\text{Voltage} = \frac{1}{20}\text{ volt}$$

$$\text{Resistance} = \frac{V}{I} = \frac{1}{20}\left(\frac{5}{10^{-3}}\right) = \frac{1000}{20}\times 5 = 250\Omega$$

Q.4 (3)
From ampere circuital law

$$\oint B.d\ell = \mu_0 I' \qquad \Rightarrow I' = \frac{I}{\pi R^2}\times\pi r^2$$

$$B2\pi r = \mu_0\frac{I}{\pi R^2}\times\pi r^2$$

$$B = \frac{\mu_0 I}{2\pi R^2}r$$

$B_{inside}\ \alpha\ r$

$B_{outside}$

$$\oint B.d\ell = \mu_0 I$$

$$B2\pi r = \mu_0 I$$

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

$$B\alpha\frac{1}{r}$$

Q.5 (1)

$$r = \frac{mv}{qB} = \frac{p}{qB} \Rightarrow r\ \alpha\ \frac{1}{q}$$

$$\frac{r_H}{r_\alpha} = \frac{q_\alpha}{q_H} = \frac{2}{1} = 2:1$$

Q.6 (4)

Q.7 **(4)**

Q.8 (1)

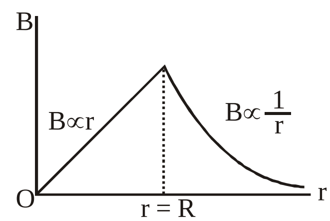
Q.9 (2)

Q.10 (3)

Q.11 (1)

Q.12 (4)

Q.13 (2)

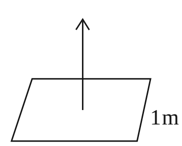


Q.14 **(2)**

$$d\vec{B} = \frac{\mu_0\left(Id\vec{\ell}\times\vec{r}\right)}{4\pi r^3}$$

As per Biot Savart law, the expression for magnetic field depends on current carrying element $Id\vec{\ell}$, which is a vector quantity, therefore, statement-I is correct and statement-II is wrong.

Q.15 (1)
B = 0.5 T



Angle between $\vec{B}$ & $\vec{A}$ is zero

ϕ = B.A. cos 0

= 0.5 × (1) × 1

= 0.5 Wb

Q.16 **(1)**

$$B = \mu_0 ni = \mu_0 \frac{N}{\ell} i$$

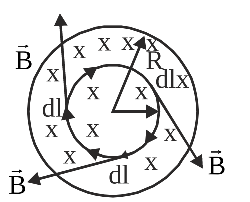
$$\therefore\ B = 4\pi\times10^{-7}\times\frac{100}{10^{-3}}\times1 = 12.56\times10^{-2}\,T$$

JEE MAIN

Q.1 **(2)**

Use Ampere's law

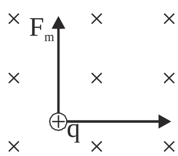
$\oint \vec{B}.d\vec{l} = \mu_0 \Sigma I_{in}$ $\otimes$ direction of current



$$B.2\pi r = \mu_0.\frac{I}{\pi R^2}.\pi r^2$$

Thus $B \propto r$

Q.2 (1)



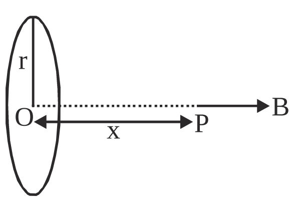
Q.3 (3)

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

where $x = 0,\ B = \frac{\mu_0 I}{2R}$

find out magnetic field when x = R/2

$$B' = \frac{\mu_0 IR^2}{2\left(R^2+\left(\frac{R}{2}\right)^2\right)^{3/2}} = \frac{\mu_0 IR^2}{2\left(R^2+\frac{R^2}{4}\right)^{3/2}}$$



$$B' = \frac{\mu_0 IR^2}{2\left(\frac{5R^2}{4}\right)^{3/2}} = \frac{\mu_0 IR^2}{2\left(\frac{5}{4}\right)^{3/2} R^3}$$

$$B' = \frac{\mu_0 I}{2R\left(\frac{5}{4}\right)^{3/2}}$$

$$B' = \frac{B}{\left(\frac{5}{4}\right)^{3/2}} = \frac{(4)^{3/2}}{(\sqrt{5})^3} B$$

$$B' = \frac{8}{(\sqrt{5})^3} B = \left(\frac{2}{\sqrt{5}}\right)^3 B$$

Q.4 **(4)**

Proton $\rightarrow$ m, e

Deuteron $\rightarrow$ 2m, e

α-particle $\rightarrow$ 4m, 2e

$$\because R = \frac{mv}{qB} = \frac{\sqrt{2m(KE)}}{qB}$$

$$R_P : R_D : R_\alpha = \frac{\sqrt{2\,mk}}{eB} : \frac{\sqrt{2(2m)k}}{eB} : \frac{\sqrt{2(4m)k}}{2eB}$$

$$= 1 : \sqrt{2} : 1$$

Q.5 (1)

$B = \mu_0 nI$ ...(1) n $\rightarrow$ No. of turn per unit length

I $\rightarrow$ Current

$B' = \mu_0 (n/2)\, 2I$

$B' = \mu_0 nI$ ...(2)

$\boxed{B' = B}$

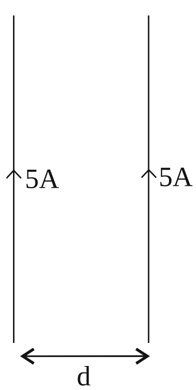
Q.6 (3)

Q.7 **[5]**

It should be mentioned, 10 cm wire is part of long wire.

Force experienced by unit length of wire

$$= \frac{\mu_0 I_1 I_2}{2\pi d}, I_1 = I_2 = 5A$$



Force experienced by wires of length 10 cm

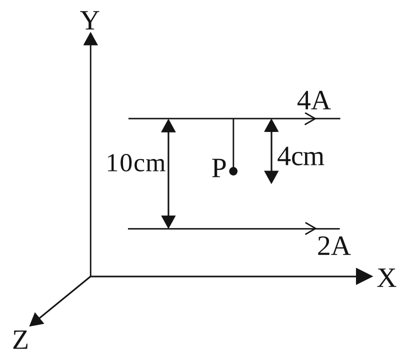
$$= \frac{\mu_0 I_1 I_2}{2\pi d} \times 10 \times 10^{-2}$$

$$10^{-5} = \frac{2\times10^{-7}\times5\times5}{d}\times10\times10^{-2}$$

$d = 50 \times 10^{-3}$ m

$d = 50 \times 10^{-1}$ cm $= 5$ cm

Q.8 (3)



$$B_{net} = B_1 - B_2 = \frac{\mu_0 \times 4}{2\pi[.04]} - \frac{\mu_0 \times 2}{2\pi[0.6]}$$

$$\vec{B}_{net} = \frac{\mu_0}{2\pi}\left[\frac{200}{3}\right](-\hat{k})$$

$$\vec{F} = q[\vec{v}\times\vec{B}]$$

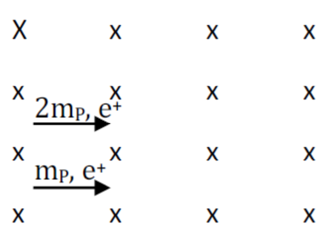
$$= [3\pi]\left[(2\hat{i}+3\hat{j})\times\left(\frac{\mu_0}{2\pi}\right)\left(\frac{200}{3}\right)-\hat{k}\right]$$

$$= 3\pi\times\frac{\mu_0}{2\pi}\left(\frac{200}{3}\right)[2\times\hat{j}-3(\hat{i})]$$

$$= (4\pi\times10^{-7})(100)(-3\hat{i}+2\hat{j})$$

$$= 4\pi\times10^{-5}\times\left[-3\hat{i}+2\hat{j}\right]$$

Q.9 (2)



$$R = \frac{mv}{q_B}$$

$$R_D = \frac{(2m_p)V_D}{eB}$$

$$R_P = \frac{(m_P)v_P}{eB}$$

$$\frac{R_D}{R_P} = \frac{2V_D}{V_P} = \frac{2v_D}{\sqrt{2}v_D} = \frac{\sqrt{2}}{1}$$

$$\frac{1}{2}(2mp)v_D^2 = \frac{1}{2}m_p.v_P^2$$

$$\sqrt{2}V_D = v_P$$

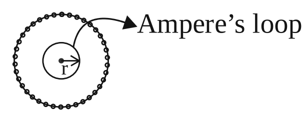
$x = 2$

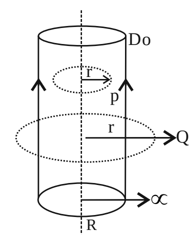
Q.10 (4)

Magnetic field due to infinitely long cylindrical wire carrying on its outer surface :

(Hollow cylinder)

(a) Inside (r < R)





$$\int \overline{Bd\ell} = \mu_0 I_{inside}$$

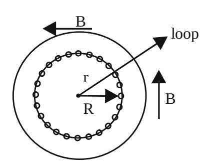
$\{I_{inside} = \text{zero}\}$

$B = 0$

(b) At point Q outside (r > R)

$$\int \vec{B}d\vec{\ell} = \mu_0 I_{inside}$$

$\{I_{inside} = I\}$

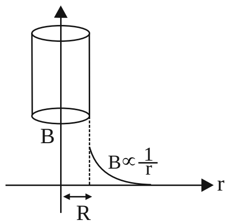


$$B\int d\ell = \mu_0 I$$

$$B.\,2\pi r = \mu_0 I$$

$$B = \frac{\mu_0}{2\pi}\frac{i}{r}$$

$$B \propto \frac{1}{r}$$



Q.11 (10)

A = 24

KE = 5 kev

B = 0.5T

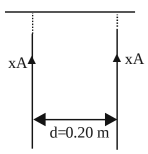
Radius of Path $R = \frac{\sqrt{2km}}{qB}$

$= \frac{\sqrt{2\times5\times10^3\times1.6\times10^{-19}\times24\times1.67\times10^{-27}}}{1.6\times10^{-19}\times0.5}$

= 0.1 m

R = 10 cm

Q.12 (3)



Force per unit length $= \frac{\mu_0 i_1 i_2}{2\pi d}$

$= \frac{\mu_0 . x^2}{2\pi\times0.2}$

$F = 2\times10^{-6} = \frac{4\pi\times10^{-7}\times x^2}{2\pi\times0.2}$

$\Rightarrow 10^{-6} \Rightarrow 10^{-7}\frac{x^2}{0.2}$

$\Rightarrow x^2 = 10\times0.2$

= 2

$\Rightarrow x = \sqrt{2} \approx 1.4\text{Amp}$

Q.13 (3)

$K.E_{(f)} = 4 K. E_{(i)}$

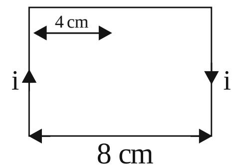
$r = \frac{mv}{qB} = \frac{\sqrt{2mK}}{qB}$

$\frac{r_i}{r_f} = \frac{\sqrt{K_i}}{\sqrt{K_f}} = \frac{\sqrt{K}}{\sqrt{4K}} = \frac{1}{2}$

$\therefore \frac{r_f}{r_i} = \frac{2}{1}$

Q.14 (2)

Current due to both wires has to be in opposite directions only then magnetic fields due to both wires will be in same direction and resultant magnetic field will not be zero.



We know that magnetic field due to an infinite wire at a distance r is : $B = \frac{\mu_0 i}{2\pi r}$

For wires let current be i

$= 2\times\frac{\mu_0 i}{2\pi r} = 300\times10^{-6}\text{ T}$

$= \frac{4\pi\times10^{-7}\times i}{\pi\times4\times10^{-2}} = 300\times10^{-6}\text{T}$

$\Rightarrow i = 30\text{ A}$

Q.15 (2)

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

$R = \frac{\sqrt{2mk}}{qB}\{k = \text{same}, B = \text{same}\}$

$\frac{q_1}{q_2} = \left(\sqrt{\frac{m_1}{m_2}}\right)\left(\frac{R_2}{R_1}\right)$

$\frac{q_1}{q_2} = \left(\sqrt{\frac{9}{4}}\right)\left(\frac{5}{6}\right)$

$\frac{q_1}{q_2} = \frac{5}{4}$

Q.16 (2)

$B_1 = \frac{2\mu_0 i}{2R_1}$ $\qquad 2\times2\pi R_1 = 5\times2\pi R_2$

$B_2 = \frac{5\mu_0 i}{2R_2}\frac{R_1}{R_2} = \frac{5}{2}$

$\frac{B_2}{B_1} = \frac{5}{2}\frac{R_1}{R_2}$

$= \frac{5}{2}\times\frac{5}{2} = \frac{25}{4}$

Q.17 (3)

$$f = \frac{qB}{2\pi m} = \frac{1.6\times10^{-19}\times1\times10^{-4}}{2\times3.14\times9\times10^{-31}}$$

$= 0.028 \times 10^{-23+31}$

$= 0.028 \times 10^{8}$

$= 2.8 \times 10^{6}\text{Hz}$

Q.18 (2)

$\vec{B}.\vec{a} = 0, \left[\vec{B} \perp \vec{a}\right]$

$2\alpha - 12 = 0$

$\alpha = 6$

Q.19 (2)

$$\frac{B_x}{B_y} = \frac{\frac{\mu_0 N_1 I}{2r}}{\frac{\mu_0 N_2 I}{2r}} = \frac{N_1}{N_2} = \frac{200}{400} = \frac{1}{2}$$

Q.20 (2)

Given, I = 7 A

$R_1 = 30$ cm

$R_2 = 50$cm

Magnetic Moment (M) = nIA {A is area of coil}

$$M_1 = 7\times\pi\times\left(\frac{30}{100}\right)^2 = 7\times\frac{22}{7}\times\frac{9}{100} = 1.98\text{A} - \text{m}^2$$

$$M_2 = 7\times\pi\times\left(\frac{50}{100}\right)^2 = 7\times\frac{22}{7}\times\frac{25}{100} = 5.50\text{A} - \text{m}^2$$

And in vector form these magnetic moments are:

$\overrightarrow{M_1} = 1.98\hat{k}\left(\text{A} - \text{m}^2\right)$

$\overrightarrow{M_1} = -5.50\hat{k}\left(\text{A} - \text{m}^2\right)$

$\Rightarrow \overrightarrow{M} = \overrightarrow{M}_1 + \overrightarrow{M}_2$

$\Rightarrow \overrightarrow{M} = (-5.50 + 1.98)\hat{k}\left(\text{A - m}^2\right)$

$\Rightarrow \overrightarrow{M} = -3.52\hat{k}\left(\text{A} - \text{m}^2\right)$

Q.21 (1)

K= 728 Ev

$\Rightarrow \frac{1}{2}mv^2 = 728$

$v = \sqrt{\frac{2\times728}{m}}$ ....(1)

Now, eE = evB

$\Rightarrow E = vB$

$= \sqrt{\frac{2\times728\times1.6\times10^{-19}}{9.1\times10^{-31}}}\times12\times10^{-3}$

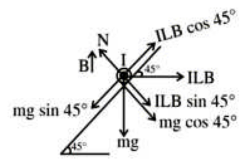
$=192\times10^{3}$ v/m

Q.22 (2)

$$r = \frac{mv}{Bq} \Rightarrow K = \frac{B^2q^2r^2}{2m} = \frac{\left(1.6\times10^{-19}\right)^2\times1^2\times\left(\frac{60}{100}\right)^2}{2\times1.6\times10^{-27}}$$

= 18 Mev

Q.23 (1)

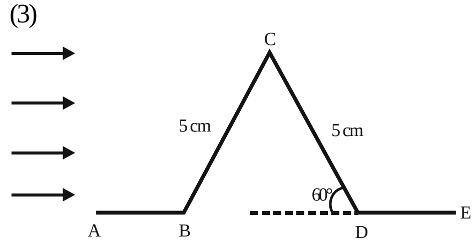


mg sin 45° = ILBcos45°

$\therefore I = \left(\frac{m}{L}\right)\frac{g}{B}$

$= \frac{(0.45)(10)}{0.15} = 30\text{A}$

Q.24 (3)



B = 0.5 T

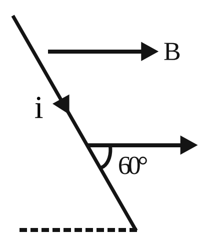
i = 10 A

Force on CD

F = iBlsin θ (θ = angle between B & l)

$F = 10 \times 0.5 \times 5 \times 10^{-2} \times \sin 60$

$= 5 \times 5 \times 10^{-2} \times \frac{\sqrt{3}}{2}$



= 0.216 N

Q.25 (3)

magnetic field at center of loop

$B_1 = \frac{\mu_0 i}{2R}$

Magnetic field at x = $\sqrt{3}R$

$$B_2 = \frac{\mu_0 iR^2}{2(R^2 + x^2)^{3/2}} = \frac{\mu_0 iR^2}{2(R^2 + 3R^2)^{3/2}}$$

$$= \frac{\mu_0 iR^2}{2(4R^2)^{3/2}} = \frac{\mu_0 i}{16R}$$

So, $\frac{B_1}{B_2} = \frac{16}{2} = \frac{8}{1}$

$B_1 : B_2 = 8 : 1$

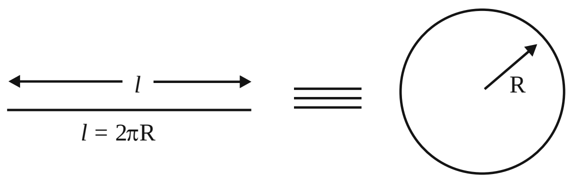
Q.26 (3)

$$B_{centre} = \frac{N\mu_0 I}{2R}$$

$$37.68 \times 10^{-4} = \frac{100 \times 4\pi \times 10^{-7} \times I}{2 \times 5 \times 10^{-2}}$$

$I = 3A$

Q.27 (11)



$$\frac{314}{100} = 2\pi R$$

$R = 0.5\, m$

Magnetic Moment = IA

$= 14 \times \pi R^2$

$$= 14 \times (3.14) \times \frac{1}{4}$$

$= 10.99 \approx 11.00$

Q.28 (1)

Force of interaction = $I_1 \ell_1 B_{12}$

$$= \frac{\mu_0 I_1 I_2}{2\pi r} \ell_1$$

$$= \frac{4\pi \times 10^{-7} \times 6 \times 0.5}{2\pi \times 5 \times 10^{-2}}$$

$= 1.2 \times 10^{-5}$ towards X

MAGNETISM AND MATTER

EXERCISE-I (MHT CET LEVEL)

Q.1 (4) **Q.2** (2) **Q.3** (1) **Q.4** (2) **Q.5** (3)
Q.6 (4) **Q.7** (1) **Q.8** (2) **Q.9** (4) **Q.10** (2)
Q.11 (Bouns) **Q.12** (4) **Q.13** (3) **Q.14** (2) **Q.15** (4)

EXERCISE-II (NEET LEVEL)

Q.1 (4)
As at very high temperature, the needle looses its magnetism

Q.2 (4)
Area enclosed by loop = energy loss per cycle

Q.3 (4) $F \propto \frac{1}{r^4}$

Q.4 (1)

$$T \propto \frac{1}{\sqrt{B}} \Rightarrow \frac{T'}{T} = \sqrt{\frac{R\cos 60°}{R}} \Rightarrow T' = \frac{T}{\sqrt{2}}$$

Q.5 (1) $T = MB\sin\theta = (10^{-3} \times 10^{-1})4\pi \times 10^{-3} \times \frac{1}{2}$

Q.6 (1) $T = MB\sin\theta = 4 \times 0.1 \times 4 \times \frac{1}{\sqrt{2}} = 1.13$ Nm

Q.7 (3) $\frac{\mu_0}{4\pi} \times \frac{2M}{r_1^3} = \frac{\mu_0}{4\pi} \times \frac{M}{r_2^3}$

$$\frac{r_1}{r_2} = 2^{1/3}$$

Q.8 (4) Factual

Q.9 (3) $T = 2\pi\sqrt{\frac{I}{MH}}$

Q.10 (1) The susceptibility of a diamagnetic substance is almost independent of its temperature

Q.11 (1) Repulsion is a sure test of magnetism

Q.12 (3) Reverse field cancels the magnetism

Q.13 (4) Definition of angle of dip

Q.14 (1) $T = 2\pi\sqrt{\frac{I}{MB}}$

Q.15 (2) Here, null points are obtained at the equator of bar magnet

Q.16 (1)

$$W = MB[\cos\theta_1 - \cos\theta_2] = 10^4 \times 4 \times 10^{-5}\left[1 - \frac{1}{2}\right] = 0.2\,J$$

Q.17 (3) Magnetic lines of force form closed loops

Q.18 (2) $T \propto \sqrt{I}$ $\{\because M = \text{same}\}$
$\Rightarrow T \propto L$

$$\frac{T'}{T} = \frac{L'}{L} = \frac{1}{3}$$

$$T' = \frac{2}{5}s$$

Q.19 (2) The retentivity should be law, as after removing current, substance doesn't remain magnetised.
The correctly should be low, so t hat magnetic field of electromagnet can be controlled easily.

EXERCISE-III

Q.1 (2)
$\vec{\tau} = \vec{M} \times \vec{B} = MB\sin\theta\hat{n}$
If $\theta = 90° \Rightarrow M \perp B \Rightarrow \tau_{max}$
S1 $\rightarrow$ correct
S2 $\rightarrow$ incorrect

Q.2 (3)
l $\rightarrow$ independent of lemp.
$\rightarrow$ net magnetic moment of diamgnetic material is zero.

Q.3 (1) S_n tangent galvanometer.

$$i = \left(\frac{2RB_N}{\mu_0 N}\right)\tan\theta$$

$$\boxed{i \propto \frac{1}{N}}$$

...(i)

Sonsitiving = $\frac{d\theta}{di}$

from (1) & (2) $\frac{d\theta}{di} = \frac{\sin 2\theta}{2i}$ ...(ii)

$\frac{d\theta}{di} \propto N$ option (1)

Q.4 (3) For paramagnetic

$$X = \frac{C}{T}$$

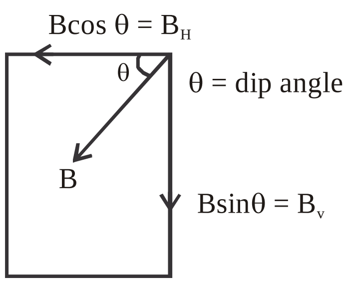
for ferromagnetic

$$k = \frac{C}{T - T_C}(T > T_C)$$

Temp. increases ⇒ aligement deweases

Q.5 (1) $u_r >> 1$ for feromognet
→ for permanent magnet retentiving & corrcivity is high
→ X = – ve for diamagnetic they move from stronges to weak magnetic field .
a → (iii), b → (iv), c → (ii),d → (i)

Q.6 (4)



a → (ii), b → (i), c → (iv),d → (iii)

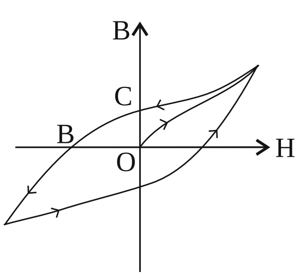
PREVIOUS YEAR'S

NEET/AIPMT

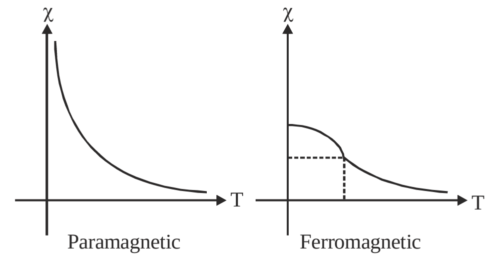
Q.1 (2)
∵ At point A, angle of dip is positive and earth's magnet north pole is in southern hemisphere so angle of dip is positive in southern hemisphere
A is located in southern hemisphere
B is located in northern hemisphere

JEE MAIN

Q.1 (3)
According to theory.
For soft iron core
OC → retentivity low
OB → Coercivity low



Q.2 (1)



as the temp. decreases χc↑ and diamagnetism occurs due to orbital motion of e^-

Q.3 (3)
Susceptibility $\chi = 99$

$$\mu_r = \frac{\mu}{\mu_0} = 1 + \chi$$

$\mu = \mu_0 (1 + \chi)$
$= 4\mu \times 10^{-7} [1 + 99]$
$= 4\mu \times 10^{-5}$

Q.4 (1)

$$\chi = 1.2 \times 10^{-5}$$

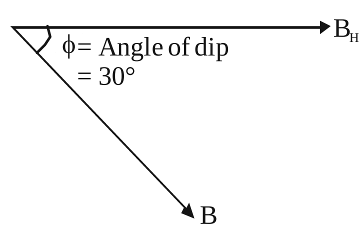
$$\mu_r = 1 + \chi = 1 + 1.2 \times 10^{-5}$$

Fractional Change

$$= \frac{\Delta B}{B} = \frac{\mu_0 \mu_r ni - \mu_0 ni}{\mu_0 ni} = (\mu_r - 1)$$

$= 1.2 \times 10^{-5}$

Q.5 (1)



$B_H = 0.50$ G
$\phi = 30°$
$B_H = B \cos\phi$

$$B = \frac{B_H}{\cos\phi} = \frac{0.5}{\cos 30°} = \frac{0.5}{\frac{\sqrt{3}}{2}} = \frac{1}{\sqrt{3}}$$

$$\boxed{B = \frac{1}{\sqrt{3}}}$$

Q.6 (1)
Work done = MB $(\cos\theta_1 - \cos\theta_2)$
$\theta_1 = 0°$, $\theta_2 = 60°$
$= 2 \times 10^5 \times 14 \times 10^{-5} (1 - 1/2)$
= 14 J

Q.7 (2)

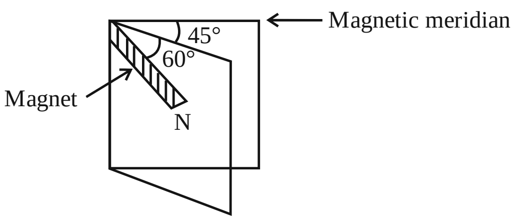
$$T = 2\pi\sqrt{\frac{I}{MB}} \quad B \to \text{Earth horizontal magnetic field}$$

$$T \propto \sqrt{\frac{I}{M}} \Rightarrow M \propto \frac{I}{T^2}$$

$$\text{So, } \frac{M_1}{M_2} = \frac{I_1}{I_2} \times \left(\frac{T_2}{T_1}\right)^2$$

$$\frac{M_1}{M_2} = \frac{3}{2} \times \left(\frac{4}{3}\right)^2 = \frac{3}{2} \times \frac{16}{9} = \frac{8}{3}$$

Q.8 (1)



Angle between real magnetic meridian and apparent magnetic meridian

$\alpha = 45°$

... (1)

Apparent angle of dip $\delta_A = 60°$

$$\tan\delta_A = \frac{\tan\delta}{\cos\alpha}$$

$$\tan 60° = \frac{\tan\delta}{\cos(45°)}$$

$$\sqrt{3} = \frac{\tan\delta}{\frac{1}{\sqrt{2}}}$$

$$\tan\delta = \frac{\sqrt{3}}{\sqrt{2}} \Rightarrow \boxed{\delta = \tan^{-1}\left(\sqrt{\frac{3}{2}}\right)}$$

Q.9 (2)

$$T_1 = 2\pi\sqrt{\frac{I}{MB_p\cos\alpha_1}}$$

$$T_2 = 2\pi\sqrt{\frac{I}{MB_Q\cos\alpha_2}}$$

$$\text{Or } \frac{10}{20} = \frac{1}{2} = \sqrt{\frac{B_Q\cos\alpha_2}{B_P\cos\alpha}}$$

$$(B_H)_P = B_P\cos\alpha$$

$$\frac{B_Q\cos 60^o}{B_P\cos 30^o} = \frac{1}{4}$$

$$\frac{B_Q}{B_P} = \frac{\cos 30}{4\cos 60} = \sqrt{3} : 4$$

Q.10 (4)

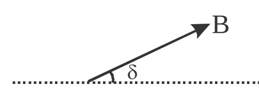
$(\delta = 37^o)$

$B_v = B\sin\delta$

$$6 \times 10^{-5} = B\,\frac{3}{5}$$

$B = 10 \times 10^{-5}T$

$= 10^{-4}T$



ELECTROMAGNETIC INDUCTION

EXERCISE-I (MHT CET LEVEL)

Q.1 (3) Mechanical energy converts into electrical energy =Lenz' s law is a consequence of conservation of energy

Q.2 (4) $e = -L\dfrac{di}{dt}$

$$\text{But } e = 4V \text{ and } \frac{di}{dt} = \frac{0-1}{10^{-3}} = \frac{1}{10^{-3}}$$

$$\therefore \frac{-1}{10^{-3}}(-L) = 4 \Rightarrow L = 4\times10^{-3} \text{ henry}$$

Q.3 (4) $|e| = N\left(\dfrac{\Delta B}{\Delta t}\right).A\cos\theta = 500 \times 1 \times (10 \times 10^{-2})^2 \cos\theta$

=5V

Q.4 (1) At any time t, the side of the square $a = (a_0 - \alpha t)$, where a_0 = side at $t = 0$.
At this instant, flux through the square :

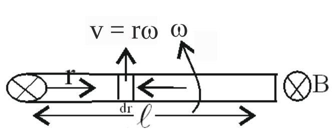
$$\phi = BA\cos 0^\circ = B(a_0 - \alpha t)^2$$

$$\therefore \text{emf induced } E = -\frac{d\phi}{dt}$$

$$\Rightarrow E = -B.2(a_0 - \alpha t)(0 - \alpha) = +2\alpha aB$$

Q.5 (1) As the inward magnetic field increases its flux also increases into the page and so induced current in bigger loop will be anticlockwise.i,e from D to C in bigger loop and then from B to A in smaller loop.

Q.6 (1)
Q.7 (3)
Q.8 (1)
Q.9 (2)
Q.10 (2)
Q.11 (2)
Q.12 (2)



$de = Br\omega\, dr$

emf = $\int de = B\omega\int_0^{l} r\,dr$ rt

$$f = \frac{B\omega l^2}{2}$$

Q.13 (1)
Q.14 (1)
Q.15 (2)
Q.16 (4)

Q.17 (1) Eddy current can be created when a conductor is moving through a magnetic field or when the magnetic field surrounding a stationary conductor is varying.

Q.18 (3)
Q.19 (1)
Q.20 (3)
Q.21 (2)
Q.22 (2)
Q.23 (3)

$L = \mu_0 N^2 A / l$

Q.24 (3)
Q.25 (3)
Q.26 (3)

EXERCISE-II (NEET LEVEL)

Q.1 (3) Because induced e.m.f. is given by $E = -N\dfrac{d\phi}{dt}$

Q.2 (4) Indiced cmf in the lop is given by $c = -B\dfrac{dA}{dt}$

where A is the area os the loop.

$$c = -B\frac{dA}{dt}(\pi r^2) = -B\pi 2r\frac{dr}{dt}$$

r = 2cm = 2 × 10^{-2} m
dr = 2 mm = 2 × 10^{-3} m

$$e = -0.04\times3.14\times2\times2\times10^{-12}\times\frac{2\times10^{-3}}{1}V$$

$$= 0.32\pi\times10^{-5}V$$

$$= 3.2\pi\times10^{-6}V \qquad = 3.2\pi\mu V$$

Q.3 (1) $e = -\frac{d\phi}{dt} = \frac{-3B_0A_0}{t}$

Q.4 (1) $\phi = BA = 10$ weber

Q.5 (1) $I = \frac{e}{R} = \frac{-N(d\phi/dt)}{R} = \frac{10 \times 10^8 \times 10^{-4} \times 10^{-4} \times 10}{20}$

$= 5A$

Q.6 (2) $e = -\frac{N(B_2 - B_1)A\cos\theta}{\Delta t}$

$= -\frac{50(0.35-0.10)\times\pi(3\times10^{-2})^2\times\cos 0°}{2\times10^{-3}} = 17.7\ V$

Q.7 (3) The induced current will be in such a direction so that it opposes the change due to which it is produced.

Q.8 (2) Factual

Q.9 (2) emf is induced in the coil due to change in magnetic flux.

Q.10 (1) Emf = $e = e_0 \sin\theta$; e will be maximum when θ is 90° i.e. plane of the coil will be horizontal

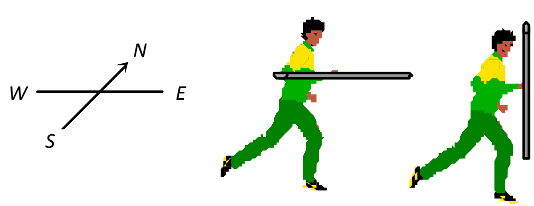
Q.11 (4) Conductor cuts the flux only when, if it moves in the direction of M.

Q.12 (2) $e = Bvl = 3\times10^{-3}\times10^2 = 0.3$ volt

Q.13 (2) If player is running with rod in vertical position towards east, then rod cuts the magnetic field of earth perpendicularly (magnetic field of earth is south to north).
Hence Maximum emf induced is

$e = Bvl = 4\times10^{-5}\times\frac{30\times1000}{3600}\times 3 = 1\times10^{-3}$ volt

When he is running with rod in horizontal position, no field is cut by the rod, so $e = 0$.



Q.14 (3) $e = NBA\omega;\ \omega = 2\pi f = 2\pi\times\frac{2000}{60}$

$\therefore e = 50\times0.05\times80\times10^{-4}\times2\pi\times\frac{2000}{60} = \frac{4\pi}{3}$

Q.15 (4) $e = -L\frac{di}{dt}$ but e = 4V and $\frac{di}{dt} = \frac{0-1}{10^{-3}} = -\frac{1}{10^{-3}}$

$\therefore \frac{-1}{10^{-3}}(-L) = 4 \Rightarrow L = 4\times10^{-3}$ henry

Q.16 (4)

Q.17 (3) Self inductance $L = \mu_0 N^2 A/l = \mu_0 n^2 lA$
Where n is the number of turns per unit length and N is the total number of turns and $N = nl$
In the given question n is same. A is increased 4 times and l is increased 2 times and hence L will be increased 8 times.

Q.18 (3) $M = -\frac{e_2}{di_1/dt} = -\frac{e_1}{di_2/dt}$

Also $e_1 = -L_1\frac{di_1}{dt}$. $e_2 = -L_2\frac{di_2}{dt}$

$M^2 = \frac{e_1e_2}{\left(\frac{di_1}{dt}\right)\left(\frac{di_2}{dt}\right)} = L_1L_2 \Rightarrow M = \sqrt{L_1L_2}$

Q.19 (4) $e = -L\frac{di}{dt} \Rightarrow 2 = -L\left(\frac{8-2}{3\times10^{-2}}\right)$

$\Rightarrow L = 0.01\ H = 10\ mH$

Q.20 (4) $e = M\frac{di}{dt} = 1.25\times80 = 100\ V$

Q.21 (4) As we know $e = -\frac{d\phi}{dt} = -L\frac{di}{dt}$

Work done against back e.m.f. e in time dt and current i is

$dW = -eidt = L\frac{di}{dt}idt = Li\,di$

$\Rightarrow W = L\int_0^i i\,di = \frac{1}{2}Li^2$

Q.22 (3) Growth in current in LR_2 branch when switch is closed given by

$i = \frac{E}{R^2}\left[1 - e^{-R_2t/l}\right]$

$\Rightarrow \frac{di}{dt} = \frac{E}{R_2}\frac{R^2}{L}e - R_2t/L = \frac{E}{L}e\frac{R_2t}{L}$

Hence, potential drop across

$L = \left(\frac{E}{L}e^{-R_2t/L}\right)L = Ee^{-R_2t/L}$

$= 12e\frac{2t}{400\times10^{-3}} = 12 - 5tv$

Q.23 (4) Because of the Lenz's law of conservation of energy.

Q.24 (3) As per Lenz law

Q.25 (2) There will be self induction effect when soft iron core is inserted.

Q.26 (3) $M = \dfrac{\mu_0 N_1 N_2 A}{l}$

Q.27 (4)

Q.28 (4) Current in inductor $= \dfrac{E}{R}$

$\therefore$ its energy $= \dfrac{1}{2}\dfrac{LE^2}{R^2}$

Same energy is later stored in capacitor

$$\frac{Q^2}{2C} = \frac{1}{2}\frac{LE^2}{R^2} \Rightarrow Q = \sqrt{LC}\,\frac{E}{R}$$

Q.29 (3)

$$\nu_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\times 3.14\sqrt{5\times10^{-4}\times 20\times10^{-6}}}$$

$$\nu_0 = \frac{10^4}{6.28} = 1592 \text{ Hz}$$

Q.30 (2) We know that for step down transformer

$V_p > V_s$ but $\dfrac{V_p}{V_s} = \dfrac{i_s}{i_p}$; $\therefore\ i_s > i_p$

Current in the secondary coil is greater than the primary.

Q.31 (1) $\dfrac{N_s}{N_p} = \dfrac{V_s}{V_p} \Rightarrow \dfrac{200}{100} = \dfrac{V_s}{120} \Rightarrow V_s = 240$ V

Also $\dfrac{V_s}{V_p} = \dfrac{i_p}{i_s} \Rightarrow \dfrac{240}{120} = \dfrac{10}{i_s} \Rightarrow i_s = 5$A

Q.32 (1) $\dfrac{V_s}{V_p} = \dfrac{N_s}{N_p} = k \Rightarrow \dfrac{V_s}{30} = \dfrac{3}{2} \Rightarrow V_s = 45$ V

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (4) Since $\Delta\phi = 0$ hence EMF induced is zero.

Q.2 (4) The direction of current in the loop such that it opposes the the change in magnetic flux in it.

Q.3 (3) The direction of current in the loop such that it opposes the the change in magnetic flux in it.

Q.4 (3) Since the magnetic flux in the loop is zero hence the current induced in it is zero.

Q.5 (1) $\phi = BA\cos\theta$

$10^{-13} = B(0.02)\left(\dfrac{1}{2}\right)$

$B = 10^{-1}$ T = 0.1 T.

Q.6 (1) $\phi = NBA$
$= 500\times5\times10^{-3}\times2\times10^{-3}$
$= 50\times10^{2}\times10^{-6}$
$= 5\times10^{-3}$ Wb.

Q.7 (3) $\phi = B.\pi(R_0 + t)^2$

$E = \dfrac{d\phi}{dt} = 2B\pi(R_0 + t)$

Q.8 (4) $\varepsilon = \dfrac{d\phi}{dt} = -(12t - 5)$

at t = 0.25 sec.

$\varepsilon = -[12(10.25) - 5] = 2$

$i = \dfrac{\varepsilon}{R} = \dfrac{2}{10} = 0.2A$

Q.9 (4) If $\vec{v} \,||\, \vec{\ell}$ or $\vec{v} \,||\, \vec{B}$ or $\vec{\ell} \,||\, \vec{B}$ then $\dfrac{d\phi}{dt}$ is zero.

Hence potential difference is zero.

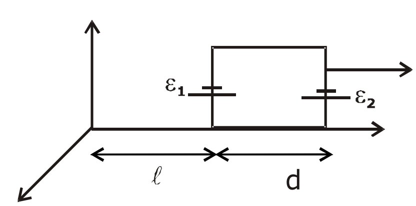
Q.10 (2) When the loop enters the magnetic field the magnetic flux in it changes till it covers a distance 'a'. Hence the EMF induced in the surface after that flux in it remains constant till its back portion has not entered in magnetic field. No emf is induced during this time.when it is out of magnetic field the magnetic flux in it decreases. EMF is again induced in the circuit hence total time for which emf is induced is $\dfrac{2a}{v}$.

Q.11 (2) $\varepsilon = \vec{B}.(\vec{V}\times\vec{\ell}) = (3\hat{i} + 4\hat{j} + 5\hat{k}).[1\hat{i}\times 5\hat{j}]$

$\varepsilon = 25$ volt.

Q.12 (2) $\varepsilon = (\vec{v}\times\vec{B})\cdot\vec{l}$

Q.13 (1)



$\varepsilon_1 = v_0 d\, B_0\left(1 + \dfrac{l}{a}\right)$, $\varepsilon_2 = v_0 d.\, B_0\left(1 + \dfrac{l + d}{a}\right)$

$$\varepsilon_2 - \varepsilon_1 = \frac{v_0 B_0 d}{a} = \frac{v_0 B_0 d^2}{a}$$

Q.14 (2) d*l* vector is same in both the cases.

Q.15 (4) There is no change in flux so induced emf is zero.

Q.16 (2) Since $\frac{d\phi}{dt}$ is same in both cases hence the induced emd thus induced current will also be same in both cases.

Q.17 (4) Induced motional emf in MNQ is equivalent to the motional emf in an imaginary wire MQ i.e.,

$e_{MNQ} = e_{MQ} = Bv\ell = Bv(2R)$

$[\ell = MQ = 2R]$

Therefore , potential difference developed across the ring is 2RBv with Q at higher potential.

Q.18 (1) $\phi = BA$

$\left(\vec{v} \times \vec{B}\right) \cdot \frac{d\phi}{dt} = e = \frac{AdB}{dt} = CA$ (Straight line)

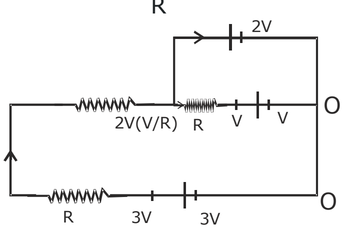
$E_{in} \downarrow$ as $r > R$

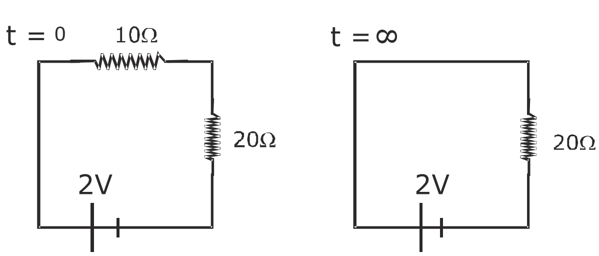
Q.19 (2) ⟵ E ⟶ eE = F

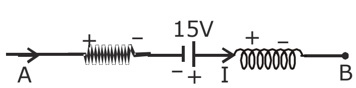
Q.20 (1) $L = \frac{\phi}{i}$, $iL = N\phi$, $iL = NBA \Rightarrow i = \frac{NBA}{L}$

$\frac{-V}{R} e^{-Rt/L}$

Q.21 (2)





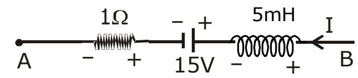


$V_A - V_B = IR - 15 + L\frac{di}{dt}$

$V_A - V_B = -15$

$V_B - V_A = 15$

Q.22 (3)



$V_B - V_A = \frac{Ldi}{dt} + 15 + IR$

$V_B - V_A = 15$ Volt

Q.23 (1)

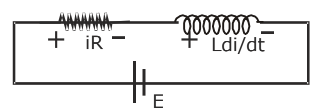
Q.24 (2) $L_1\frac{di_1}{dt} = L_2\frac{di_2}{dt}$

or $L_1di_1 = L_2di_2$ or $L_1i_1 = L_2i_2$

$\therefore \frac{i_1}{i_2} = \frac{L_2}{L_1}$

Q.25 (1) Check all the options

Q.26 (1)

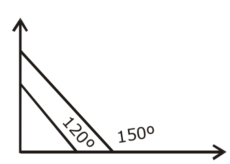


$\frac{Ldi}{dt} = E - iR$ (straight line with -ve slope)

Q.27 (3) $E = \frac{1}{2}Li^2 \quad \frac{dE}{dt} = \frac{1}{2}.2.Li\frac{di}{dt} = Li\frac{di}{dt}$

$= 2 \times 2 \times 4 = 16$ J/sec.

Q.28 (1) Lidi/dt ⟶ Depends on slope



$\tan 150° = -1/\sqrt{3}$

$\tan 120° = \sqrt{3}$

Q.29 (3) $C_{eq} = 3C$

$Q_{eq} = 3Q$

$E = \frac{1}{2}\frac{Q^2_{eq}}{C_{eq}} = \frac{3Q^2}{2C}$.

Q.30 (1) Transmitting high voltage & low current electrical energy results in less energy loss over long distance.

EXERCISE-IV

NUMERICAL VALUE BASED

Q.1 [300 mA] P.D across battery = 12 v– ir = 12 – 20 × 0.5 = 2

$= 10\, i_1 \qquad \Rightarrow i_1 = 0.2\text{ A}$

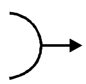
$\Rightarrow i_2 = i - i_1 = 0.3\text{ A}$

$\Rightarrow 300\text{ mA}$

Q.2 [1200] $\varepsilon = Blv = 36$

$$v = \frac{36}{0.06 \times 0.5} = 1200\text{ m/s}$$

Q.3 [0002]



$B \times v \times 2R = \varepsilon$

Q.4 [64A]

$$\frac{100 \times 0.4 \times 0.2 \times \frac{0.8}{50 \times 10^{-3}}}{2} = i$$

$i = 64\text{ A}$

Q.5 [0625] $P = \frac{\varepsilon^2}{R} = 625 \times 10^{-6}$

Q.6 [0120] When the rod moves with constant velocity, net force on the bar is zero

$\therefore$ W = gravitational force = mg = ilB

[i = induced current in the circuit]

$$\therefore \quad i = \frac{0.2 \times 10}{2 \times 0.25} = 4\text{A}$$

To produce 4A current in the bar, induced emf ε in the circuit is $\frac{100 + \varepsilon}{40} = 4 \quad \Rightarrow \varepsilon = 60\text{ V}$

We know, $\varepsilon = BlV \Rightarrow V = \frac{\varepsilon}{Bl}$

$$= \frac{60}{2 \times 0.25} = 120\text{ m/s}$$

Q.7 [4] $lB \int \frac{dq}{dt} = m \int \frac{dv}{dt}$

In steady state, $lB\,(Q - q) = mv$

$CBlv = q$

$lBQ - Cl^2B^2v = mv$

$$v = \frac{BlQ}{m + CB^2 l^2}$$

$$K = \frac{1}{2} mv^2 \qquad = \frac{1}{2} m \left(\frac{BlQ}{m + CB^2 l^2}\right)^2$$

$$\frac{dk}{dm} = 0 = \frac{1}{2}\left(\frac{BlQ}{m + CB^2 l^2}\right)^2 - \frac{2}{2}\frac{m(BlQ)^2}{(m + CB^2l^2)^3} \times 1$$

$$\Rightarrow \frac{1}{2} - \frac{m}{m + CB^2 l^2} = 0$$

$CB^2l^2 = m$

$\Rightarrow m = 4 \times 10^{-6}\text{ kg} = 4\text{ mg}$

Q.8 (1) S– 1 & S–2 both correct

$$\varepsilon = \frac{-d\phi}{dt}$$

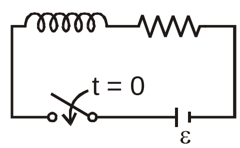
Q.9 (1) $\varepsilon = \frac{-d\phi}{dt}$

$$i = \frac{\varepsilon}{R} = \frac{-1}{R}\frac{d\phi}{dt} \qquad \{R_{Cu} < R_{Al}$$

$R_{Cu} < R_{Al}$

Q.10 (2) A → True, R → True

Q.11 (2) at t = 0 L→ open circuit



at t = 0 L → after ciracuit

$I = I_0(I - e^{-Rt/L})$

at t = 0 ⇒ I = 0

$V_L = \varepsilon$ at t = 0

Q.12 (4) DC motor principle:

Current carying coil placed in B_{ext} experience torque.

Electrical energy → M.E.

Generator ⇒ EM induction

Transformer ⇒ Mutual induction

a→ (ii) b → (i) c → (iii) d → (iv)

Q.13 (3) $v = iR, I = I_0(1-e^{-Rt/L})$

$\frac{L}{R} = \text{Time}, \frac{V}{R} = i = \text{current}$

$RC = \text{time} \Rightarrow \frac{1}{RC} = |\text{time}|^{-1}$

$q = cv \quad \frac{L}{RCV} = \frac{\text{time}}{\text{charge}} = (\text{current})^{-1}$

$a \to (iv), b \to (i), c \to (ii)\ d \to (iii)$

PREVIOUS YEAR'S

MHT CET

Q.1 (3) **Q.2** (3) **Q.3** (2) **Q.4** (1) **Q.5** (1)
Q.6 (1) **Q.7** (1) **Q.8** (2) **Q.9** (3) **Q.10** (4)
Q.11 (4) **Q.12** (1) **Q.13** (3) **Q.14** (3) **Q.15** (3)
Q.16 (1) **Q.17** (3) **Q.18** (3) **Q.19** (1) **Q.20** (3)
Q.21 (2)

Q.22 (3) Given, coefficient of mutual inductance, m=0.5 H
Resistance of primary, $R_1 = 20\Omega$
Resistance of secondary, $R_2 = 5\Omega$
Let, current in primary be I_1 such that current is secondary is $I_2 = 0.4A$.
Now, the emf induced in secondary due to change primary current is given by

$\Rightarrow \quad \varepsilon = M\frac{dI_1}{dt}$

$\Rightarrow \quad (0.4)\times 5 = (0.5)\frac{dI_1}{dt}$

$(\because \varepsilon = I_2R_2)$

$\Rightarrow \quad \frac{dI_1}{dt} = 4A/s$

NEET/AIPMT

Q.1 (4)
Energy stored in inductor is given as-

$U = \frac{1}{2}LI^2$

$25 \times 10^{-3} = \frac{1}{2} \times L \times (60 \times 10^{-3})^2$

$L = \frac{25\times 2\times 10^6 \times 10^{-3}}{3600} = \frac{500}{36} = 13.89\ H$

Q.2 (4)
Electric heater does not involve Eddy currents. It uses Joule's heating effect.

Q.3 (4)

$e_{induced} = \frac{-d\phi}{dt} = \frac{-\Delta\phi}{dt}$

$\phi_i = N(\vec{B}.\vec{A}), \qquad \phi_f = 0$

$\phi_i = 800\times 5\times 10^{-5}\times 5\times 10^{-2} = -2\times 10^{-3}$ weber

$\Delta t = 0.1s$

$E_{induced} = -\frac{(-2\times 10^{-3})}{0.1}$

$e_{induced} = 0.02\ V$

Q.4 (3)

Q.5 (2)

$i_{max} = \frac{E_{max}}{R} = \frac{NBA\omega}{R}$

$i_{max} = \frac{100\times 2\times 10^{-5}\times \pi(10^2)\times 2}{12.56}$

$i_{max} = 1A$

JEE Main

Q.1 [4]
Energy of inductor

$U = \frac{1}{2}LI^2$

$U_I = 0\ (I = 0)$
when current is 2A

$U_f = \frac{1}{2}(2)(2)^2 \qquad (L = 2.0\ H)$

$U_f = 4J$
Energy spent $= U_f - U_i$
$= 4\ J$

Q.2 (242)
$L = 200\ mH = 200\times 10^{-3}\ H$
$V_{rms} = 220\ V$
$f = 50\ Hz$
$\omega = 2\pi f = 2\pi\times 50 = 100\pi$

rms value of current $I_{rms} = \frac{V_{rms}}{z}$

$Z = \omega.L = (2\pi f)L = 2\pi\times 50\times 200\times 10^{-3}\ H$
$= 20\pi$

$I_{rms} = \frac{220}{20\pi} = \frac{11}{\pi}$

Peak value $I_0 = I_{rms}\sqrt{2} = \frac{11\sqrt{2}}{\pi}$

compare to $\frac{\sqrt{a}}{\pi}$

$a = 121 \times 2 = 242$

Q.3 (440 V)

$$e = \left|\frac{d\phi}{dt}\right| = \frac{ndBA\cos(\omega t)}{dt}$$

$e = NBA\,\omega\sin\omega t \qquad (\omega = 2\pi n = 2\pi \times 1 = 2\pi \text{ rad/s})$

$e_{max} = NBA\omega$

$= 1000 \times 0.07 \times 1 \times 2\pi$

$= 439.8 \approx 440$ volt

Q.4 (1)

As generator converts mechanical energy into electrical energy.

(2) Galvanometer shows deflection when current passes through it so it is used to show presence of current in any wire.

(3) Transformer is used to step up or step down the voltage.

(4) Metal detectors have LCR series AC circuit which is in resonance. In pressence of metal inductance of coil changes and current changes significantly.

Q.5 (1)

Q.6 [400]

Q.7 (4)

Current on both in inductor is in opposite direction.

Hence :

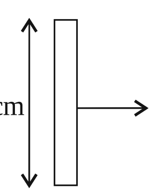
$L_{eq} = L_1 + L_2 - 2M$

Q.8 (2)

emf induced between the two ends $\frac{B_H\omega\ell^2}{2}$

$$\frac{0.2\times10^4\times5\times1}{2} = 0.5\times10^{-4} = 50\times10^{-6}\text{ V} = 50\mu\text{V}$$

Q.9 (16)



$B_H = 4\times10^{-3}$ T

$\theta \to 45°$

$B_v = B_H$

$e = (\vec{V}\times\vec{B}).\vec{\ell}, \quad = \left((4\times10^{-3})(20)\frac{20}{100}\right)$

$= 16\times10^{-3}\text{V} = 16\text{ mV}$

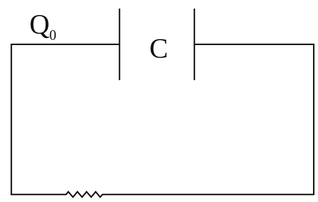
Q.10 (4)

$$P = \frac{\varepsilon^2}{R} = \frac{\left(NA\frac{dB}{dt}\right)^2 \times A_C}{\rho\ell}$$

$$P' = \frac{\left(\frac{NA}{2}\frac{dB}{dt}\right)^2 \times 4A_C}{\rho\ell/2}$$

$$\Rightarrow P' = 2P$$

Q.11 (4)



Let initial charge on capacitor is Q_0 and U_0 is initial energy.

$$\Rightarrow U_0 = \frac{Q_0^2}{2C}$$

For energy to be half

$$U = \frac{U_0}{2} = \frac{Q_0^2}{4C}$$

$$\Rightarrow \frac{Q^2}{2C} = \frac{Q_0^2}{4C} \Rightarrow Q^2 = \frac{Q_0^2}{2}$$

$$\Rightarrow Q = \frac{Q_0}{\sqrt{2}}$$

For discharging

$Q = Q_0.\,e^{-t/RC}$

$$\frac{Q_0}{\sqrt{2}} = Q_0.e^{-t/RC}$$

$$\Rightarrow \frac{1}{\sqrt{2}} = e^{-t/RC}$$

$$\Rightarrow \text{In}1 - \frac{1}{2}\ln 2 = -t_{1/RC}$$

$$\Rightarrow t_1 = \frac{1}{2}RC\text{ in}2$$

For charge to reduce to $\frac{Q_0}{8}$.

$$\frac{Q_0}{8} = Q_0 = e^{-t/RC}$$

$$\Rightarrow \frac{1}{8} = e^{-t/RC}$$

Taking log

$$\Rightarrow \text{In } 1 - 3\ln 2 = -\frac{t^2}{RC}$$

$$\Rightarrow t_2 = 3RC \ln 2$$

$$\frac{t_1}{t_2} = \frac{1}{6}$$

Q.12 (3)

Magnetic field at centre

$$B = 4\left(\frac{\mu_0 I}{4\pi(\frac{L}{2})}\right)(2\sin 45^\circ)$$

$$B = 2\sqrt{2}\frac{\mu_0 I}{\pi L}$$

Mangnetic flux in small loop

$$\phi = B\ell^2$$

$$\phi = 2\sqrt{2}\frac{\mu_0 1}{\pi L}\ell^2$$

Mutual Inductance $M = \frac{\phi_S}{I_P}$

$$M = 2\sqrt{2}\frac{\mu_0 \ell^2}{\pi L}$$

Q.13 (2)

By theory

Q.14 [250]

$\phi(t) = 8t^2 - 9t + 5$

$$\frac{d\phi(t)}{dt} = 16t - 9$$

$$e = \left|-\frac{d\phi(t)}{dt}\right| = |-16(0.25) + 9| \qquad t = 0.25$$

$e = 5v$

$e = IR$

$5v = I(20\Omega)$

$$I = \frac{5}{20} = \frac{1}{4} = 0.25 \text{ Amp.}$$

$I = 250$ mA

Q.15 [2]

$$V = -\frac{d\phi}{dt} = \frac{4}{3}t$$

$\phi = 0 \Rightarrow t = 3$

$\therefore V = 4$

Now

$$H = \frac{V^2}{R} = \frac{16}{8} = 2$$

Q.16 [12]

$$e = A.\frac{dB}{dt}$$

$$e = \pi(1)^2 \times \frac{d}{dt}(3t^2)$$

Or

$e = 3\pi t^2$

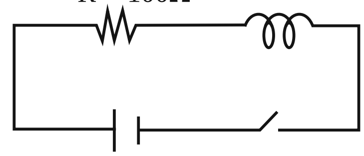
At $t = 2$

$e = 3\pi(2)^2$

$e = 12\pi$

Q.17 (3)

Given circuit is R-L growth circuit



$$i = \frac{E}{R}\left(1 - e^{-t/\tau}\right)$$

$$i = \frac{E}{2R} = \frac{E}{R}\left(1 - e^{-t/\tau}\right)$$

Solving $t = \tau\ln 2$

$$t = \frac{1}{R}\ln 2 = \frac{1}{100}0.693 = 0.00693$$

$= 7$ ms

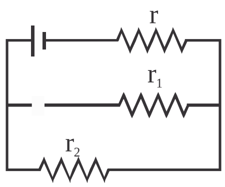
$$i(15\text{ ms}) = \frac{E}{R}\left(1 - e^{-\frac{15}{10}}\right)$$

$$i = \frac{6}{100}\left(1 - \frac{1}{4}\right) = \frac{3}{4}\times\frac{6}{100}$$

$$U = \frac{1}{2}LI^2$$

By solving we get $U = 1$ mJ

Q.18 [10]



In steady state

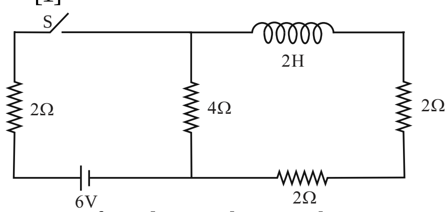
Current $I = \frac{E}{r + r_2}$

Potential disterence across AB = $Ir_2 = \frac{Er_2}{r + r_2}$

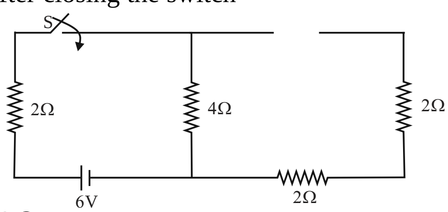
Charge on capacitor Q = C (ΔV) AB

$Q = \frac{CEr_2}{r + r_2} = 10\mu C$

Q.19 [1]



Just after closing the switch



$R_{eq} = 6\ \Omega$

So, $i = \frac{6\nu}{6\Omega} = 1$ Amp.

ALTERNATING CURRENT

EXERCISE-I (MHT CET LEVEL)

Q.1 (1) $I_{ms} = \frac{I_O}{\sqrt{2}} = \frac{6}{\sqrt{2}} = 3\sqrt{2}$ amp

Q.2 (1) $If\ \omega = 50 \times 2\pi then \omega L = 20\Omega$

$If\ \omega = 100 \times 2\pi then \omega L = 40\Omega$

Current flowing in the coil is

$$I = \frac{200}{Z} = \frac{200}{\sqrt{R^2 + (\omega L)^2}} = 4A$$

Q.3 (1)

$$z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

$$= \sqrt{10^2 + \left(2000 \times 5 \times 10^{-3} - \frac{1}{2000 \times 50 \times 10^{-6}}\right)^2}$$

$= 10\ \Omega$

$$= i = \frac{V_0}{2} = \frac{20}{10} = 2A$$

Q.4 (3)
Q.5 (1)
Q.6 (2)
Q.7 (3)

Q.8 (3) $Z = \sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}$

Q.9 (2)
Q.10 (3)
Q.11 (1)
Q.12 (1)
Q.13 (3)
Q.14 (4)
Q.15 (1)
Q.16 (1)
Q.17 (2)
Q.18 (4)
Q.19 (1)

The phase angle between voltage V and currect I is $\frac{\pi}{2}$

Q.20 (4)

Mechanical energy (Input) ⟶ Generator ⟶ Electrical energy (output)

Mechanical energy converts into electrical energy on the basic of electromagnetic induction.

Q.21 (1)

$$V_{rms} = \frac{V_{peak}}{\sqrt{2}} = \frac{50}{\sqrt{2}} \text{volt}$$

$$I_{rms} = \frac{I_{peak}}{\sqrt{2}} = \frac{40}{\sqrt{2}} \frac{1}{1000} A$$

$P_{avg} = V_{rms} I_{rms} \cos\phi$

$$= \frac{50}{\sqrt{2}} \frac{40}{\sqrt{2}} \left(\frac{1}{1000}\right) \cos\frac{\pi}{3}$$

$$= \frac{1}{2} = 0.5\,w$$

Q.22 (2)
Q.23 (4)
Q.24 (3)
Q.25 (2)
Q.26 (4)
Q.27 (1)
Q.28 (2)
Q.29 (4)
Q.30 (3)
Q.31 (1)
Q.32 (1)
Q.33 (2)
Q.34 (2)

EXERCISE-II (NEET LEVEL)

Q.1 (3)

$$\mathbf{I_{rms}} = \frac{I_0}{\sqrt{2}} = \frac{\text{Peak value}}{\sqrt{2}}$$

Q.2 (4)

Given $I_{rms} = 10$
f = 50 Hz

Time period = $\frac{1}{f} = \frac{1}{50}$ sec.

Time taken by current to increase from zero to maximum value, $\Delta t = \frac{T}{4} = \frac{1}{200}$

$= 5 \times 10^{-3}$ sec.

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$\Rightarrow I_{max}\ 10\sqrt{2} = 14.14A$

Q.3 (4) DC ammeter measures average value of current. Since the average value of AC is zero, thus it reads zero. while AC ammeter is disigned to read rms current value.

Q.4 (2) E_{mf} generated in the coil is given by
$E = NABW \sin\omega t$
$\because$ maximum value of $\sin\omega t = 1$
$\Rightarrow E_{max} = NABW$

Q.5 (2) Total carrent, $1 = (5 + 10\sin\omega t)$

$$\Rightarrow I_{cff} = \left[\frac{\int_0^T I^2 dt}{\int_0^T dt}\right]^{1/2}$$

$$= \left[\frac{1}{T}\int_0^T (5 + 10\sin\omega t)^2 dt\right]^{1/2}$$

$$= \left[\frac{1}{T}\int_0^T \left(25 + 100\sin\omega t + 100\sin^2\omega t\right)\right]^{1/2}$$

But, $\frac{1}{T}\int_0^T \sin\omega t.dt = 0$ and $\frac{1}{T}\int_0^T \sin^2\omega t.dt = \frac{1}{2}$

So, $I_{eff} = \left[25 + \frac{1}{2}\times 100\right]^{1/2} = 5\sqrt{3}A$

Q.6 (2) A coil behaves as an indvetor Inductive reactance,
$X_L = wL$
Þ $X_L \alpha w$

$$\frac{X_{L,2}}{X_{L,1}} = \frac{\omega_2}{\omega_1} = \frac{150\times 2\pi}{50\times 2\pi} = 3$$

$\Rightarrow X_{L,2} = 3X_{L,1} = 3 \times (100)$
$= 300\Omega$

Q.7 (2)

$$I_{rms} = \frac{E_{rms}}{Z} = \frac{\frac{200\sqrt{2}}{\sqrt{2}}}{10^4} = 20mA$$

$$\left[\because R = 0, X_L = 0 \Rightarrow z = X_C = \frac{1}{WC} = \frac{1}{100\times 10^{-6}} = 10^4\right]$$

Q.8 (2) Angular Resonance frequency

$$W_R = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10^{-6}\times 10^{-6}}} = 10^6$$

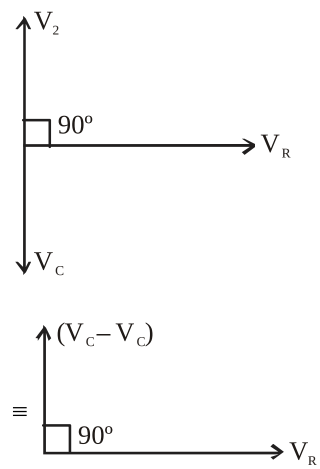
$\Rightarrow$ Resonance frequency, $F_R = \frac{W_R}{2\pi} = \frac{10^6}{2\pi}$ Hz

Q.9 (3) Given $F = \frac{1000}{2\pi}$ Hz
$\Rightarrow$ w = 2pF = 1000 rad/s
L = 2H
Reactance, $X_L = WL$
$= 1000 \times 2$
$= 2000\Omega$

Q.10 (2) In pure inductive circuit, current lags the potential in phase by $\frac{\pi}{2}$.

Q.11 (4)

Q.12 (3)



Voltage phase diagram.

Resultant voltage, $V_{net} = \sqrt{V_R^2 + (V_C - V_C)^2}$

Q.13 (2)

Q.14 (3) For resorance to occur, the in of LCR circeuit needs to be min

$\because$ Inpedance, $Z = \sqrt{R^2 + (X_L)}$

If $X_L = X_C$
$\Rightarrow Z = R$

Q.15 (1) Bulb behaves as a resistor. So the given circuit is RC circuit

Impedance, $Z = \sqrt{R^2 + X_C^2} = \sqrt{R^2 + \frac{1}{\omega^2 c^2}}$

If w increases, impedance will decrease. Thus current through the bulb increases and it will burn more intensely.

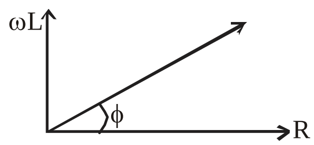
Q.16 (2) In an inductor, the voltage leads the current by a phase difference of $\frac{\pi}{2}$

$\because I = I_0 \sin wt$

$\therefore V = V_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

$= I_0 \omega L \sin\left(\omega t + \frac{\pi}{2}\right)$

Q.17 (2) Power factor, $\cos\theta = \frac{R}{\sqrt{(\omega L)^2 + R^2}}$



Q.18 (1) A shows current across R
V_2 shows voltage across R
V_1 shows voltage across C
We know that current and voltage through R are in same phase. Hence, statement (i) is correct.
Voltage across C lags the voltage/ current across R. Hence, statement (ii) and (iii) are incrrect.

Q.19 (4) Q $X_2 = X_C$
\ $Z = R = 30W$
and $V_R = V_S = 240V$
Reading of volt meter $= V_L - V_C = I(X_L - X_C)$

Reading of ammeter $= I_R = \frac{240}{30} = 8A$

Q.20 (1) No less of power occurs in a powerly inductive circuit.

$\because \phi = \frac{\pi}{2}$ or 90^o

$P_{Less} = V_{Rms} I_{Rms} \cos\theta = 0$

Q.21 (1) In an ac circuit, a pure indcutor does not consume any power. Therefore, power is consumed by the resistor only.

$\therefore P = I_v^2 R$

or $108 = (3)^2 R$ or $R = 12\Omega$

Q.22 (2) $P_{max} = I_m{}^2 R$

Half power $\Rightarrow P = \frac{P_{max}}{2}$

$\rightarrow I^2 R = \frac{I_m^2 R}{2}$

$\rightarrow I = \frac{I_m}{\sqrt{2}}$

Q.23 (3) Power factor $= \cos s = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$

for low resistance, high inductance

$R \simeq 0$ and $X_L \simeq \infty$

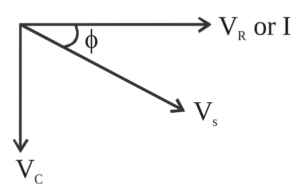
then $\cos\phi \simeq 0$

Q.24 (4) in a purely capacitive circuit, $\phi = 90^o$ or $\frac{\pi}{2}$

$\Rightarrow P_{arg} = V_{Rms} I_{Rms} . \cos\theta$
$= 0$

Q.25 (4) Before resonance, $W < W_R$
$\therefore X_L < X_C$
$\Rightarrow$ Circuit is predominantly capacitive so, current leads potential
After resonance, $w > W_R$
$\therefore X_L < X_C$
$\Rightarrow$ Circuit is predominantly inductive so, current.

Q.26 (2)



$\cos\phi = \frac{R}{\sqrt{R^2 + X_C^2}} = \frac{100}{\sqrt{100^2 + 100^2}}$

$= \frac{1}{\sqrt{2}}$

$\Rightarrow \phi = 45^o$
$\therefore$ Current leads the source voltage by 45^o

Q.27 (4) The hot wire ammeter may be used to measure both AC and DC current.

Q.28 (1) Given, $R = 11\Omega$, $X_2 = 120\Omega$, $X_C = 120\Omega$
$V_S = 110\,V$ $\Omega = 2\pi F = 2\pi(60)$
$= 120\pi$ rad
$\because X_L = X_C$
$\Rightarrow V_L = V_C$

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (3) $V = 100 \sin 100\pi t \cos 100 \pi t$
$V = 50 \sin 200 \pi t$
here $V_O = 50$ & $\omega = 200 \pi$ f = 100 Hz

Q.2 (4) Given $T = 1\mu s = 10^{-6}$ s

$$f = \frac{1}{T} = \frac{1}{10^{-6}} = 10^6 \text{ Hz}$$

Q.3 (3) $$I_{avg} = \frac{\int_0^{T/2} 10 \sin(314t)\,dt}{\int_0^{T/2} dt}$$

$$= \frac{2i_0}{\pi} = 0.637\, i_0 = 0.637 \times 10 = 6.37 \text{ A}$$

Q.4 (3) $$V_{rms} = \frac{V_0}{\sqrt{2}} = 220$$

$$V_0 = 220\sqrt{2} = 311 \text{ volt}$$

Q.5 (2)

Q.6 (1) $$I_{rms} = \frac{V_{rms}}{Z} = \frac{V_{rms}}{\sqrt{R^2 + (\omega L)^2}} = 2A$$

$$\tan\phi = \frac{\omega L}{R} = \frac{66}{88} = \frac{3}{4}.$$

Q.7 (2) $$I_{rms} = \frac{V_{rms}}{Z} = \frac{100}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

P.d. across resistance = $R\, I_{rms}$ = 100 volt.

Q.8 (2) $$V_{net} = \sqrt{V_R^2 + V_L^2} = \sqrt{(20)^2 + (16)^2} = 25.6.$$

Q.9 (4) Voltage of source is always less than $(V_1 + V_2 + V_3)$,

Q.10 (3) $X_L = \omega t = 1000\,\Omega$

$$(X_L)_{new} = (2\omega)(2t) = 4 \times 1000 = 4000\,\Omega$$

Q.11 (4) $X_L = \omega L = 100 \times 0.1 = 10\,\Omega$

$$i = \frac{100}{10} \sin\left(100t - \frac{\pi}{2}\right) = -10\cos(100t)\text{ A}$$

Q.12 (2) $X_L = \omega L = 2\pi f \times L$
$100 = 2\pi \times 50 \times L$ ....(Eqn. 1)
$(X_L)_{new} = 2\pi \times 150 \times L$ ....(Eqn. 2)
from eqn. (i) & (ii)
$(X_L)_{new} = 300\,\Omega$

Q.13 (2) Given $R = 50\,\Omega$, $L = \frac{20}{\pi}$ H, $C = \frac{5}{\pi}\mu F$

$$X_L = \omega L = 2\pi \times 50 \times \frac{20}{\pi} = 2000\,\Omega$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi \times 50 \times \frac{5}{x} \times 10^{-6}} = 2000\,\Omega$$

$X_L = X_C$ then $Z = R$

Q.14 (3) In resonance condition

$$\omega = \frac{1}{\sqrt{LC}}$$

when L ↑ 25% and C ↓ 20% then

$$\omega_{new} = \frac{1}{\sqrt{\frac{125}{100}L \times \frac{80}{100}C}} = \frac{1}{\sqrt{\frac{5}{4}L \times \frac{4}{5}C}}$$

$$\omega_{new} = \frac{1}{\sqrt{LC}} \Rightarrow \omega_{new} = \omega$$

Q.15 (1)

Q.16 (3)

Q.17 (4) Given $R = 3\Omega$, $X_L = 4\Omega$, $X_C = 8\Omega$

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$

$$Z = \sqrt{3^2 + (8-4)^2} = 5\Omega$$

then

$$P = VI\cos\phi = VI\frac{R}{Z} \qquad \left(\cos\phi = \frac{R}{Z}\right)$$

$$= V\frac{V}{Z}\frac{R}{Z} = \frac{V^2}{Z}\frac{R}{Z}$$

$$= \frac{50 \times 50 \times 3}{5 \times 5} = 300 \text{ watt}$$

Q.18 (3)

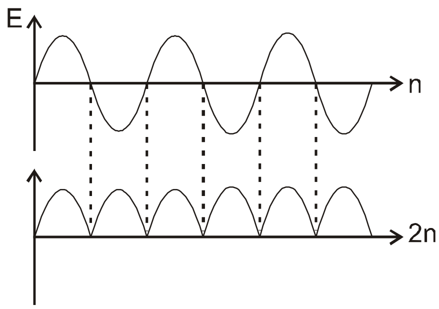
Q.19 (1) $P_{av} = v_{rms} I_{rms} \cos\phi$
Here $\phi = 90^\circ$ so $P_{av} = 0$

Q.20 (3) $$\frac{H_{D.C.}}{H_{A.C.}} = \frac{I^2 R}{I_{rms}^2 R} = 2$$

Q.21 (2) $\tan\phi = \frac{x}{R} = \frac{4}{3}$

$\cos\phi = \frac{3}{5} = 0.6$

Q.22 (2)



Q.23 (4) $\cos\phi = \frac{R}{z} = \frac{R}{\sqrt{R^2 + (x_L - x_C)^2}} = 1$

Because $x_L = x_C$

Q.24 (4) Given $E = 5\cos\omega t$, $I = 2\sin\omega t$, $\phi = \frac{\pi}{2}$

then

$P = V_{rms} I_{rms} \cos\phi$

$= \frac{5}{\sqrt{2}} \times \frac{2}{\sqrt{2}} \cos\frac{\pi}{2} = 0$

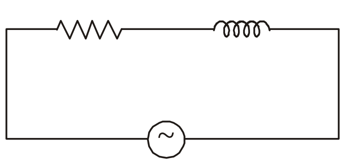
Q.25 (4) $\frac{V_2}{V_1} = \frac{N_2}{N_1} = \frac{8}{1}$

$V_2 = 8 \times 120 = 960$ volt

$I = \frac{960}{10^4} = 96$ mA.

EXERCISE-IV

Q.1 **[0064]**



$i = \frac{V_0}{Z} = \frac{V_0}{R}$

$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{1.6 \times 250 \times 10^{-6}}}$

$V_C = i_0 \times i_0 \times \frac{1}{\omega_C} = \frac{V_0}{\omega CR}$

$\frac{10^3}{4\times5} = 50$

$400 = \frac{32}{50\times250\times10^{-6}\times R}$

$R = \frac{32 \times 10^{-6}}{50\times250\times400} = 6.4\Omega$ $\Rightarrow$ **6 4**

Ans.

Q.2 [0119] $\tan\phi = \frac{wL_1}{R_1} = \frac{3}{4}$

$wL_1 = \frac{3}{4} R_1$

$1 = \frac{100}{\sqrt{\frac{9}{16}R_1^2 + R_1^2}}$

$R_1 = 80\Omega \quad \omega L_1 = 60\Omega$

$\frac{wL_2}{R_2} = \frac{4}{3} \Rightarrow \quad wL_2 = \frac{4}{3} R_2$

$5 = \frac{100}{\sqrt{\frac{16}{9}R_2^2 + R_2^2}} \Rightarrow R_2 = 12\Omega\ ;\ WL_2 = 16\Omega$

$z = \sqrt{(wL_1 + wL_2)^2 + (R_1 + R_2)^2} = 119\Omega$

Q.3 [0.1] $\frac{24}{10\times10^{-3}} = z = \sqrt{(\omega L)^2 + R^2}$

$\sqrt{R^2 + (\omega L)^2} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

$(\omega L) = -\omega L + \frac{1}{\omega C}$

$L = \frac{1}{2\omega^2 C} = \frac{1}{2\times100\pi\times100\pi\times10^{-6}} = 5H$

$(2400)^2 = (500\pi)^2 + R^2$

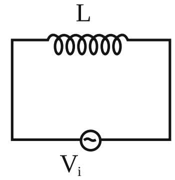
$R = \sqrt{(2400)^2 - (5\pi \times 100)^2}$

$= 100\sqrt{(24)^2 - 25\pi^2}$

$= 10 \times \sqrt{326} \cong 1800$

$I = 0.1A$

Q.4 (1)



$X_L = w_L$

$i = \frac{V_0}{X_L}\sin\left(w.d. - \frac{\pi}{2}\right)$

$w\hat{i} \rightarrow X_L \hat{i} \Rightarrow i \rightarrow \downarrow$

S1-Correct & S2-Correct

Q.5 (1) $P_{av} = V_{rms} i_{rms} \cos\phi$

Power consumption is only takes place across resistance in R_C, R_L or LCR circuit

S1 and S2 both are correct

Q.6 (1)

Q.7 (1) P = VrmsIrmscorp

Power factor = cosf

$V = V_0 \sin wt$

we cant comment on emf lead or lag

$i = i_0 \sin(wt \pm \phi) \Rightarrow$ two possible value

$\cos\phi = \cos(-\phi)$

Both A, R true

Q.8 (1) $i = 4\sin\left(100\pi t + \frac{\pi}{3}\right)$

$i = i_0 \sin(wt + \phi)$

$i_{rmp} = \frac{i_0}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}A$

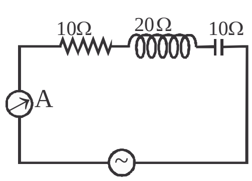
$i_0 = 4A$ $\quad w = 2\pi f = 100\pi$

$f = 50$ Hz

at t = 0, $i = 4\sin\frac{\pi}{3} = 2\sqrt{3}$

$a \rightarrow (ii), b \rightarrow (iii), c \rightarrow (iv), d \rightarrow (i)$

Q.9 (1)



V = 100sinwt

$R = 10\Omega, X_L = 20, X_C = 10$

$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{100 + 100}$

$Z = 10\sqrt{2}$

$i_0 = \frac{V_0}{Z} = \frac{100}{10\sqrt{2}} = \frac{10}{\sqrt{2}}$

$V_C = iX_C = \frac{i_0}{\sqrt{2}} \times 10 = \frac{10}{2} \times 10 = 50$

$i = \frac{i_0}{\sqrt{2}} = \frac{10}{\sqrt{2} \times \sqrt{2}} = 5$

$a \rightarrow (iii), b \rightarrow (i), c \rightarrow (iv), d \rightarrow (ii)$

PREVIOUS YEAR'S

Q.1 (2)	**Q.2** (4)	**Q.3** (1)	**Q.4** (3)	**Q.5** (3)
Q.6 (4)	**Q.7** (3)	**Q.8** (2)	**Q.9** (4)	**Q.10** (3)
Q.11 (1)	**Q.12** (2)	**Q.13** (2)	**Q.14** (2)	**Q.15** (3)
Q.16 (1)	**Q.17** (2)	**Q.18** (2)	**Q.19** (4)	**Q.20** (3)
Q.21 (2)	**Q.22** (4)	**Q.23** (2)	**Q.24** (2)	**Q.25** (1)
Q.26 (1)	**Q.27** (2)	**Q.28** (4)	**Q.29** (4)	**Q.30** (2)
Q.31 (2)	**Q.32** (1)	**Q.33** (3)	**Q.34** (4)	**Q.35** (2)
Q.36 (4)	**Q.37** (4)	**Q.38** (4)	**Q.39** (2)	**Q.40** (3)
Q.41 (1)	**Q.42** (2)	**Q.43** (4)	**Q.44** (4)	**Q.45** (4)
Q.46 (2)				

Q.47 (3) Given, V = 50V, V_L = 90V, Vc = 60 V In L-C-R circuit,

In L-C-R circuit,

$\therefore \; V = \sqrt{V_R^2 + (V_L - V_c)^2}$

$\Rightarrow \; V^2 = V_R^2 + (V_L - V_C)^2$

$\Rightarrow \; 50^2 = V_R^2 + (90 - 60)^2$

$\Rightarrow 2500 = V_R^2 + 900$

$\Rightarrow V_R^2 = = 1600$

$\Rightarrow \; V_R = \sqrt{1600} = 40V$

Q.48 (1) Since, the voltage across inductor and capacitor is same, so they are in resonance i.e.,

$X_L = X_C$

The impedance of circuit,

$Z = \sqrt{R^2 + (X_L - X_C)^2} = R$

$\therefore$ Voltage across, R = 220 V

By Ohm's law, V = IR

$\Rightarrow \; I = \frac{V}{R} = \frac{220}{100} = 2.2A$

Hence, ammeter reading is 2.2 A and voltmeter reading is 220 V.

Q.49 (3) Given, $C = 2.4\mu F = 24 \times 10^{-6}$ F

$L = 10^{-8}$ H

At resonant frequency, $v = \frac{1}{2\pi\sqrt{LC}}$

$$\Rightarrow \quad LC = \frac{1}{4\pi^2 v^2} = \frac{\lambda^2}{4\pi^2 c^2} \qquad \left(\because v = \frac{c}{\lambda}\right)$$

$$\lambda = \sqrt{4\pi^2 c^2 LC}$$

$$= \sqrt{4\times\pi^2\times\left(3\times10^8\right)^2\times10^{-8}\times2.4\times10^{-6}}$$

$= 292$ m

Q.50 (4) We know that, capacitive reactance,

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi v C}$$

$$\Rightarrow X_C \propto \frac{1}{v}$$

Hence, graph shown in option (d) represents correct variation of X_C with v.

Q.51 (4) In LC parallel resonance circuit, at resonance, inductive and capacitive reactance is same i.e., $X_L = X_C$. So, impedance is minimum and current is maximum.

Also, resonance frequency, $fr = \frac{1}{2\pi\sqrt{LC}}$

Q.52 (1) Since, capacitive reactance, $X_C = \frac{1}{2\pi fC}$

Inductive reactance, $X_L = 2\pi fL$

Impedance, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

So, if the angular frequency $(\omega = 2\pi f)$ is gradually increased, then X_C will continuously decrease, X_L will continuously increase, R remains same because it does not depend on angular frequency and Z will first decrease and then increase.

Q.53 (3) The voltage across a pure capacitor in an AC circuit is given by

$e_c = e_0 \sin\omega t$ ......(i)

and current across it is given by

$$i_c = i_0 \sin\left(\omega t + \frac{\pi}{2}\right) \qquad ....(ii)$$

From Eqs. (i) and (ii), we observe that the current in a capacitor is leading the voltage by $\frac{\pi}{2}$. So, correct phase diagram is shown in Fig. (B).

Q.54 (2) The impedence of series L-C-R circuit is given by

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$= \sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}$$

The value of impedance (Z) first decreases with increase of frequency(f) of AC source and becomes minimum at resonance frequency ($f = f_0$) because at resonance frequency, $X_L = X_C$, thus $Z_{min} = R$.

If we increase the frequency of AC source further f($f > f_0$); then Z starts increasing. Thus, correct graph is shown in option (2).

NEET/AIPMT

Q.1 **(3)**

$$P_{av} = \left(\frac{V_{RMS}}{Z}\right)^2 R$$

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = 56\Omega$$

$$\therefore P_{av} = \left(\frac{10}{\left(\sqrt{2}\right)56}\right)^2 \times 50 = 0.79\text{W}$$

Q.2 (2)

Q.3 (3)

Q.4 (4)

Q.5 (2)

Q.6 (1)

$\omega = 100$

$$v = \frac{\omega}{2\pi} = \frac{100}{2\pi} = \frac{50}{\pi}\text{Hz}$$

Resonance frequency

$$v_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi}\sqrt{\frac{1}{10\times10\times10^{-6}}}$$

$$= \frac{50}{\pi}\text{Hz}$$

Q.7 **(2)**

Peak voltage is $\sqrt{2}$ times rms voltages in ac.

JEE MAIN

Q.1 (1)

$i = i_0 \sin(\omega t + \phi)$

$\phi = 0$ as only resistance

$$\frac{i_0}{\sqrt{2}} = i_0 \sin(\omega t)$$

$$\omega t = \frac{\pi}{4}$$

$$t = \frac{\pi}{4\omega}$$

$$= \frac{\pi}{4 \times 2\pi \times 50} \times 1000\,\text{ms}$$

$= 2.5$ ms

Q.2 (3)

$\therefore$ $z = X_L - X_c$ may be zero,

$$\begin{pmatrix} P = V_{rms} I_{rms} \cos\phi \\ \text{If } \phi = 90, P = 0 \end{pmatrix}$$

Q..3 **(1)**

(1) As generator converts mechanical energy into electrical energy.

(2) Galvanometer shows deflection when current passes through it so it is used to show presence of current in any wire.

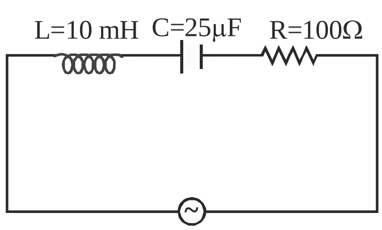
(3) Transformer is used to step up or step down the voltage.

(4) Metal detectors have LCR series AC circuit which is in resonance. In pressence of metal inductance of coil changes and current changes significantly.

Q.4 **(2)**

Wattless current flowing that means current is in $\frac{\pi}{2}$ phase with applied voltage. $P_{avg} = V_{rms}\ I_{rms}\ \cos\phi = 0$
Purely inductive circuit have $\cos\phi = 0$

Q.5 (1)



$v(t) = 210 \sin(3000t)$ ...(1)

$L = 10$ mH

$X_L = \omega L = 3000 \times 10 \times 10^{-3}$

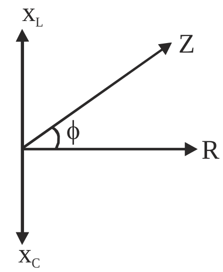
$X_L = 30\Omega$ ...(2)

$C = 25\ \mu F$

$$X_C = \frac{1}{C} = \frac{1}{3000 \times 25 \times 10^{-6}} = \frac{1000 \times 1000}{25 \times 3000} = \frac{40}{3}\Omega$$

$R = 100\Omega$

using phasor diagram :-

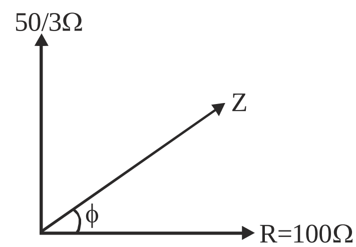


$X = X_L - X_C$

$$= 30 - \frac{40}{3} = \frac{50}{3}\Omega$$

$R = 100\Omega$

So



$$\tan\phi = \frac{50/3}{100}$$

$$\tan\phi = \frac{1}{6} = 0.167$$

$$\boxed{\phi = \tan^{-1}(0.167)}$$

$$\boxed{\phi \simeq \tan^{-1}(0.17)}$$

Q.6 **(22)**

Q.7 (0)

Q.8 (4)

$$\omega = 120\pi = \frac{2\pi}{T} \Rightarrow T = \frac{1}{60}\text{sec}$$

time taken to reach peak value

$$= \frac{T}{4} = \frac{1}{240}\text{S}$$

Q.9 (15)

$|(X_L - X_c)| = |10 - 10^2| = 90\Omega$

Z = Impedance

$$= \sqrt{(X_L - X_C)^2 + R^2} = \sqrt{(90)^2 + (120)^2} = 150\Omega$$

$$i_{rms} = \frac{V_{rms}}{z} = \left(\frac{2}{15}\right)A$$

$$\text{Now } i_{rms}^2 R\Delta t = ms(\Delta T)$$

$\Rightarrow \Delta t = 15$sec

Q.10 (100)

length = 100 km capacity = 0.01 μf/km

Capacitance $C = 0.01 \times 10^{-6} \times 100 = 0.01 \times 10^{-4}F$

$f = 0.5 \times 10^3$ Hz

For impedance to be minimum

$X_L = X_C$

$$2\pi f L = \frac{1}{2\pi fc} \qquad (\pi = \sqrt{10})$$

$$L = \frac{1}{4\pi^2 f^2 c}$$

$$= \frac{1}{4\times10\times(0.5\times10^3)^2\times0.01\times10^{-4}}$$

$L = 10^{-1}$ H.

L = 100 mH

Q.11 (0)

$V_L = V_C = 2V_R$

$X_L = X_C = 2R$

$$X_L = 10\Omega$$

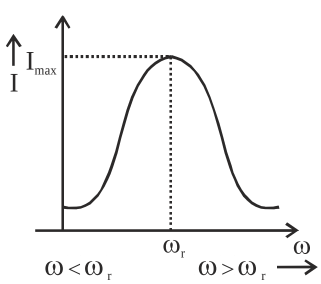
$$\omega L = 10$$

$$2\pi f L = 10$$

$$L = \frac{10}{2\pi f} = \frac{1}{10\pi} H = \frac{1000}{10\pi} mH$$

$$L = \frac{1}{\frac{1}{100}\pi}; K = \frac{1}{100} = 0.01 \approx 0$$

Q.12 (3)



At resonance in LCR

Z = R = (min)

Z = Impedance

$\omega < \omega_r$ $\qquad$ $\omega > \omega_r$

$$\omega L < \frac{1}{\sqrt{LC}} \qquad \omega L > \frac{1}{\sqrt{LC}}$$

$$\omega L < \frac{1}{\omega C} \qquad \omega L > \frac{1}{\omega C}$$

$\boxed{X_L < X_C}$ $\qquad$ $\boxed{X_L > X_C}$

Capacitive $\qquad$ Inductive

Q.13 (20)

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$f = \frac{1}{2\pi\sqrt{0.5\times10^{-3}\times200\times10^{-6}}}$$

$$= \frac{1}{2\pi\sqrt{10^{-7}}}$$

$= 2 \times 10^3$ Hz

$= 20 \times 10^2$ Hz = 20

Q.14 (3)

Resonant frequency $F_r = \frac{1}{2\pi\sqrt{LC}}$

By adding a capacitor in series equivalent capacitance decreases

Hence resonant frequency increases.

Q.15 (2)

$$I_{rms} = \frac{v_{rms}}{x_c}\left\{x_c = \frac{1}{\omega c}\right\}$$

$$I_{rms} = V_{rms}\ \omega C$$

$$C = \frac{I_{rms}}{\omega V_{rms}} \Rightarrow C = \frac{6.9x10^{-6}}{600x230}$$

C = 50 pF

Q.16 (2)

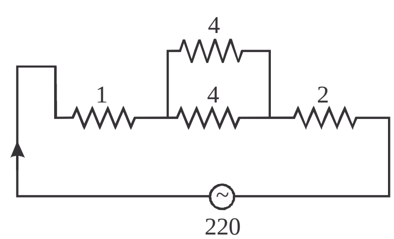
$$P_1 = \cos\phi_1 = \frac{R}{z} = \frac{R}{\sqrt{R^2+R^2}} = \frac{R}{R\sqrt{2}} = \frac{1}{\sqrt{2}}$$

$$P_2 = \cos\phi_2 = \frac{R}{z} = \frac{R}{\sqrt{R^2+(R-R^2)}} = \frac{R}{R} = 1$$

$$\frac{P_1}{P_2} = \frac{\frac{1}{\sqrt{2}}}{1} = \frac{1}{\sqrt{2}}$$

Q.17 [44]

At high frequency $(X_C = \simeq 0, X_L = \simeq \infty)$



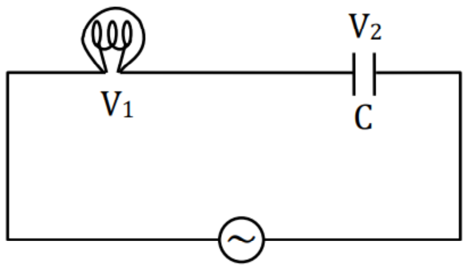
Z = 1 + 4 || 4 + 2

$\boxed{z = 5}$

$$I = \frac{V}{z} = \frac{220}{5}$$

$\boxed{I = 44A}$

Q.18 [3]

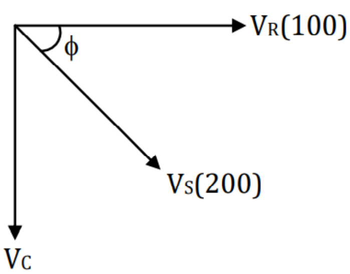


200 V, 50 Hz

$$R = \frac{V^2}{P} \Rightarrow R = \frac{100 \times 100}{50}$$

$\boxed{R = 200\Omega}$

$V_R = 100\,V$



$$\cos\phi = \frac{100}{200} \Rightarrow \boxed{\phi = 60^\circ}$$

Now

$$\tan 60^\circ = \frac{Xc}{R}$$

$$\sqrt{3} = \frac{Xc}{R}$$

$$\sqrt{3} = \frac{Xc}{200} \Rightarrow Xc = 200\sqrt{3}$$

$$X_C = \frac{1}{2\pi(50)} \times \frac{\pi\sqrt{x} \times 10^6}{5000} = \frac{\sqrt{x}}{5} \times 10^3$$

Now

$$200\sqrt{3} = \frac{\sqrt{x}}{5} \times 1000$$

x = 3

Q.19 (2)

As

$$\omega = \frac{.6}{\sqrt{LC}} \text{ given}$$

$$\text{Current } I = \frac{v}{z} = \frac{50}{\sqrt{(10)^2 + \left(0.6\sqrt{\frac{L}{C}} - \frac{1}{0.6}\sqrt{\frac{C}{L}}\right)^2}}$$

$$\text{Or } I = \frac{50}{\sqrt{100 + \left(0.6 \times 100 - \frac{100}{0.6}\right)^2}} \cong 0.238 \text{ or } 238\text{mA}$$

Q.20 (4)

$v = i_0 X_L = i_0(wL)$

$= (5)(49\pi)(30 \times 10^{-3}) = 23.1$

Voltage will lead current by 90°

$\therefore\ V = 23.1 \sin(49\pi t + 60^\circ)$

Q.21 (250)

$$\text{Band width} = 232 - 212 = \frac{R}{L}$$

$$\therefore\ L = \frac{5}{20} = 250 \text{ mH}$$

Q.22 (3)

$V_p = 8kv$ $V_s = 160v$

power load = 80 kW power factor = unity

Primary load

$$R_1 = \frac{v_p^2}{p} = \frac{(8 \times 10^3)^2}{80 \times 10^3} = 800\,\Omega$$

Secondary load

$$R_2 = \frac{v_s^2}{p} = \frac{(160)^2}{80 \times 10^3} = 0.32\,\Omega$$

Q.23 (3)

$$E = 440 \sin 100\pi t,\ L = \frac{\sqrt{2}}{\pi} H$$

$$X_L = \omega L = 100\pi \frac{\sqrt{2}}{\pi} = 100\sqrt{2}\Omega$$

$$\text{Peak current } I_0 = \frac{E_0}{X_L} = \frac{440}{100\sqrt{2}} = 2.2\sqrt{2}A$$

AC ammeter reads RMS value therefore reading will be I_{rms}

$$I_{rms} = \frac{I_0}{\sqrt{2}} = 2.2\,A$$

Q.24 (4)

Element X should be resistive with R = 20Ω
Element Y should be inductive with $X_L = 20\Omega$
When X and Y are connector in series

$$Z = \sqrt{X_L^2 + R^2} = 20\sqrt{2}$$

$$I_0 = \frac{E_0}{Z} = \frac{100}{20\sqrt{2}} = \frac{5}{\sqrt{2}}A$$

$$I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{5}{2}A$$

Q.25 (10)
Energy stored in capacitor

$$= \frac{1}{2}CV^2 = \frac{1}{2}500\times10^{-6}\times10^4 = \frac{5}{2}J$$

Current will be maximum when whole energy of capacitor becomes energy of inductor.

$$\frac{1}{2}LI^2 = \frac{5}{2}$$

$$I = \sqrt{\frac{5}{L}} = \sqrt{\frac{5}{50\times10^{-3}}} = 10A$$

ELECTROMAGNETIC WAVES

EXERCISE-I (MHT CET LEVEL)

Q.1 (2)

$\vec{E}_o = \vec{B}_o \times \vec{C}$

$\left|\vec{E}_o\right| = \left|\vec{B}_o\right| . \left|\vec{C}\right| = 20 \times 10^{-9} \times 3 \times 10^{8} = 6Vm.$

Q.2 (1) Energy density

$= \varepsilon_0 E_{rms}^2 = \varepsilon_0 \left(\frac{E_0}{\sqrt{2}}\right)^2 = \frac{1}{2}\varepsilon_0 E_0^2$

Q.3 (3) Smallest wavelength means maximum frequency, energy of that particular radiation is maximum $\rightarrow \gamma -$ rays

Q.4 (3) The direction of propagation of electromagnetic wave is perpendicular to the variation of electric field $\vec{E}$ as well as to the variation field $\vec{B}$.

Q.5 (2)
Q.6 (3)
Q.7 (3)
Q.8 (1)
Q.9 (3)
Q.10 (1)
Q.11 (4)

EXERCISE-II (NEET LEVEL)

Q.1 (1, 2)

Q.2 (4) An electron is negatively charged. Thus it will experience a force in the opposite direction of electric field.

Q.3 (2) An electromagnetic wave has both energy and momentum.

Q.4 (1) Ampere's circuital law is applicable for conductiar current but not, applicable for displacement current.

Q.5 (2) During the charging of a capacitor the current is maximum initially when the change on capacitor is zero. As the change increases , the current starts to decrease and cases to exist when charge is maximum.

Q.6 (1) Order of frequency of visible light is 10^{15} Hz
Q.7 (3)
Q.8 (3)
Q.9 (2)
Q.10 (4)
Q.11 (2)
Q.12 (4)
Q.13 (1)
Q.14 (2)

EXERCISE-III (JEE MAIN LEVEL)

Q.1 (3) **Q.2** (2) **Q.3** (1) **Q.4** (2) **Q.5** (2) **Q.6** (4)

PREVIOUS YEAR'S

MHT CET

Q.1 (2) **Q.2** (2) **Q.3** (3) **Q.4** (3) **Q.5** (3) **Q.6** (1) **Q.7** (2) **Q.8** (3) **Q.9** (4) **Q.10** (3)

Q.11 (3) Given, rate of loss of charge = 2×10^{-7} Cs^{-1}
Magnitude of displacement current is given by

$i_d = i_c = \left|\frac{dq}{dt}\right| = 2 \times 10^{-7} Cs^{-1} = 2 \times 10^{-7}$ A

$\therefore$ Displacement current is 2×10^{-7} A.

Q.12 (2) Let the shift in apparent frequency be Δn, then
$\Delta n = 100 \times 10^3 Hz = 10^5 Hz$
$n = 500$ MHz $= 5000 \times 10^6$ Hz $= 5 \times 10^9$ Hz and
v = relative speed

Then, $\frac{\Delta n}{n} = \frac{2\nu}{c}$

$\Rightarrow \nu = \frac{\Delta n}{2n} c = \frac{10^5}{2 \times 5 \times 10^9} \times 3 \times 10^8$
$= 3000\ ms^{-1}$
$= 3\ kms^{-1}$

NEET/AIPMT

Q.1 (2)

Q.2 **(1)**

Q.3 (1)

Q.4 (4)

Q.5 **(3)**

(a) Radio wave (ii) ≈ 10^2 m (ii)
(b) Microwave ≈ (iii) 10^{-2} m (iii)
(c) Infrared radiations ≈ (iv) 10^{-4} m (iv)
(d) X - ray (i) ≈ Å = 10^{-10} m (i)
(a) – (ii), (b) – (iii), (c) – (iv), (d) – (i)

Q.6 **(3)**

$$n = \sqrt{\epsilon_r\ u_r}$$

$$n = \frac{c}{v} \Rightarrow v = \frac{c}{n}$$

$$v = \left(\frac{c}{\sqrt{\epsilon_r\ \mu_r}}\right)$$

JEE MAIN

Q.1 (Bonus)

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$$v = \frac{1}{\sqrt{\mu\varepsilon}}$$

$$\&\ \mu_r = \frac{\mu}{\mu_0}, \varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$$

combining above three we get

$$v = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$$

$$\frac{E}{B} = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$$

$$\frac{E}{\mu_0 \mu_r H} = \frac{c}{\sqrt{\mu_r \varepsilon_r}}$$

$$E = \frac{3\times10^8}{\sqrt{1.61\times6.44}} \times 4\pi\times10^{-7}\times1.61$$

E = 8.48 V/m

Q.2 (2)

$$P = \frac{200\times3.5}{100}$$

= 7 watt

$$I = \frac{P}{4\pi r^2} = \frac{7}{4\pi\times(4)^2}$$

$$I = \frac{7}{64\pi} = \frac{7\times7}{64\times22}$$

$$I = \frac{1}{2}\varepsilon_0 E_0^2 c$$

$$I = \frac{1}{2}\frac{B_0^2}{\mu_0} C$$

$$B_0 = \sqrt{\frac{2\mu_0 I}{c}}$$

$$= \sqrt{\frac{2\times4\pi\times10^{-7}\times7}{3\times10^8\times64\times\pi}}$$

$$= \sqrt{\frac{7\times10^{-15}}{3\times8}}$$

$$= \sqrt{\frac{70\times10^{-16}}{24}}$$

$$= \sqrt{2.912}\times10^{-8}$$

$= 1.71 \times 10^{-8}$T

Q.3 **(2)**

Intensity is the average power propagating per unit area.

$$I = \frac{1}{2}\varepsilon_0 E_0^2 c$$

$$I = \frac{1}{2}\times(8.85\times10^{-12})\,(56.5)^2\times(3\times10^8)$$

$= 4.24$ Wm^{-2}

Q.4 (1)

$V_m = 2 \times 10^8$m/s $\quad \mu_r = 1 \quad \varepsilon = ?$

$$v_m = \frac{c}{\sqrt{\mu_r \varepsilon_r}} \Rightarrow 2\times10^8 = \frac{3\times10^8}{\sqrt{1.\varepsilon_r}}$$

$$\sqrt{\varepsilon_r} = \frac{3}{2} \Rightarrow \varepsilon_r = \frac{9}{4}$$

$$\boxed{\varepsilon_r = 2.25}$$

Q.5 (3)

Q.6 (4)

Q.7 **(2)**

From electromagnetic wave spectrum.
λ increases →

γ - ray	x - rays	ultra violet	visible	infrared	microwave	Radio wave

$$\lambda_{gamma\ -\ ray} > \lambda_{X-ray} < \lambda_{visible} < \lambda_{microwave}$$

Q.8 (1)
(Fact)

Q.9 (3)

The statement II is wrong as the velocity of em wave in a medium is $\frac{1}{\sqrt{\mu\varepsilon}} = \frac{1}{\sqrt{\mu_0 \mu r\, \varepsilon_0 \varepsilon r}}$

Q.10 (2)

$$C = \frac{E_0}{B_0} = \frac{2.25}{1.5\times10^{-8}} = 1.5\times10^{8}\ ms^{-1}$$

$$t = \frac{6\times10^3}{1.5\times10^8} = 4\times10^{-5}s$$

Q.11 (2)

$$B_0 = \frac{E_0}{c} = \frac{60}{3\times10^8} = 2\times10^{-7}T$$

$\hat{E}\times\hat{B}$ must be direction of propagation.

So, $\hat{B} \rightarrow$ z-axis

$$K = \frac{2\pi}{\lambda} = \frac{\pi}{4}\times10^3\ m^{-1}$$

$$E_y = 60\sin\left[\frac{\pi}{4}\times10^3(x - 3\times10^8 t)\right]\hat{j}Vm^{-1}$$

$$B_Z = 2\times10^7 \sin\left[\frac{\pi}{4}\times10^3(x - 3\times10^8 t)\right]\hat{k}T$$

Q.12 (43)

$I = \frac{B_0^2 c}{2\mu_0}$ $\qquad$ $I = 0.22\ w/m^2$,

$B_0 = \sqrt{\frac{2\mu_0 I}{c}}$ $\qquad$ $c = 3\times10^8$ m/sec

$\epsilon_0 = 8.85\times10^{-12}C^2N^{-2}$

$B_0 = \sqrt{\frac{2\times4\pi\times10^{-7}\times0.22}{3\times10^8}}$ $\qquad$ $= 4.3\times10^{-8}$

$B_0 = 43\times10^{-9}T$

Q.13 (1)

$$\frac{E_0}{B_0} = C$$

$$B_0 = \frac{E_0}{C} = \frac{540}{3\times10^8}$$

$= 18\times10^{-7}$

Q.14 (3)

$K = 0.5\times10^3$, $\qquad$ $w = 1.5\times10^{11}$

$B_{max} = 2\times10^{-8}$, $\qquad$ v =

$$\frac{w}{K} = \frac{1.5\times10^{11}}{0.5\times10^3}$$

$C = \frac{E_{max}}{B_{max}}$ $\qquad$ $v = 3\times10^8 = C$

$E_{max} = CB_{max}$

$= 3\times10^8\times2\times10^{-8} = 6$ volt/m

Direction of propagation $\rightarrow$ (–x)

Direction of B propagation $\rightarrow$ (+x)

Direction of E propagation $\rightarrow$ (along z axis)

As E, B and C are perpendicular

So answer (C).

Q.15 (4)

From the wave equation, we get $v = \frac{\omega}{k} = \frac{4\times10^8}{5}$

Now, amplitude of electric field is given by $E_0 = vB_0$

$$\therefore E_0 = \frac{4\times10^8}{5}\times5\times10^{-6} = 4\times10^2\ Vm^{-1}$$

Q.16 (3)

$$E_y = 900\sin\left(wt - \frac{wx}{c}\right)$$

$$C = \frac{E_o}{B_o} \Rightarrow B_o = \frac{E_o}{C} = \frac{900}{3\times10^8} = 300\times10^{-8} = 3\times10^{-6}T$$

$$\frac{F_e}{F_m} = \frac{qE}{qVB} = \frac{900}{3\times10^7\times3\times10^{-6}} = \frac{900}{90} = \frac{10}{1}$$

Q.17 (2)

By Theory

Q.18 (4)

$A = 36\ cm^2$

$F = 7.2\times10^{-9}$ N $\qquad$ t = 20 min

complete absorption

energy per unit time $\frac{E}{t} = IA$

energy flux $= \frac{E}{AT} = I$

$F = \frac{IA}{c}$ So, $I = \frac{F\times C}{A}$

Energy flux $I = \frac{7.2\times10^{-9}\times3\times10^8}{36} = 0.06\ \frac{w}{cm^2}$

Q.19 (2)

(a) UV rays - used for water purification

(b) X-rays used for diagnosing fracture

(c) Microwaves are used for mobile and radar communication

(d) Infrared waves show less scattering therefore used in foggy days

(a-ii), (b-i), (c-iii), (d-iv)

Q.20 [84]

P' = 10% of 110W