TARGET : JEE (Advanced) 2015

Course: VIJETA & VIJAY (ADP & ADR) **Date : 21-04-2015**

PHYSICS

DPP

DAILY PRACTICE PROBLEMS

NO. 05

TEST INFORMATION

TEST : PART TEST (PT)-2 (3 hours) **Test Date : 22-04-2015**

Syllabus : Current electricity, Capacitor, Magnetic field and force, Work, power, energy, Circular motion, Centre of mass complete

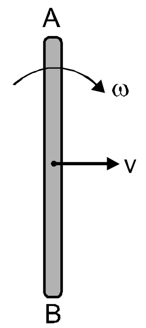
This DPP is to be discussed (24-04-2015)

PT-2 to be discussed (24-04-2015)

DPP No. # 05

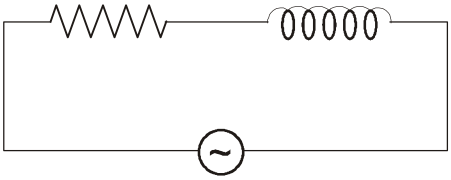
Total Total Marks : 150	**Max. Time : 117 min.**	
Single choice Objective (–1 negative marking) Q. 1 to 15	**(3 marks 2½ min.)**	**[45, 37½]**
Multiple choice objective (–1 negative marking) Q. 16 to 21	**(4 marks, 3 min.)**	**[24, 18]**
Single Digit Subjective Questions (no negative marking) Q.22 to Q.29	**(4 marks 2½ min.)**	**[32, 20]**
Double Digits Subjective Questions (no negative marking) Q. 30	**(4 marks 2½ min.)**	**[4, 2½]**
Comprehension (–1 negative marking) Q.31 to 42	**(3 marks 2½ min.)**	**[36, 30]**
Match Listing (–1 negative marking) Q.43 to Q.45	**(3 marks, 3 min.)**	**[9, 9]**

1. A metal rod of length ℓ, moving with an angular velocity ω and velocity of its centre is v. Find potential difference between points A and B at the instant shown in figure. A uniform magnetic field of strength B exist perpendicular to plane of paper :



(A) $Bv\ell$ (B) $Bv\ell + \frac{1}{2}B\omega\ell^2$ (C) $B\omega\ell - \frac{1}{2}B\omega\ell^2$ (D) $Bv\ell + B\omega\left(\frac{\ell}{2}\right)^2$

2. In LR circuit (shown in figure), current is lagging by $\frac{\pi}{3}$ in phase with applied voltage, then select correct alternative :



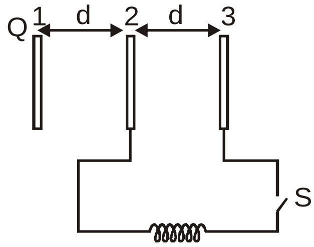
(A) $L = \frac{10}{\sqrt{3}\pi}$ H, i = 10 A

(B) $L = \frac{10}{\pi}$ H, i = 5A

(C) $L = \frac{10}{\sqrt{3}\pi}$ H, i = 5A

(D) $L = \frac{\sqrt{3}}{10\pi}$ H, i = 5A

3. Three identical large plates are fixed at separation of d from each other as shown. The area of each plate is A. Plate 1 is given charge +Q while plates 2 and 3 are neutral and are connected to each other through coil of inductances L and switch S. If resistance of all connected wires is neglected the maximum current flow through coil after closing switch is ($C = \varepsilon_0 A/d$) (neglect fringe effect)



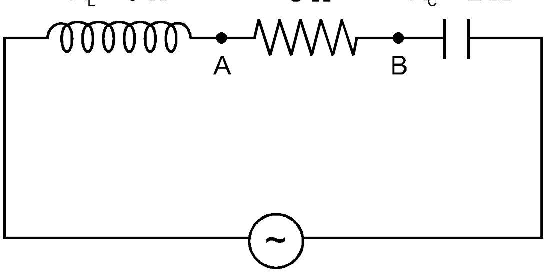
(A) $\frac{Q_0}{\sqrt{LC}}$

(B) $\frac{Q_0}{\sqrt{2LC}}$

(C) $\frac{2Q_0}{\sqrt{LC}}$

(D) $\frac{Q_0}{2\sqrt{LC}}$

4. The instantaneous potential difference between points. A and B is :



V = 10 sin (50πt)

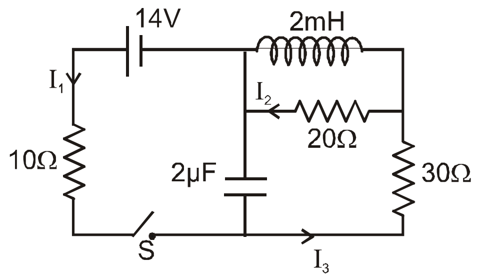
(A) $8 \sin (50\pi t + 37 \frac{\pi}{180})$

(B) $8 \sin (50\pi t - 37 \frac{\pi}{180})$

(C) $10 \sin (50\pi t)$

(D) $10 \cos (50\pi t)$

5. In the circuit shown, the switch is closed at t = 0, the currents I_1, I_2 & I_3 are



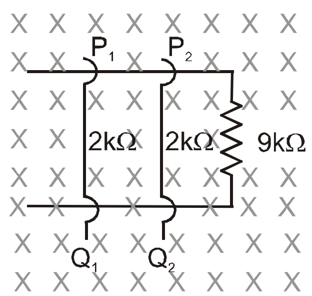
(A) 1.4 A, 0 , 0 (B) 1.4 A, 0.70 A, 0.70 A
(C) 0, 0, 0 (D) 1.2 A, 0.6 A, 0.6 A

6. An LCR series circuit is in resonance with the frequency of applied ac generator. Select the incorrect statement :
(A) Power consumed decreases on increasing frequency
(B) Power consumed decreases on decreasing frequency
(C) Impedence of the circuit decreases on increasing frequency
(D) Impedence of the circuit increases on increasing frequency

7. The series RLC circuit in resonance is called:
(A) selector circuit (B) rejector circuit (C) amplifier circuit (D) oscillator circuit.

8. In a series LR circuit, the voltage drop across inductor is 8 volt and across resistor is 6 volt. Then voltage applied and power factor of circuit respectively are:
(A) 14 V, 0.8 (B) 10 V, 0.8 (C) 10 V, 0.6 (D) 14 V, 0.6

9. In the diagram shown, the wires P_1Q_1 and P_2Q_2 each of length 40 cm are made to slide on the rails with same speed of 5 m/s. In this region a magnetic field of 1T exists. The electric current in 9kΩ resistor is

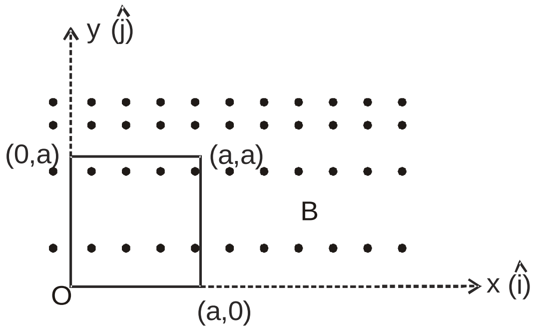


(A) zero if both wires slide towards left.
(B) 0.1mA if both wires slide in opposite direction
(C) 0.2 mA if both wires move towards left.
(D) 0.2 mA if both wires move in opposite direction .

10. In a Young's double slit experiment, the separation between the slits is d, distance between the slit and screen is D (D >> d). In the interference pattern, there is a maxima exactly in front for each slit. Then the possible wavelength used in the experiment are :

(A) $\frac{d^2}{D},\frac{d^2}{2D},\frac{d^2}{3D}$ (B) $\frac{d^2}{D},\frac{d^2}{3D},\frac{d^2}{5D}$ (C) $\frac{d^2}{2D},\frac{d^2}{4D},\frac{d^2}{6D}$ (D) none of these

11. A square loop of side 'a' is placed in x – y plane as shown in figure. In this region there is non-uniform time dependent magnetic field $\vec{B} = \left(cy^3t^2\right)\hat{k}$. [where t is time and c is constant] then magnitude of emf induced in loop is



(A) Zero (B) $\frac{ca^4t^2}{5}$ (C) $\frac{ca^5t}{2}$ (D) data is insufficient

12. In a YDSE, distance between the slits and the screen is 1m, separation between the slits is 1mm and the wavelength of the light used is 5000nm. The distance of 100th maxima from the central maxima is:
(A) 0.5 m (B) 0.577 m (C) 0.495 m (D) does not exist

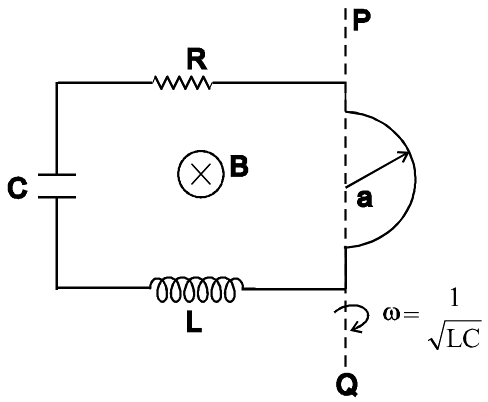
13. A rectangular loop of sides of length ℓ and b is placed in x–y plane. A uniform but time varying magnetic field of strength $\vec{B} = 20\,t\,\hat{i} + 10\,t^2\,\hat{j} + 50\,\hat{k}$ where t is time elapsed. The magnitude of induced e.m.f. at time t is:
(A) 20 + 20 t (B) 20 (C) 20 t (D) zero

14. Assume Earth's surface is a conductor with a uniform surface charge density σ. It rotates about its axis with angular velocity ω. Suppose the magnetic field due to Sun at Earth at some instant is a uniform field B pointing along earth's axis. Then the emf developed between the pole and equator of earth due to this field is. (R_e = radius of earth)

(A) $\frac{1}{2}B\omega R_e^2$ (B) $B\omega R_e^2$ (C) $\frac{3}{2}B\omega R_e^2$ (D) zero

15. A series RLC circuit is connected to an ac generator. The instant at which current in the circuit is zero, the energy stored in the capacitor & inductor are :
(A) zero in both
(B) maximum in both
(C) zero & maximum respectively
(D) maximum & zero respectively

16. A wire shaped as a semicircle of radius a, is rotating about an axis PQ with a constant angular velocity $\omega = 1/\sqrt{LC}$, with the help of an external agent. A uniform magnetic field B exists in space and is directed into the plane of the figure. (circuit part remains at rest) (left part is at rest)



(A) The rms value of current in the circuit is $\frac{\pi B a^2}{R\sqrt{2LC}}$

(B) The rms value of current in the circuit is $\frac{\pi B a^2}{2R\sqrt{2LC}}$

(C) The maximum energy stored in the capacitor is $\frac{\pi^2 B^2 a^4}{8R^2 C}$

(D) The maximum power delivered by the external agent is $\frac{\pi^2 B^2 a^4}{4LCR}$

17. Consider a series LCR circuit connected to an AC supply of 220 V. If voltage drop across resistance R is V_R, voltage drop across capacitor is $V_c = 2V_R$ and that across inductor coil is $V_L = 3V_R$ then choose correct alternative(s)

(A) $V_R = 220\sqrt{2}$ V

(B) Power factor of circuit is $\frac{1}{\sqrt{2}}$

(C) V_R = 156 V

(D) Phase difference between current and source voltage is $\frac{\pi}{4}$

18. If the two slits of double slit experiment were moved symmetrically apart with small relative velocity v and the distance between screen and mid–point of slits is fixed and equal to D. Consider a point P on the screen at a distance x from central maxima then (x <<< D) :

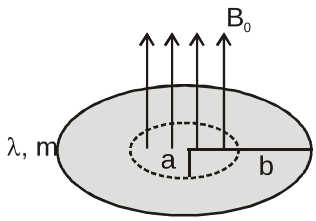
(A) Rate of change of number of fringes between central maxima and point P changes with respect to time is $\frac{xv}{\lambda D}$

(B) number of fringes contained between central maxima and point P increases with time

(C) fringe width decreases as time passes

(D) fringe width increases as time passes

19. A nonconducting ring of uniform mass m, radius b and uniform linear charge density 'λ' is suspended as shown in figure in a gravity free space. There is uniform coaxial magnetic field B_0, pointing up in a circular region of radius 'a' (<b). Now if this field is switched off, then :-



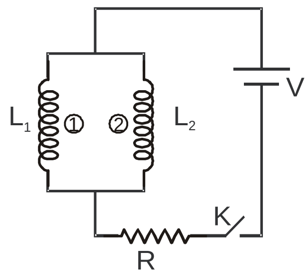
(A) There will be induced electric field on periphery of ring, in anticlockwise sense when seen from above

(B) Induced electric field imparts angular momentum of magnitude $\lambda\pi a^2 b B_o$

(C) Final angular velocity of ring will be more if time taken to switch of the field (B_o) is small

(D) Final angular velocity will always be independent of time taken to switch off the field (B_o).

20. In the figure shown the key is switched on at t = 0. Let I_1 and I_2 be the currents through inductors having self inductances L_1 & L_2 at any time t respectively. The magnetic energy stored in the inductors 1 and 2 be U_1 and U_2. Then $\frac{U_1}{U_2}$ at any instant of time is :

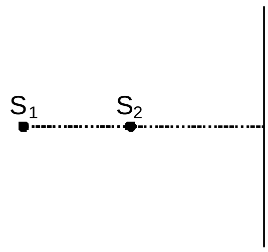


(A) $\frac{L_1}{L_2}$ (B) $\frac{L_2}{L_1}$ (C) $\frac{I_1}{I_2}$ (D) $\frac{I_2}{I_1}$

21. In a Young's Double Slit experiment, films of thickness t_A and t_B and refractive indices μ_A and μ_B are placed in front of slits A and B respectively. If $\mu_A t_A = \mu_B t_B$, then the central maxima may

(A) not shift (B) shift torwards A (C) shift towards B (D) None of these

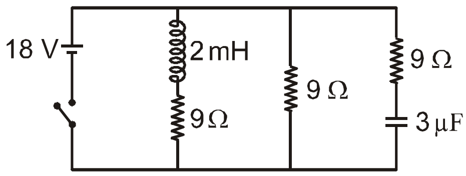
22. Two coherent monochromatic point sources S_1 and S_2 are placed in front of an infinite screen as shown in figure. Wavelength of the light emitted by both the sources is λ. Initial phase difference between the sources is zero.



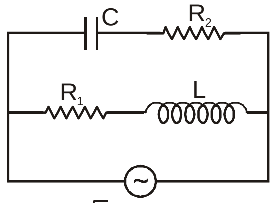
Initially $S_1S_2 = 2.5\lambda$ and the number of bright circular rings on the screen in n_1. If the distance S_1S_2 is increased and made 5.7λ, the number of bright circular rings becomes n_2. The difference $n_2 - n_1$ is :

23. A conducting circular loop having a radius of 1.0 cm, is placed perpendicular to a magnetic field of 0.50 T .It is removed from the field in 0.50 s. The average emf produced in the loop during this time is $x\pi \times 10^{-4}$ V .then find out value of x

24. In circuit,initially capacitor and inductor do not have any energy, Then find current through the battery in Ampere just after switch is closed

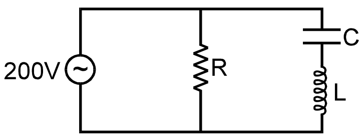


25. In the shown circuit, $R_1 = 10\Omega$, $L = \frac{\sqrt{3}}{10}$H, $R_2 = 20\,\Omega$, $C = \frac{\sqrt{3}}{2}$ milli-farad and t is time in seconds. Then at the instant current through R_1 is $10\sqrt{2}$A ; find the current through resistor R_2 in amperes.

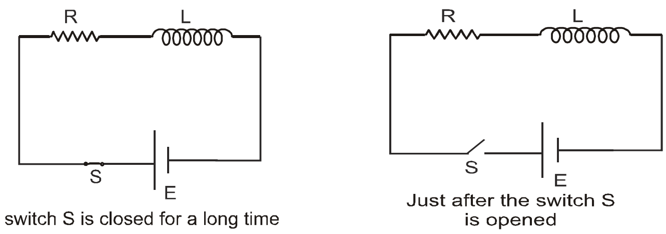


26. What is the ratio of powers delivered by 20 V dc and 20 V peak ac to the same load resistance?

27. In the circuit diagram shown, $X_C = 100\,\Omega$, $X_L = 200\,\Omega$ & $R = 100\,\Omega$. The effective current through the source is $\sqrt{X}$ then find out value of X :



28. In the LR circuit the switch S was closed for a long time. The ideal cell in the circuit has emf E volts.Later on the switch is opened. The current in the resistor of resistance R ohms just after the switch was opened is $\frac{XE}{4R}$, then x is

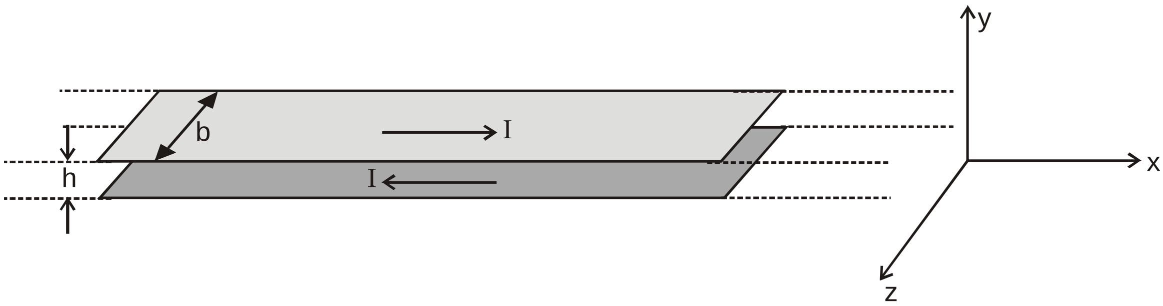


29. In YDSE with monochromatic light, fringes are obtained on the screen placed at some distance from the slits. If screen is moved by 5×10^{-2}m towards the slits, fringe width changes by 3×10^{-5} m. If separation between the slits is 10^{-3} m, if wavelength of light used is 1000 y Å, then y is : (Assume distance between the two slits is very small than the distance betwen the slits and screen)

30. Interference fringes were produced using white light in a double slit arrangement. When a mica sheet of uniform thickness of refractive index 1.6 (relative to air) is placed in the path of light from one of the slits, the central fringe moves through some distance. This distance is equal to the width of 30 interference bands if light of wavelength 4800 Å is used. The thickness (in μm) of mica is:

COMPREHENSION-1 :

A certain transmission line (very long) is constructed from two thin metal plates (parallel to each other) of width b, which are separated by a very small distance 'h' < < 'b' . The current travels down one strip and back along the other, and it is distributed uniformly over the surface of the plates as shown in figure. Neglect fringing field at ends of plates.



31. Capacitance per unit length of this combination is

(A) Infinite (B) $\frac{\varepsilon_0 h^2}{b}$ (C) $\frac{\varepsilon_0 b^2}{h^2}$ (D) $\frac{\varepsilon_0 b}{h}$

32. Magnetic field between the space of two plates is

(A) $\frac{\mu_0 I}{2h}(\hat{k})$ (B) $\frac{\mu_0 Ib}{2h^2}(\hat{k})$ (C) $\frac{\mu_0 I}{b}(-\hat{k})$ (D) $\frac{\mu_0 Ih}{b^2}(-\hat{k})$

33. Self inductance per unit length of combination is (c is speed of light)

(A) $\frac{b}{\varepsilon_0 c^2 h}$ (B) $\frac{c^2 h}{\varepsilon_0 b}$ (C) $\frac{h}{\varepsilon_0 c^2 b}$ (D) $\frac{c^2 b}{\varepsilon_0 h}$

COMPREHENSION-2 :

A fan operates at 200 volt (DC) consuming 1000 W when running at full speed. It's internal wiring has resistance 1 Ω. When the fan runs at full speed, its speed becomes constant. This is because the torque due to magnetic field inside the fan is balanced by the torque due to air resistance on the blades of the fan and torque due to friction between the fixed part and the shaft of the fan. The electrical power going into the fan is spent (i) in the internal resistance as heat, call it P_1 (ii) in doing work against internal friction and air resistance producing heat, sound etc., call it P_2. When the coil of fan rotates, an emf is also induced in the coil. This opposes the external emf applied to send the current into the fan. This emf is called back-emf, call it 'e'. Answer the following questions when the fan is running at full speed.

34. The current flowing into the fan and the value of back emf 'e' is :
(A) 200 A, 5 volt (B) 5 A, 200 volt (C) 5 A, 195 volt (D) 1 A , 0 volt

35. The value of power 'P_1' is
(A) 1000 W (B) 975 W (C) 25 W (D) 200 W

36. The value of power 'P_2 is
(A) 10000 W (B) 975 W (C) 25 W (D) 200 W

COMPREHENSION-3 :

Consider a conducting circular loop placed in a magentic filed as shown. When magnetic field changes with time, magentic flux also changes and emf is induced.

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

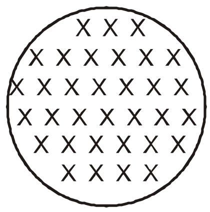
If resistance of loop is R then induced current .

$$i = \frac{e}{R}$$

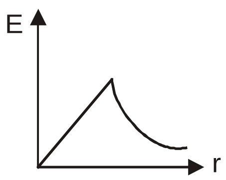
For Current, charge must have come into motion. Magnetic force cannot make the statinoary charges to move. Actually there is an induced electric field in the conductor caused by changing magnetic flux, which make the change to move

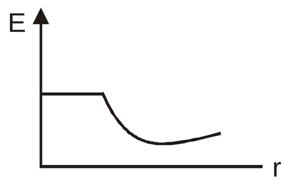
$$\int \vec{E}.d\vec{\ell} = e = - \frac{d\phi}{dt}$$

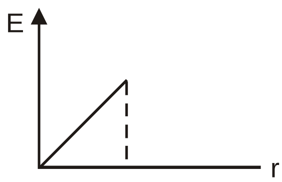
This induced electric field is non- electrostatic by nature. Line integral of $\vec{E}$ around a closed path is non - zero

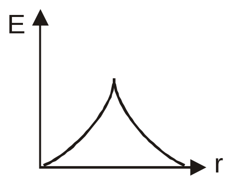


37. The magnetic field within cylindrical region whose cross - section is indicated starts increasing at a constant rate α tesla/sec The graph showing the variation.of induced electric field with distance r from the axis of cylinder is :

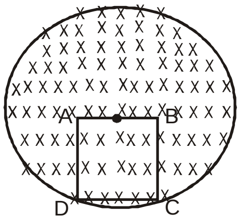
(A) 

(B) 

(C) 

(D) 

38. A square non- conducting loop 20 cm on a side is placed in a magnetic field The centre of side AB coincides with the centre of magnetic field The magnetic field is increasing at the rate of 2T/s. Find the magnitude of line integral of induced electric field along path BC.

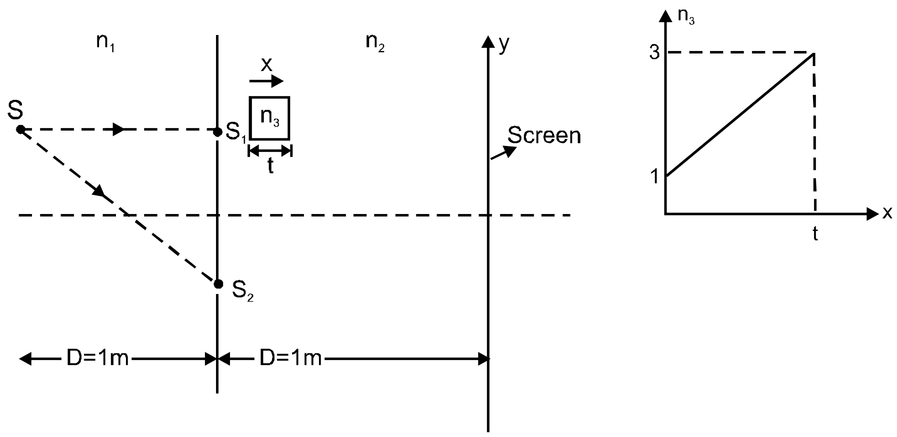


(A) 10 mV (B) 20 mV (C) 30 mV (D) zero

39. Refer to above questions, Find the magnitude of line integral of induced electric field along path CD.
(A) 40 mV (B) 60 mV (C) 80 mV (D) zero

COMPREHENSION-4:

In YDSE arrangement as shown in figure, fringes are seen on screen using monochromatic source S having wavelength 3000 Å (in air). S_1 and S_2 are two slits seperated by d = 1 mm and D = 1m. Left of slits S_1 and S_2 medium of refractive index n_1 = 2 is present and to the right of S_1 and S_2 medium of n_2 = 3/2, is present. A thin slab of thickness 't' is placed in front of S_1 . The refractive index of n_3 of the slab varies with distance from it's starting face as shown in figure.



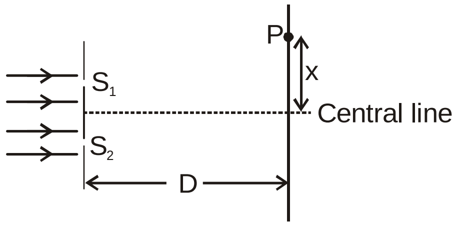
40. In order to get central maxima at the centre of screen, the thickness of slab required is :
(A) 1 μm (B) 2 μm (C) 0.5 μm (D) 1.5 μm

41. If thickness of the slab is selected 1 μm, then position of central maxima will be : (y–coordinate)

(A) $\frac{1}{3}$ mm (B) $-\frac{1}{3}$ mm (C) $\frac{1}{6}$ mm (D) $-\frac{1}{6}$ mm

42. Fringe width on the screen is :
(A) 0.4 mm (B) 0.1 mm (C) 0.2 mm (D) 0.3 mm

43. A parallel beam of light consisting of two wavelenths λ_1 = 4000 Å and λ_2 = 8000 Å is incident perpendicular to plane of both slits in a typical Young's double slit experiment. The seperation between both slits is d = 2mm and the distance between slits and screen is D = 1 meter. In each situation of column-I a point P on screen is specified by its distance 'ℓ' from central bright on screen. Match the proper entries from column-2 to column-1 using the codes given below the columns,



Column-I	Column-II
(P) At P such that ℓ = 0	(1) intensity is maximum for λ_1 = 4000 Å
(Q) At P such that ℓ = 0.1 mm	(2) intensity is minimum for λ_1 = 4000 Å
(R) At P such that ℓ = 0.2 mm	(3) intensity is maximum for λ_2 = 8000 Å
(S) At P such that ℓ = 0.4 mm	(4) intensity is minimum for λ_2 = 8000 Å

	P	Q	R	S
(A)	3	2	4	3
(B)	1	2	3	1
(C)	1	4	4	3
(D)	3	2	1	2

44. Time varying magnetic filed is present in a circular region of radius R. Match the proper entries from column-2 to column-1 using the codes given below the columns,

Column I	Column II
(P) An unsteady magnetic field	(1) Electric field is perpendicular to the length of rod
(Q) Induced electric field at a point within magnetic field (r < R)	(2) $\frac{r}{2}\frac{dB}{dt}$
(R) Induced electric field at a point out Side the magnetic field (r > R)	(3) $\frac{R^2}{2r}\frac{dB}{dt}$
(S) If a rod is placed along the diameter of the magnetic field	(4) Induced electric field.

Codes :

	P	Q	R	S
(A)	3	2	1	4
(B)	2	1	3	4
(C)	4	2	1	3
(D)	4	2	3	1

45. In a series RLC AC circuit, the frequency of source can be varied. When frequency is varied gradually in one direction from f_1 to f_2, the power is found to be maximum at f_1. When frequency is varied gradually at the other direction from f_1 to f_3, the power is found to be same at f_1 and f_3. Match the proper entries from column-2 to column-1 using the codes given below the columns, (consider $f_1 > f_2$)

Column–I		**Column–II**	
When the frequency is equal to		The circuit is or can be	
(AM : arithmetic mean ; GM : geometric mean)			
(P)	AM of f_1 and f_2	(1)	capacitative
(Q)	GM of f_1 and f_2	(2)	inductive
(R)	AM of f_1 and f_3	(3)	resistive
(S)	GM of f_1 and f_3	(4)	at resonance

	P	Q	R	S
(A)	4	3	2	4
(B)	3	1	3	2
(C)	2	1	2	3
(D)	1	3	3	4

ANSWER KEY OF DPP NO. # 04

1.	(A)	**2.**	(A)	**3.**	(A)	**4.**	(C)	**5.**	(A)	**6.**	(B)	**7.**	(D)
8.	(C)	**9.**	(C)	**10.**	(B)	**11.**	(D)	**12.**	(B)	**13.**	(C)	**14.**	(C)
15.	(A)	**16.**	(B,C)	**17.**	(A,B,D)	**18.**	(A,B,C)	**19.**	(A,C,D)	**20.**	(B,C,D)	**21.**	(B,D)
22.	(A,B,C,D)		**23.**	(A,C)	**24**	8	**25.**	1	**26.**	1	**27.**	8	
28.	6 m/sec		**29.**	7	**30.**	5	**31.**	12	**32.**	20	**33.**	2600	
34.	(C)	**35.**	(B)	**36.**	(D)	**37.**	(A)	**38.**	(D)	**39.**	(B)	**40.**	(C)
41.	(A)	**42.**	(D)	**43.**	(B)	**44.**	(B)	**45.**	(A) – p,t ; (B) – p,q ; (C) – q,s ; (D) – p,q,r				

DPP No. # 05

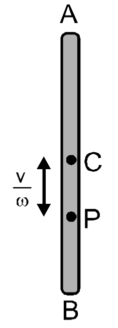
1. Point P is at instantaneous rest,

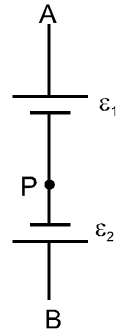
$$\varepsilon_1 = |v_P - v_A| = \frac{1}{2}B\omega\left(\frac{\ell}{2}+\frac{v}{\omega}\right)^2$$

$$\varepsilon_2 = |v_P - v_B| = \frac{1}{2}B\omega\left(\frac{\ell}{2}-\frac{v}{\omega}\right)^2$$

$$|v_A - v_B| = \varepsilon_1 - \varepsilon_2$$

$$|v_A - v_B| = B\ell v$$



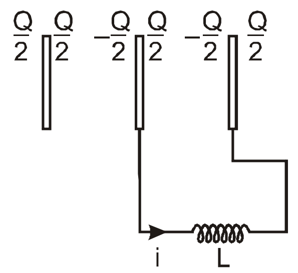


2. $\frac{X_L}{R} = \sqrt{3} \Rightarrow X_L = R\sqrt{3}$

$$i = \frac{100}{\sqrt{(10\sqrt{3})^2+(10)^2}} = 5A$$

$$L = \frac{10\sqrt{3}}{100\pi} = \frac{\sqrt{3}}{10\pi}\,H$$

3. $$\frac{\left(\frac{Q}{2}\right)^2}{2C} = \frac{1}{2}Li_0^2$$



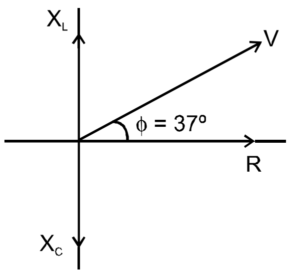
$$\Rightarrow \quad I_0 = \frac{Q}{2\sqrt{LC}}$$

4. impedance $z = \sqrt{(8-2)^2+(8)^2} = 10\ \Omega$

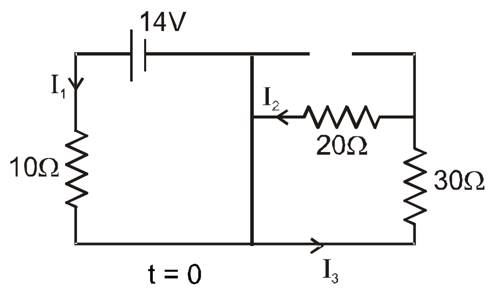
current lags voltage by 37º, then

$$i = \frac{10}{10}\sin(50\pi t - 37º)$$

$$V_{AB} = i \times R = 8\sin(50\pi t - 37º)$$



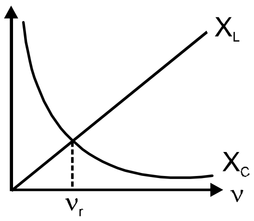
5.



$$I_1 = \frac{14}{10} = 1.4$$

$$I_2 = I_3 = 0$$

6.



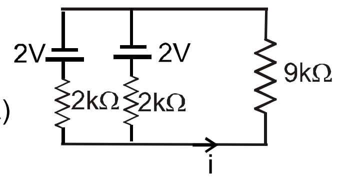
From graph, When frequency is increased more then resonating frequency ($X_C \sim X_L$) will increase hence impedence of the circuit will increase

7. Only for resonating fraquency circuit is able to drive appreciable current. So we can use these type of cicuit in tuining of radio and TV for selecting perticular frequency sent by a perticular sorce.

8. $V_L = 8V$, $V_R = 6V$, $V = \sqrt{V_L^2 + V_R^2} = 10$ V

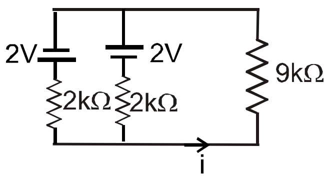
power factor = $\cos\phi = \frac{V_R}{V} = \frac{6}{10} = 0.6$

9. (A)



$i = \frac{2}{9+1} = 0.2$ A

(B)



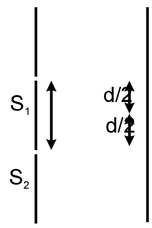
i = 0

10. Fringe width = $n\frac{\lambda D}{d}$

From given situation

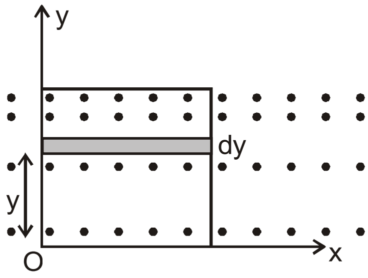
F.W. = $\frac{d}{2}$

$\Rightarrow \quad n\frac{\lambda D}{d} = \frac{d}{2} \quad \Rightarrow \quad \lambda = \frac{d^2}{2nD}$



Hence (C) is possible.

11.



$\phi = \int \vec{B}.\overrightarrow{dA}$

$\phi = \int cy^3t^2a\,dy$

$\phi = ct^2a.\int_0^a y^3dy$

$\phi = ct^2a.\frac{a^4}{4}$

$\phi = \frac{ct^2a^5}{4}$

$e = \left|-\frac{d\varphi}{dt}\right|$

Now induced e.m.f.

$e = \left|-\frac{2cta^5}{4}\right| = \frac{2cta^5}{4} = \frac{cta^5}{2}$

12. For 100th maximum
d sin θ = 100 λ

sin θ = $\frac{100 \times 5000 \times 10^{-9}}{1 \times 10^{-3}} = \frac{5 \times 10^{-4}}{10^{-3}} = 0.5 = \frac{1}{2}$

$\therefore$ y = D tan θ
= 1 × tan 30

$= \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3} = \frac{1.732}{3} = 0.577$

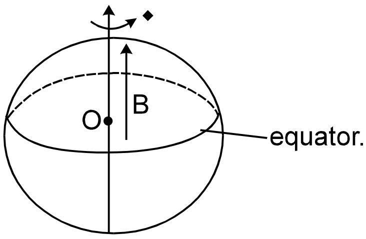
13. The area vector of loop $\vec{A} = \pm \ell b\,\hat{k}$

& $\vec{B} = 20t\,\hat{i} + 10\,t^2\,\hat{j} + 50\hat{k}$

$\therefore$ Magnetic flux is $\phi = \vec{B}\,.\,\vec{A} = \pm\,50\,\ell b$

$\therefore$ emf $= \frac{d\phi}{dt} = 0$

14.



the equator can be seen as a conducting ring of radius R_e revolving with angular velocity ω in a perpendicular magnetic field B.

$\therefore$ Potential difference. across its center and periphery = $\frac{B\omega R_e^2}{2}$

Potential at pole = potential of the axis of earth i.e. potential at point O

$$\therefore \qquad V_{equator} - V_{pole} = \frac{B\omega {R_e}^2}{2}.$$

15. $\frac{dq}{dt} = i = 0 \qquad Q \to \text{max}$

$E_C = \frac{Q^2}{2c} \Rightarrow$ max

$E_L = \frac{Li^2}{2} \Rightarrow$ zero

16. Let at time t the angle between magnetic field and area vector(semicircle) be θ , then $\theta = wt$

$$\phi = \vec{B}\cdot\vec{S} = \frac{\pi a^2 B}{2}\cos\omega t.$$

$$\varepsilon = -\frac{d\phi}{dt} = \frac{\pi B a^2 \omega}{2}\sin\omega t$$

$$\varepsilon_0 = \frac{\pi B a^2}{2\sqrt{LC}} \text{ peak emf}$$

Since the circuit is in resoanance,

$$|z| = R \qquad \Rightarrow \qquad i_0 = \frac{\pi B a^2}{2R\sqrt{LC}} \text{ peak current}$$

$$i_{rms} = \frac{i_0}{\sqrt{2}} \qquad \Rightarrow \qquad i_{rms} = \frac{\pi B a^2}{2R\sqrt{2LC}}$$

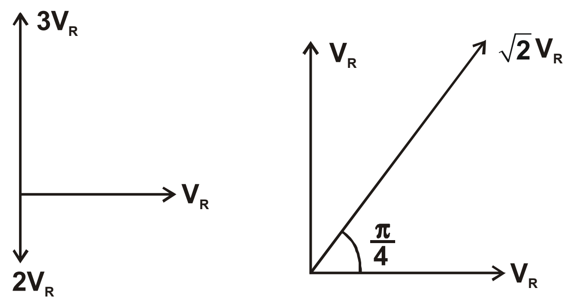
$$U_C = \frac{1}{2}CV_0^2 \to \text{max. energy , } V_0 \to \text{peak voltage}$$

$$V_0 = i_0 X_c = \frac{i_0}{C\omega} = \frac{i_0\sqrt{LC}}{C}$$

$$U_C = \frac{1}{2}C\times\frac{\pi^2 B^2 a^4}{4R^2C^2} = \frac{\pi^2 B^2 a^4}{8R^2 C}$$

$$P_{Ext.} = P_{Dissipated} = \varepsilon_0 i_0 = \frac{\pi B a^2}{2\sqrt{LC}}\times\frac{\pi B a^2}{2R\sqrt{LC}}, \qquad P_{Ext.} = \frac{\pi^2 B^2 a^4}{4LCR}$$

17. V_R, V_L, V_C are r.m.s voltage across the R, L & C respectively



$\theta = \frac{\pi}{4}$

P.F. = $100\theta = \frac{1}{\sqrt{2}}$

$\sqrt{2}\,V_R = 220$

$V_R = \frac{220}{\sqrt{2}}$ = 156 V

18. Let N be the number of fringes within the length x, then we have,

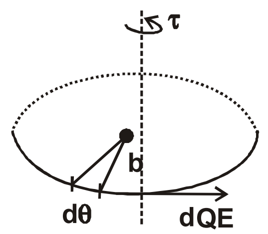
$\beta N = x \Rightarrow \quad \frac{D\lambda}{d} N = x \quad \Rightarrow \quad N = \frac{xd}{\lambda D}$

At any time t

$N = \frac{x}{\lambda D}(d + vt)$

$\frac{dN}{dt} = \frac{xv}{\lambda D}$.

19. Changing magnetic field (at switching off B_0 to zero) induce electric field in such a way to restore the upward flux, hence anticlockwise (E) as seen from above.



$\int \vec{E}.\vec{dl} = -\frac{d\phi}{dt} = -\pi a^2 \frac{dB}{dt} = \int E\,dl$

There is force on small element dQ of ring, tangentially

Now this force produces torque about axis of ring to rotate in anticlockwise sense, so,

$\tau = \int dQE \times b = \int \lambda d\ell\, Eb \ = \lambda b \int E\, d\ell \ = \lambda b\,\pi a^2 \frac{dB}{dt}$

so Impulse of torque

$\int \tau\, dt = \lambda b \pi a^2 \int_{B_o}^{o} dB \ = \int \tau\, dt = \lambda b \pi a^2 B_o$

$L_f - L_i = \Delta L = \int \tau\, dt = \lambda b \pi a^2 B_o = I\omega$ (in magnitude)

It is independent of time taken

$I\omega_f - I\omega_i = \lambda b \pi a^2 B_0$

Where I is moment of inertia

So , $\omega_f = \frac{\lambda b \pi a^2 B_o}{mR^2}$

20. Because both inductors are in parallel

$\therefore\ L_1I_1 = L_2I_2$

$$\frac{U_1}{U_2} = \frac{\frac{1}{2}L_1 I_1 I_1}{\frac{1}{2}L_2 I_2 I_2} = \frac{I_1}{I_2} = \frac{L_2}{L_1}$$

21. The parth difference

$\Delta x = (\mu_A - 1)t_A - (\mu_B - 1)t_B$

$\Rightarrow \Delta x = \mu_A t_A - t_A - \mu_B t_B + t_B$

$\Rightarrow \Delta x = t_B - t_A$

if $t_B = t_A$ $\Rightarrow \Delta x = 0$

$\Rightarrow$ no shift

if $t_B > t_A$ or $t_B < t_A$

$\Delta x \neq 0$

$\Rightarrow$ central maxima may shift towards A or B.

22. For $S_1S_2 = 2.5\lambda$, max path different = 2.5λ
min path different = 0
Between 2.5λ and 0 lie 2λ and $\lambda \Rightarrow$ two circular bright fringes
$n_1 = 2$
For $S_1S_2 = 5.7\lambda$, max. path different = 5.7λ
min path different = 0
Between 5.7λ and 0 lie 5λ, 4λ, 3λ, 2λ, $\lambda \Rightarrow$ Five circular bright fringes.
$\Rightarrow\ n_2 = 5$
$\therefore\ n_2 - n_1 = 5 - 2 = 3$

23. $$\varepsilon = -\frac{\Delta\phi}{\Delta t} = -\frac{(\phi_2 - \phi_1)}{\Delta t}$$

$$= \frac{\phi_1 - \phi_2}{\Delta t}$$

$$= \frac{BA - 0}{\Delta t} = \frac{0.5\times\pi\left(1\times10^{-2}\right)^2}{0.5} = \pi\times10^{-4}\text{ V}$$

24. Just after the switch is closed, there is no current through the coil and capacitor offers no resistance.

Net Resistance = $\frac{9}{2} = 4.5\ \Omega \Rightarrow i_0 = \frac{18}{4.5} = 4$ A.

25. For $R_1 - L$ branch

$$X_L = \omega L = 100 \times \frac{\sqrt{3}}{10} = 10\sqrt{3}\ \Omega,\ R_1 = 10\Omega$$

$\therefore$ $\tan\phi = \frac{X_L}{R_1} = \sqrt{3}$ or $\phi = 60°$

Hence current I_1 lags voltage by 60°.
For $R_2 - C$ branch

$$X_C = \frac{1}{\omega C} = \frac{1}{100\times\frac{\sqrt{3}}{2}\times10^{-3}} = \frac{20}{\sqrt{3}}\ \Omega$$

$\therefore$ $\tan\phi = \frac{X_C}{R_2} = \frac{1}{\sqrt{3}}$ or $\phi = 30°$

Hence current I_2 leads voltage by 30º.

$\therefore$ The phase difference between I_1 and I_2 is 90º.

The maximum current through $R_1 - L$ branch is

$$= \frac{V_0}{\sqrt{R_1^2 + \omega^2 L^2}} = \frac{200\sqrt{2}}{\sqrt{10^2 + (10\sqrt{3})^2}} = 10\sqrt{2} \text{ amp.}$$

Hence when current through $R_1 - L$ branch is $10\sqrt{2}$ amp., the current through $R_2 - C$ branch will be zero.

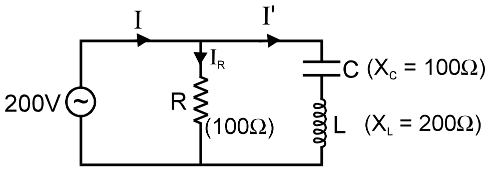
26. $P = V^2/R$

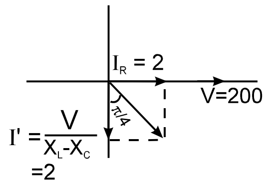
20V peak ac is equivalent to $20/\sqrt{2}$ dc

i.e. 14.14V dc power

$$\frac{\text{dc power}}{\text{ac power}}$$

$$= \frac{\left(20^2/R\right)}{\left[\left(20/\sqrt{2}\right)^2 / R\right]} = \frac{20^2}{\left(20/\sqrt{2}\right)^2} = 2$$

27. 



$$I_R = \frac{V}{R} = \frac{200}{100} = 2A$$

$$I' = \frac{V}{X_L - X_C} = \frac{200}{100} = 2A$$

$$I = \sqrt{{I_R}^2 + I'^2} = 2\sqrt{2} \text{ Amp.}$$

29. $\frac{\lambda D_1}{d} - \frac{\lambda D_2}{d} = 3 \times 10^{-5}$

$\lambda \times \frac{5 \times 10^{-2}}{10^{-3}} = 3 \times 10^{-5} \Rightarrow \qquad \lambda = 0.6 \times 10^{-6} = 6000$ Å.

30. Shift of fringe pattern = $(\mu - 1)\,\frac{tD}{d}$

$\therefore \quad \frac{30\,D\,(4800 \times 10^{-10})}{d} = (0.6)\,t\,\frac{D}{d}$

$30 \times 4800 \times 10^{-10} = 0.6$

$t = \frac{30 \times 4800 \times 10^{-10}}{0.6} = \frac{1.44 \times 10^{-5}}{0.6} = 24 \times 10^{-6}$

31 to 33

Considering length of line is

$$E = \frac{\sigma}{\varepsilon_0} \Rightarrow V = Eh$$

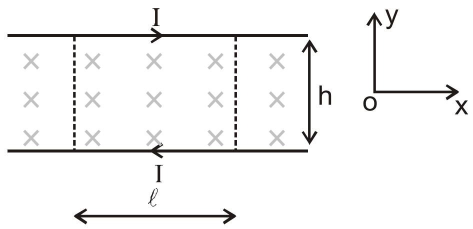
$$V = \frac{\sigma}{\varepsilon_0}h = \frac{Q}{\varepsilon_0 b\ell}.h = c = \frac{Q}{v}$$

$$C = \frac{\varepsilon_0 b\ell}{h}$$

$$\frac{C}{\ell} = \frac{\varepsilon_0 b}{h}$$

$$\Rightarrow B = \frac{\mu_0 K}{2} + \frac{\mu_0 K}{2} = \mu_0 K = \frac{\mu_0 I}{b} \text{ (K = current per unit width)}$$

$$\vec{B} = \frac{\mu_0 I}{b}\left(-\hat{k}\right)$$



Consider a rectangular surface as shown in the figure.
Now $\phi = Bh\ell$

$$\phi = \frac{\mu_0 I}{b}.h\ell = LI$$

$$L = \frac{\mu_0 h\ell}{b}$$

$$\frac{L}{\ell} = \frac{\mu_0 h}{b}$$ But

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$$c^2 = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$$\mu_0 = \frac{1}{\varepsilon_0 c^2}$$

$$\frac{L}{\ell} = \frac{h}{\varepsilon_0 c^2 b}$$

34 to 36

The fan is operating at 200 V, consuming 1000 W, then $I = \frac{1000}{200} = 5A$

But as coil resistance is 1Ω then power dissipated by internal resistance heat is $P_1 = I^2R = 25W$

If V is net emf across coil then

$\frac{V^2}{R} = 25$ W V = 5 volt

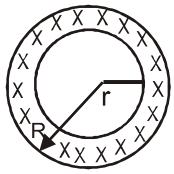
Net emf = source emf – back emf

$V = V_s - e \Rightarrow e = 195$ V

The work done $P_2 = 1000 - 25 = 975$ W.

37. Explanation :

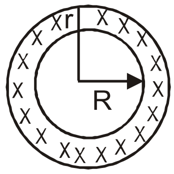
For $r < R$ $\oint E\,dl = A\frac{dB}{dt}$.



$E\,2\pi r = (\pi r^2)\,\alpha$

$E = \frac{r\alpha}{2}$ or $E \propto r$

So, E - r graph is a straight line passing through origin.



At $r = R$ $E = \frac{R\alpha}{2}$

For $r > R$ $E\,2\pi r = (\pi R^2)\,\alpha$

Hence, choice (a) is correct and choices (b), (c) and (d) are wrong.

38. Explanation :

Perpendicular distance between BC and centre O is 10 cm. Component of induced electric field along

the rod $= \frac{d}{2}\frac{dB}{dt}$

Where d = Perpendicular distance from centre to the rod.

Hence, potential difference between the ends of rod

$$v = E\ell = \ell.\ \frac{d}{2}\ \frac{dB}{dt}$$

$$= \frac{10}{2} \times 10^{-2} \times 20 \times 10^{-2} \times 2 = 20 \text{ mV}$$

Hence, choice (b) is correct and choices (a), (c) and (d) are wrong.

39. Explanation :

Perpendicular distance between CD and O is 20 cm.

Therefore, induced emf in CD

$$= \frac{d}{2}\ell\frac{dB}{dt} = \frac{20}{2} \times 10^{-2} \times 20 \times 10^{-2} \times 2$$

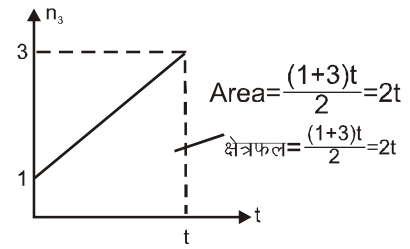
$$= 40 \text{ mV}$$

40. Path difference,

$$\Delta x = n_1\, SS_2 + n_2S_2P - \left[(n_1SS_1 + n_2S_1P) - \int_0^t (n_3 - n_2)dx\right]$$

$$= \quad n_1\,(SS_2 - SS_1) + n_2(S_2P - S_1P) - \int_0^t n_3 dx + n_2 t$$

In order to get central maxima at centre of screen –



$$O = \frac{2\times(1\times10^{-3})^2}{2\times1} + 0 - 2t + \frac{3t}{2}$$

$0.5\,t = 1\ \mu m.$

$t = 2\ \mu m.$

41. From previous equation :

$$0 = 1\ \mu m + \frac{3yd}{2D} - 0.5\,t$$

$$\frac{3}{2}\frac{yd}{D} = -0.5\ \mu m$$

$$y = -\left(\frac{10^{-6}}{3}\right)\left(\frac{1m}{1\times10^{-3}}\right) = \frac{10^{-3}}{3} = \frac{-1}{3}\text{ mm, below centre.}$$

42. $\beta = \frac{\lambda D}{n_2 d} = \frac{3000\times10^{-10}\times1\times2}{3\times1\times10^{-3}} = 2\times10^{-4}\text{ m} \qquad = 0.2\text{ mm.}$

44. **Explanation :**

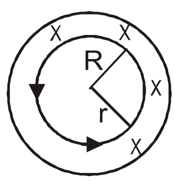
Time varying magnetic field produced electric field known as induced electric field.

So (P) $\rightarrow$ (4)

For r < R

$$\oint E.Dl = -\frac{AdB}{dt}$$

$$E\ 2\pi r = -\ \pi r^2\ \frac{dB}{dt}$$



$$E = -\ \frac{r}{2}\frac{dB}{dt}$$

So (Q) $\rightarrow$ (2)

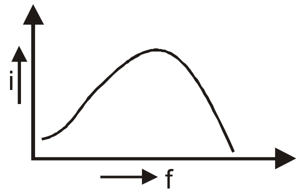
For r > R .

$$E\ 2pr = -\ \pi R^2\ \frac{dB}{dt}\text{ ss,}\quad E = -\ \frac{R^2}{2r}\frac{dB}{dt}$$

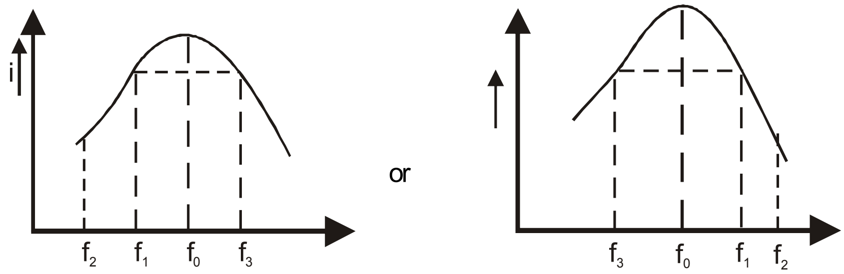
So (R) $\rightarrow$ (3)

If rod is placed along the diameter of magnetic field, then electric field is perpendicular to length of rod.

45. power = i^2R graph of 'i' vs f is :



From data, the possibilities are



f_0 is resonant frequency $\Rightarrow$ means same as circuit being resistive.
The circuit is capacitative when $f < f_0$ and inductive when $f > f_0$
Power at f_1 and f_3 same $\Rightarrow$ i same $\Rightarrow$ z same

$$\Rightarrow \quad 2\pi f_1 L - \frac{1}{2\pi f_1 C} = \frac{1}{2\pi f_3 C} - 2\pi f_3 L$$

$$\Rightarrow \quad 2\pi L\,(f_1 + f_3) = \frac{1}{2\pi C}\left(\frac{1}{f_1} + \frac{1}{f_3}\right)$$

$$\Rightarrow \quad f_1 f_3 = \frac{1}{4\pi^2 LC} \quad \Rightarrow \quad \sqrt{f_1 f_3} = \frac{1}{2\pi\sqrt{LC}} = \frac{\omega_0}{2\pi}$$

$$\text{AM} > \text{GM} \Rightarrow \frac{f_1 + f_3}{2} > f_0$$

$$\Rightarrow \quad \text{Inductive at frequency} = \frac{f_1 + f_3}{2}.$$