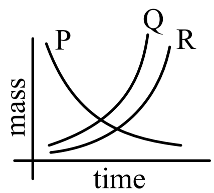
JEE–MAIN EXAMINATION – APRIL 2025

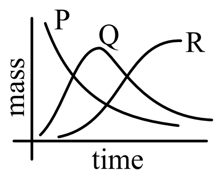
(HELD ON FRIDAY 04th APRIL 2025) **TIME : 3:00 PM TO 6:00 PM**

PHYSICS **TEST PAPER WITH SOLUTION**

SECTION-A

26. A radioactive material P first decays into Q and then Q decays to non-radioactive material R. Which of the following figure represents time dependent mass of P, Q and R?

(1)


(2)


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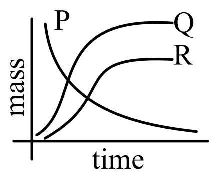

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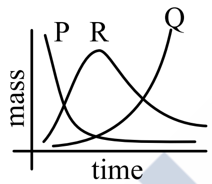
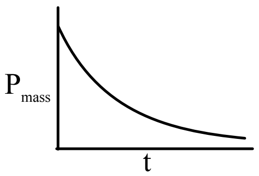
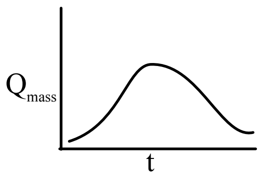
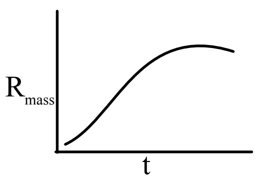


Ans. **(2)**

Sol. $P \rightarrow Q \rightarrow R$







27. There are 'n' number of identical electric bulbs, each is designed to draw a power p independently from the mains supply. They are now joined in series across the main supply. The total power drawn by the combination is :

(1) np (2) $\frac{p}{n^2}$

(3) $\frac{p}{n}$ (4) p

Ans. **(3)**

Sol. $R_s = R_1 + R_2 + R_3 + \ldots\ldots + R_n$

$$\frac{V^2}{P_s} = \frac{V^2}{P} + \frac{V^2}{P} + \ldots\ldots + \frac{V^2}{P_n}$$

$$P_s = \frac{P}{n}$$

28. Consider a rectangular sheet of solid material of length ℓ = 9 cm and width d = 4 cm. The coefficient of linear expansion is $\alpha = 3.1 \times 10^{-5}\ K^{-1}$ at room temperature and one atmospheric pressure. The mass of sheet m = 0.1 kg and the specific heat capacity $C_v = 900\ J\ kg^{-1}K^{-1}$. If the amount of heat supplied to the material is 8.1×10^2 J then change in area of the rectangular sheet is :-

(1) $2.0 \times 10^{-6}\ m^2$

(2) $3.0 \times 10^{-7}\ m^2$

(3) $6.0 \times 10^{-7}\ m^2$

(4) $4.0 \times 10^{-7}\ m^2$

Ans. **(1)**

Sol. $\Delta Q = ms\Delta T$

$8.1 \times 10^2 = 0.1 \times 900 \times \Delta T$

$\Delta A = A_0\, 2\, \alpha\, \Delta T = 2.0 \times 10^{-6}\ m^2$

29. Given below are two statements :

Statement (I) : The dimensions of Planck's constant and angular momentum are same.

Statement (II) : In Bohr's model electron revolve around the nucleus only in those orbits for which angular momentum is integral multiple of Planck's constant.

In the light of the above statements, choose the **most appropriate answer** from the options given below :

(1) Both **Statement I** and **Statement II** are correct

(2) **Statement I** is incorrect but **Statement II** is correct

(3) **Statement I** is correct but **Statement II** is incorrect

(4) Both **Statement I** and **Statement II** are incorrect

Ans. (3)

Sol. $E = hf$

$ML^2T^{-2} = [h] \times [T^{-1}]$

$[h] = [ML^2T^{-1}]$

$L = [MVR] = [ML^2T^{-1}]$

$$L = \frac{nh}{2\pi}$$

L is integral multiple of $\frac{h}{2\pi}$

30. A cylindrical rod of length 1 m and radius 4 cm is mounted vertically. It is subjected to a shear force of 10^5 N at the top. Considering infinitesimally small displacement in the upper edge, the angular displacement θ of the rod axis from its original position would be : (shear moduli, $G = 10^{10}$ N/m^2)

(1) $1/160\pi$

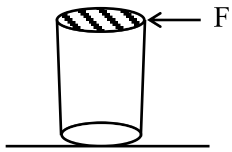
(2) $1/4\pi$

(3) $1/40\pi$

(4) $1/2\pi$

Ans. (1)

Sol.

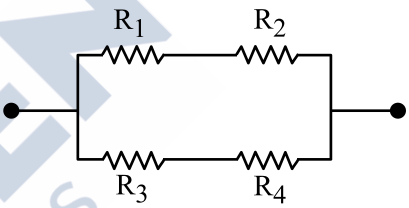


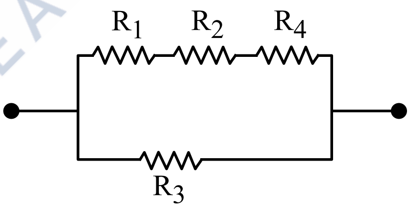
$$\text{Shear moduli} = \frac{\sigma_{shear}}{\theta}$$

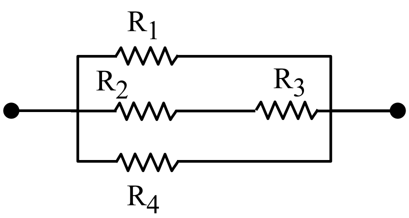
$$10^{10} = \frac{10^5}{\pi \times 16 \times 10^{-4}} \times \frac{1}{\theta}$$

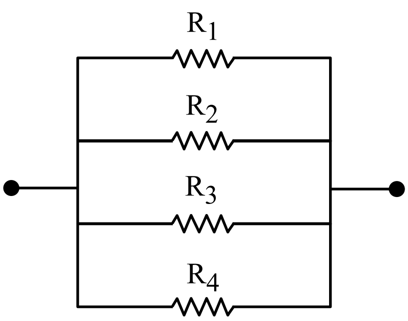
$$\theta = \frac{1}{160\pi} \text{ Radian}$$

31. From the combination of resistors with resistance values $R_1 = R_2 = R_3 = 5\ \Omega$ and $R_4 = 10\ \Omega$, which of the following combination is the best circuit to get an equivalent resistance of 6Ω ?

(1) 

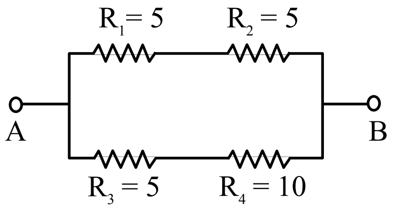
(2) 

(3) 

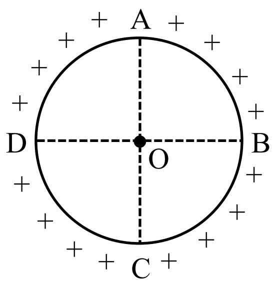
(4) 

Ans. (1)

Sol. $\frac{1}{R_P} = \frac{1}{10} + \frac{1}{15} = \frac{3+2}{30} = \frac{1}{6}$



32. A metallic ring is uniformly charged as shown in figure. AC and BD are two mutually perpendicular diameters. Electric field due to arc AB to 'O' is 'E' is magnitude. What would be the magnitude of electric field at 'O' due to arc ABC ?



(1) 2E

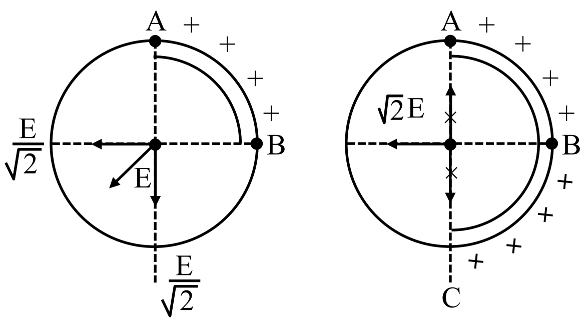
(2) $\sqrt{2}$ E

(3) E/2

(4) Zero

Ans. **(2)**

Sol.



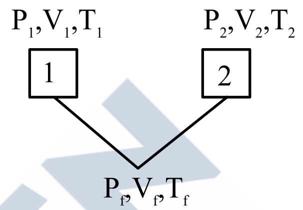
33. There are two vessels filled with an ideal gas where volume of one is double the volume of other. The large vessel contains the gas at 8 kPa at 1000 K while the smaller vessel contains the gas at 7 kPa at 500 K. If the vessels are connected to each other by a thin tube allowing the gas to flow and the temperature of both vessels is maintained at 600 K, at steady state the pressure in the vessels will be (in kPa).

(1) 4.4 (2) 6

(3) 24 (4) 18

Ans. **(2)**

Sol.



Number of masses will remain constant

$n_1 + n_2 = n_f$

$$\frac{P_1V_1}{RT_1} + \frac{P_2V_2}{RT_2} = \frac{P_fV_f}{RT_f}$$

$$\frac{8 \times 2V}{R \times 1000} + \frac{7 \times V}{R \times 500} = \frac{P_f(3V)}{R \times 600}$$

$$\frac{16}{1000} + \frac{14}{1000} = \frac{P_f}{R \times 600}$$

$$\frac{30}{1000} = \frac{P_f}{200}$$

$P_f = 6$ kPa

34. An object is kept at rest at a distance of 3R above the earth's surface where R is earth's radius. The minimum speed with which it must be projected so that it does not return to earth is :

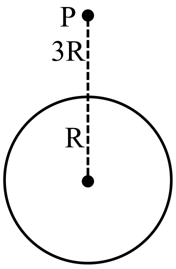
(Assume M = mass of earth, G = Universal gravitational constant)

(1) $\sqrt{\frac{GM}{2R}}$ (2) $\sqrt{\frac{GM}{R}}$

(3) $\sqrt{\frac{3GM}{R}}$ (4) $\sqrt{\frac{2GM}{R}}$

Ans. **(1)**

Sol.



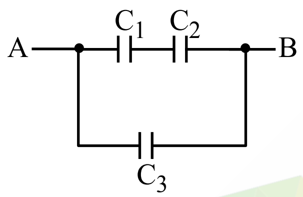
$P_P + k_P = P_O + k_0$

$$-\frac{GMm}{4R} + \frac{1}{2}mV_P^2 = 0$$

$$V_P = \sqrt{\frac{GM}{2R}}$$

Choice 1

35. Three parallel plate capacitors C_1, C_2 and C_3 each of capacitance 5 μF are connected as shown in figure. The effective capacitance between points A and B, when the space between the parallel plates of C_1 capacitor is filled with a dielectric medium having dielectric constant of 4, is :



(1) 22.5 μF (2) 7.5 μF

(3) 9 μF (4) 30 μF

Ans. **(3)**

Sol. After dielectric

$C_1 = 4C$

$$C_1 = 4 \times 5 = 20\mu F$$
$$C_2 = C_3 = 5\mu F$$

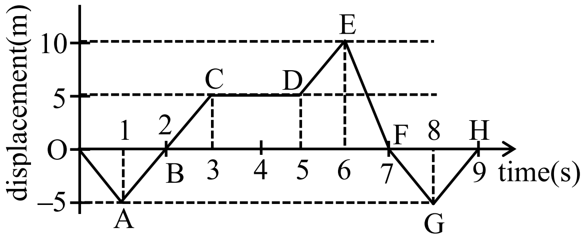
C_1 & C_2 are in series which is parallel to C_3 So

$$C_{eq} = \frac{C_1C_2}{C_1 + C_2} + C_3 \Rightarrow \frac{20 \times 5}{20+5} + 5$$

$= 4 + 5 = 9$ μF

Correct Option (3)

36. The displacement x versus time graph is shown below.



(A) The average velocity during 0 to 3 s is 10 m/s

(B) The average velocity during 3 to 5 s is 0 m/s

(C) The instantaneous velocity at t = 2 s is 5 m/s

(D) The average velocity during 5 to 7 s and instantaneous velocity at t = 6.5 s are equal

(E) The average velocity from t = 0 to t = 9 s is zero

Choose the **correct** answer from the options given below:

(1) (A), (D), (E) only

(2) (B), (C), (D) only

(3) (B), (D), (E) only

(4) (B), (C), (E) only

Ans. **(4)**

Sol. $$<\vec{v}> = \frac{\Delta\vec{s}}{\Delta t} = \frac{S_f - S_i}{t_f - t_i}$$

$$\vec{v} = \frac{ds}{dt} = \text{slope}$$

(A) 0 to 3 sec ; $<\vec{v}> = \frac{5-0}{3} = 5/3 m/s$

(B) 0 to 5 sec ; $<\vec{v}> = \frac{5-5}{2} = 0$

(C) t = 2; slope = $\vec{v} = 5m/s$

(D) t = 5 to 7 sec ; $<\vec{v}> = \frac{0-5}{2} = -2.5m/s$

At t= 6.5 sec; $\vec{v} = 10$

(E) t = 0 to t = 9 ; $<\vec{v}> = 0$

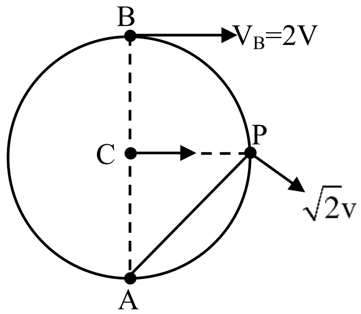
37. A wheel is rolling on a plane surface. The speed of a particle on the highest point of the rim is 8 m/s. The speed of the particle on the rim of the wheel at the same level as the centre of wheel, will be :

(1) $4\sqrt{2}\,m/s$ (2) 8 m/s

(3) 4 m/s (4) $8\sqrt{2}\,m/s$

Ans. (1)

Sol.



If $V_B = 2V$

Point A is instantaneous center of rotation

Given $V_B = 8$ m/s

$V = 4$ m/s

$V_P = \sqrt{2}v \Rightarrow V_p = 4\sqrt{2}m/s$

correct (1)

38. For the determination of refractive index of glass slab, a travelling microscope is used whose main scale contains 300 equal divisions equals to 15 cm. The vernier scale attached to the microscope has 25 divisions equals to 24 divisions of main scale. The least count (LC) of the travelling microscope is (in cm) :

(1) 0.001 (2) 0.002

(3) 0.0005 (4) 0.0025

Ans. (2)

Sol. 300 msd = 15 cm

$1\text{ msd} = \frac{15}{300}\text{cm} = 0.05\text{cm}$

25 vsd = 24 msd

$1\text{ vsd} = \frac{24}{25}\text{msd}$

LC = 1 msd – 1 vsd

$LC = 1\text{ msd} - \frac{24}{25}\text{msd} = \frac{1}{25}\text{msd}$

$LC = \frac{1}{25} \times 0.05 = 0.002\text{ cm}$

correct option (2)

39. A block of mass 25 kg is pulled along a horizontal surface by a force at an angle 45° with the horizontal. The friction coefficient between the block and the surface is 0.25. The displacement of 5 m of the block is:

(1) 970 J

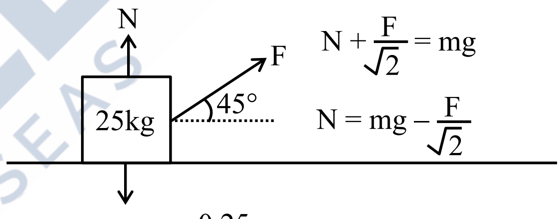
(2) 735 J

(3) 245 J

(4) 490 J

Ans. (3)

Sol.



$N + \frac{F}{\sqrt{2}} = mg$

$N = mg - \frac{F}{\sqrt{2}}$

Block travels with uniform velocity

So $a = 0 \Rightarrow F\cos 45° = \text{friction}$

$$\frac{F}{\sqrt{2}} = \mu\left[mg - \frac{F}{\sqrt{2}}\right]$$

$$\frac{F}{\sqrt{2}} = 0.25\left[25\times 9.8 - \frac{F}{\sqrt{2}}\right]$$

$$\Rightarrow 1.25\frac{F}{\sqrt{2}} = 61.25$$

$$F = \frac{61.25\times\sqrt{2}}{1.25} = 49\sqrt{2}$$

$W_{ext} = FS\cos 45°$

$$= 49\sqrt{2} \times 5 \times \frac{1}{\sqrt{2}} = 245\text{ J}$$

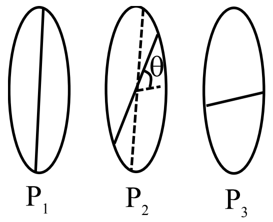
40. Two polarisers P_1 and P_2 are placed in such a way that the intensity of the transmitted light will be zero. A third polariser P_3 is inserted in between P_1 and P_2, at the particular angle between P_2 and P_3. The transmitted intensity of the light passing the through all three polarisers is maximum. The angle between the polarisers P_2 and P_3 is :

(1) $\frac{\pi}{4}$ (2) $\frac{\pi}{6}$

(3) $\frac{\pi}{8}$ (4) $\frac{\pi}{3}$

Ans. (1)

Sol. Through P_2 $I_1 = I_0 \sin^2\left(\frac{\pi}{2} - \theta\right)$



$I_1 = I_0 \cos^2\theta$

Through P_3 $I_{net} = \left(I_0 \cos^2\theta\right)\sin^2\theta$

$I_{net} = \frac{I_0}{4}[\sin(2\theta)]^2$ for max I_{net} $\theta =$ 45°

So angle between P_2 and $P_3 = \frac{\pi}{4}$

Correct Ans. (1)

41. Consider a n-type semiconductor in which n_e and n_h are number of electrons and holes, respectively.

(A) Holes are minority carriers

(B) The dopant is a pentavalent atom

(C) $n_e n_h \neq n_i^2$

(where n_i is number of electrons or holes in semiconductor when it is intrinsic form)

(D) $n_e n_h \geq n_i^2$

(E) The holes are not generated due to the donors

Choose the **correct** answer from the options given below :

(1) (A), (C), (D) only (2) (A), (C), (E) only

(3) (A), (B), (E) only (4) (A), (B), (C) only

Ans. (3)

Sol. (A) n type semiconductor holes are minority carriers and e^- are majority carriers

(B) Dopant are pentavalent atom.

(C) $n_e \cdot n_h = n_i^2$ for intrinsic semiconductor

(E) In n type semiconductor primary source of holes generation are thermal excitation.

42. Match **List-I** with **List-II**.

List-I	List-II
(A) Isobaric	(I) $\Delta Q = \Delta W$
(B) Isochoric	(II) $\Delta Q = \Delta U$
(C) Adiabatic	(III) ΔQ = zero
(D) Isothermal	(IV) $\Delta Q = \Delta U + P\Delta V$

ΔQ = Heat supplied

ΔW = Work done by the system

ΔU = Change in internal energy

P = Pressure of the system

ΔV = Change in volume of the system

Choose the **correct** answer from the options given below :

(1) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(2) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)

(3) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(4) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)

Ans. (3)

Sol. (A) Isobaric (P = C)

$\boxed{\Delta Q = \Delta U + P\Delta V}$

(B) Isochoric (V = C)

$\boxed{\Delta Q = \Delta U}$

(C) Adiabatic ($\Delta Q = 0$)

$\boxed{\Delta Q = 0}$

(D) Isothermal ($\Delta U = 0$)

$\boxed{\Delta Q = \Delta W}$

43. Displacement of a wave is expressed as $x(t) = 5\cos\left(628t + \frac{\pi}{2}\right)$ m. The wavelength of the wave when its velocity is 300 m/s is :

(1) 5 m (2) 3 m
(3) 0.5 m (4) 0.33 m

Ans. (2)

Sol. $x(t) = 5\cos\left[628t + \frac{\pi}{2}\right]$ m

velocity $(v_\omega) = 300$ m/s

$$v_w = \frac{\omega}{K}$$

$$300 = \frac{628}{K} \Rightarrow K = \frac{628}{300}$$

$$\frac{2\pi}{\lambda} = \frac{628}{300} \Rightarrow \lambda = \frac{2\times3.14\times300}{628}$$

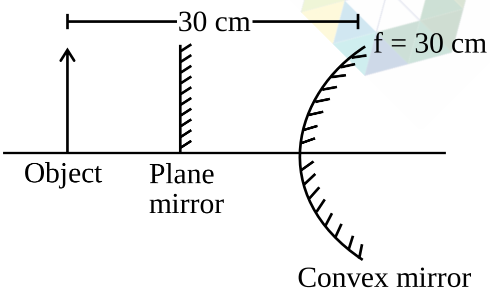
$\lambda = 2$m

44. A finite size object is placed normal to the principal axis at a distance of 30 cm from a convex mirror of focal length 30 cm. A plane mirror is now placed in such a way that the image produced by both the mirrors coincide with each other. The distance between the two mirrors is :

(1) 45 cm (2) 7.5 cm
(3) 22.5 cm (4) 15 cm

Ans. (2)

Sol.



For Convex mirror

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{30} = \frac{1}{30}$$

$$\frac{1}{v} = \frac{2}{30} = \frac{1}{15} \Rightarrow v = 15 \text{ cm}$$

Image formed by convex mirror is at 45cm from object so plane mirror should be placed midway at 22.5 cm from object so that both of their images may coinside,

Therefore distance between both mirrors

= 30 – 22.5 = 7.5 cm

Correct Answer : Option 2

45. In an electromagnetic system, a quantity defined as the ratio of electric dipole moment and magnetic dipole moment has dimension of $[M^P L^Q T^R A^S]$. The value of P and Q are :

(1) – 1, 0 (2) – 1, 1
(3) 1, – 1 (4) 0, – 1

Ans. (4)

Sol. Electric dipole moment $(\vec{P}) = q \times 2\ell$

Magnetic dipole moment $(\vec{M}) = IA$

$$\left[\frac{P}{M}\right] = \left[\frac{LTA}{L^2A}\right] = L^{-1}T = M^0L^{-1}T^1A^0$$

After compering values of P & Q are 0, –1

Correct Answer : Option 4

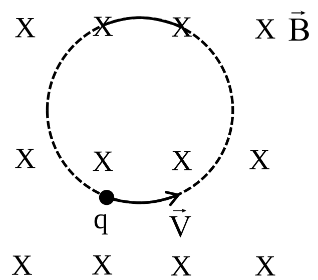
SECTION-B

46. A particle of charge 1.6 μC and mass 16 μg is present in a strong magnetic field of 6.28 T. The particle is then fired perpendicular to magnetic field. The time required for the particle to return to original location for the first time is _________ s. ($\pi = 3.14$)

Allen Ans. 0

NTA Ans. 10

Sol.



Angle between $\vec{V}$ of charge & $\vec{B}$ is 90° motion will be uniform circular motion time period is given by

$$T = \frac{2\pi m}{qB} = \frac{2\pi \times 16\times10^{-9}\text{ kg}}{1.6\times10^{-6}\times6.28}$$

T = 0.01 seconds

NTA Answer is 10

Correct Answer is 0 (nearest integer)

47. A solid sphere with uniform density and radius R is rotating initially with constant angular velocity (ω_1) about its diameter. After some time during the rotation its starts loosing mass at a uniform rate, with no change in its shape. The angular velocity of the sphere when its radius become R/2 is $x\omega_1$. The value of x is ______.

Ans. (32)

Sol. When sphere is of radius R, its mass is M, when radius is reduced to $\frac{R}{2}$, mass will reduced to $\frac{M}{8}$

Now by conservation of angular momentum ($\tau_{ext} = 0$)

$L_1 = L_2$

$I_1\omega_1 = I_2\omega_2$

$$\left(\frac{2}{5}MR^2\right)\omega_1 = \left(\frac{2}{5}\left(\frac{M}{8}\right)\left(\frac{R}{2}\right)^2\right)\omega_2$$

$\boxed{\omega_2 = 32\,\omega_1}$ value of x is 32

$\boxed{\text{Answer is 32}}$

48. If an optical medium possesses a relative permeability of $\frac{10}{\pi}$ and relative permittivity of $\frac{1}{0.0885}$, then the velocity of light is greater in vacuum than that in this medium by ______ times.

($\mu_0 = 4\pi \times 10^{-7}$ H/m, $\epsilon_0 = 8.85 \times 10^{-12}$ F/m, $c = 3 \times 10^8$ m/s)

Ans. (6)

Sol. Since velocity of light in terms of μ & E is

$$V = \frac{1}{\sqrt{\mu \in}} = \frac{1}{\sqrt{\mu_0\mu_r}} \times \frac{1}{\sqrt{\in_0 \in_r}}$$

$$= \frac{1}{\sqrt{\mu_r \in_r}} \times \frac{1}{\sqrt{\mu_0 \in_0}}$$

$$= \frac{C}{\sqrt{\mu_r \in_r}} = \frac{C}{\sqrt{\frac{10}{\pi} \times \frac{1}{0.0885}}}$$

$$= \frac{C}{\sqrt{36}} = \frac{C}{6}$$

$$V = \frac{C}{6}$$

$C = 6V$

Velocity of light in vacuum is greater by 6 times the velocity of light in medium

Answer is 6

49. In a Young's double slit experiment, two slits are located 1.5 mm apart. The distance of screen from slits is 2 m and the wavelength of the source is 400 nm. If the 20 maxima of the double slit pattern are contained within the centre maximum of the single slit diffraction pattern, then the width of each slit is $x \times 10^{-3}$ cm, where x-value is _____.

Ans. (15)

Sol. Width of 20 maxima of double slit = width of central maxima of single slit

$$\frac{20\lambda D}{d} = \frac{2\lambda D}{a}$$

$$\frac{10}{d} = \frac{1}{a}$$

$$a = \frac{d}{10} = \frac{1.5 \times 10^{-1}}{10}\text{cm} = 15 \times 10^{-3}\text{cm}$$

Value of x is 15

Answer is 15

50. An inductor of self inductance 1 H connected in series with a resistor of 100 π ohm and an ac supply of 100 π volt, 50 Hz. Maximum current flowing in the circuit is _______ A.

Ans. (1)

Sol. Impedance of circuit

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

$$= \sqrt{(100\pi)^2 + (2\pi \times 50 \times 1)^2}$$

$$= \sqrt{(100\pi)^2 + (100\pi)^2}$$

$$= \sqrt{2} \times 100\pi$$

$$I_{rms} = \frac{V}{2} = \frac{100\pi}{\sqrt{2} \times 100\pi} = \frac{1}{\sqrt{2}}$$

$$I_{max} = \sqrt{2}\, I_{rms} = \sqrt{2} \times \frac{1}{\sqrt{2}} = 1\,\text{Ampere}$$

Correct Answer : 1