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JEE (Main)

PAPER-1 (B.E./B. TECH.)

2023

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 24 January, 2023 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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PART : PHYSICS

1. For equation of wave y = 0.05 sin (2x – 4t), find velocity of wave. (Here x is in meter, t is in sec. & y is in meter)

in meter)

(1) 4 m/s (2) 6 m/s (3) 2 m/s (4) 8 m/s

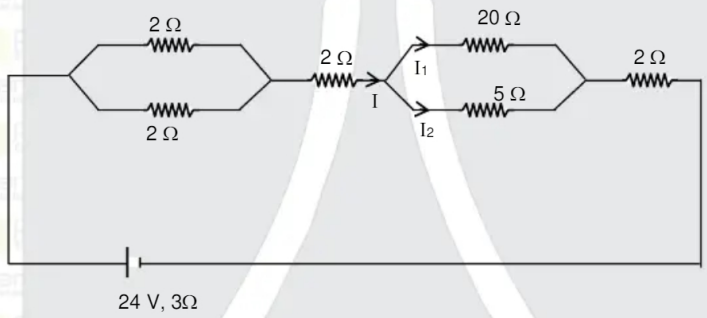
Ans. **(3)**

Sol. Compare the equation with y = a sin (kx – ωt)

k = 2, ω = 4

Velocity = $v = \frac{\omega}{k} = \frac{4}{2} = 2$ m/s.

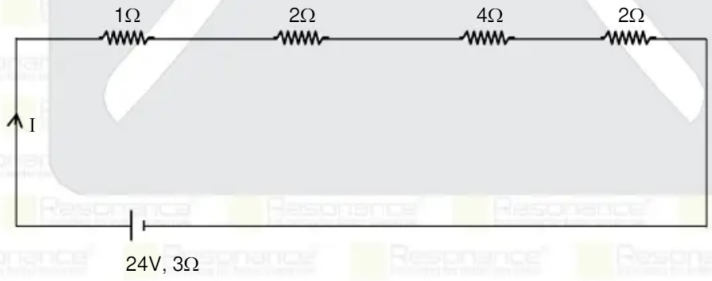
2. For the given circuit find current in 20Ω & 5Ω resistance.

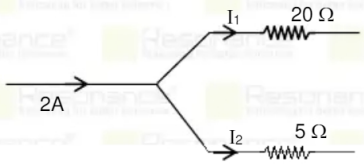


(1) 1.2A, 0.2A (2) 1.6A, 0.4A (3) 1.6A, 2.6A (4) 1.3A, 1.2A

Ans. **(2)**

Sol.





$I = \frac{24V}{(1\Omega + 2\Omega + 4\Omega + 2\Omega + 3\Omega)}$

$I = \frac{24V}{12\Omega} = 2A$

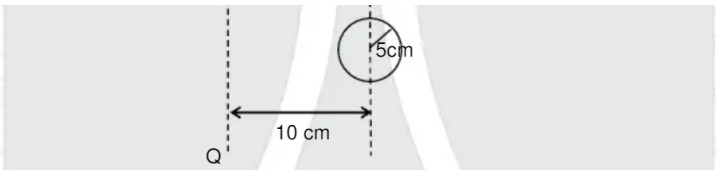
$I_1 = \frac{5\Omega}{(20+5)\Omega} \times 2 = \frac{5}{25} \times 2A = \frac{10}{25}$ A

$I_1 = \frac{2}{5} = 0.4A$ Ans.

$I_2 = I - I_1$

$I_2 = 1.6A$. Ans.

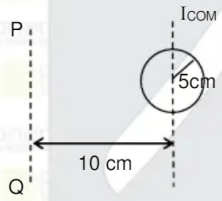
3. Find radius of gyration for uniform solid sphere of radius 5 cm about the axis PQ, as shown in figure



(1) 10 (2) $\sqrt{110}$ (3) $\sqrt{90}$ (4) $\sqrt{50}$

Ans. **(2)**

Sol.



$I_{PQ} = I_{COM} + md^2$

$I_{PQ} = \frac{2}{5} MR^2 + Md^2$

$= M\left[\frac{2}{5} \times 25 + 10^2\right]$

$I_{PQ} = M[10 + 100] = 110\ M$

$MK^2 = 110\ M$

$k = \sqrt{110}$

4. Match the column. and choose the correct option.

(i) h (plank's constant)	(a) $ML^2 T^{-1}$
(ii) P (linear momentum)	(b) MLT^{-1}
(iii) V (stopping potential)	(c) $ML^2 A^{-1} T^{-3}$
(iv) ϕ (work function)	(d) $ML^2 T^{-2}$

(1) (i) a (ii) b (iii) c (iv) d

(2) (i) b (ii) c (iii) d (iv) a

(3) (i) c (ii) d (iii) a (iv) b

(4) (i) c (ii) a (iii) b (iv) d

Ans. **(1)**

Sol. $E = h\nu$

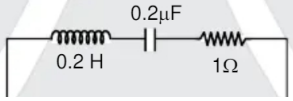
$h = \frac{E}{\nu} = \frac{ML^2T^{-2}}{1/T} = [ML^2T^{-1}]$

$P = mv = [MLT^{-1}]$

$V_0 = \frac{W}{q} = \frac{ML^2T^{-2}}{AT} = [ML^2 A^{-1} T^{-3}]$

$\phi = w = [ML^2T^{-2}]$

5. Calculate ratio between bandwidth and quality factor for the following circuit.



(1) $\frac{1}{2}$ (2) $\frac{1}{4}$ (3) 2 (4) $\frac{1}{8}$

Ans. **(4)**

Sol. Band width = R/L $= \frac{5}{0.2} = 25$

Quality factor = $\frac{\sqrt{L}}{R\sqrt{C}} = \frac{\sqrt{0.2}}{5\times\sqrt{0.2\times10^{-6}}} = 200$

$\frac{\text{Band width}}{\text{Qualityfactor}} = \frac{25}{200} = \frac{1}{8}$

6. If a person can throw a ball to maximum height 136 m. Find maximum range ?

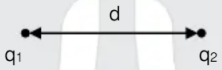
(1) 272 (2) 280 (3) 390 (4) 372

Ans. **(1)**

Sol. $H_{max} = \frac{u^2}{2g} = 136$ m.

$\Rightarrow \quad R_{max} = \frac{u^2}{g} = 136 \times 2 = 272$ m

7. Two charges q_1 and q_2 separated by a distance d are placed in a medium of dielectric constant k, if they are placed in the air then find equivalent distance at which they experience same force.



(1) $\frac{d}{\sqrt{k}}$ (2) $\frac{d}{k}$ (3) $\sqrt{k}\,d$ (4) k^2d

Ans. **(3)**

Sol. $F_1 = \frac{1}{4\pi\varepsilon_0 k}\frac{q_1q_2}{d^2}$ ...(1)

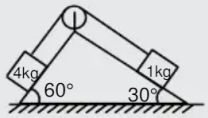
$F_2 = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{d'^2}$ ...(2)

(1) = (2)

$d'^2 = kd^2$

$d' = \sqrt{k}\,d$

8. There are two blocks system as shown in the figure placed on a fixed smooth inclined surface. Given that the mass of pulley and rope is negligible. Find the tension in the string.



(1) $2(\sqrt{3}+1)$ N (2) $4(\sqrt{3}+1)$ N (3) $2(\sqrt{3}-1)$ N (4) $5(\sqrt{3}+1)$ N

Ans. **(2)**

Sol. $a = \frac{F_{net}}{m_1 + m_2}$

$a = \frac{4g\sin 60° - 1g\sin 30°}{4+1} \Rightarrow a = \frac{4\times 10\times\frac{\sqrt{3}}{2} - 10\times\frac{1}{2}}{5}$

$a = 4\sqrt{3} - 1 \text{ m/s}^2$

$T = 1.\ a + 1.g\sin 30° = 4\sqrt{3} - 1 + 10 \times \frac{1}{2}$

$T = (4\sqrt{3} + 1)\text{ N}$

9. Find atomic number of "G" for the given equation

$${}^{x}_{86}A \xrightarrow{\alpha} B \xrightarrow{\beta^-} C \xrightarrow{\alpha} D \xrightarrow{\beta^+} E \xrightarrow{\beta^+} F \xrightarrow{\gamma} G$$

(1) 86 (2) 81 (3) 78 (4) 83

Ans. **(2)**

Sol. ${}^{x}_{86}A \xrightarrow{\alpha} {}^{x-4}_{84}B \xrightarrow{\beta^-} {}^{x-4}_{85}C \xrightarrow{\alpha} {}^{x-8}_{83}D \xrightarrow{\beta^+} {}^{x-8}_{82}E \xrightarrow{\beta^+} {}^{x-8}_{81}F \xrightarrow{\gamma} {}^{x-8}_{81}G$

Final atomic number = 81

10. A circular loop of radius $\frac{10}{\sqrt{\pi}}$ cm is placed in a uniform magnetic field which is perpendicular to the plane of the loop, and its value is decrease linearly with time from 0.5 tesla to zero in 0.5 seconds. The EMF induced in the loop will be :

(1) 0.01 volt (2) 0.005 volt (3) 0.02 volt (4) 0.003 volt

Ans. **(1)**

Sol. $\phi = BA = B(t) \times \pi \times \left(\frac{0.1}{\sqrt{\pi}}\right)^2$

$\phi(t) = B(t) \times 10^{-2}$

$EMF = \frac{d\phi}{dt} = (10^{-2})\frac{dB}{dt} = (10^{-2})\left(\frac{0.5}{0.5}\right)$

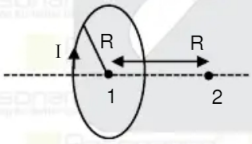
EMF = 0.01 volt

11. Find the ratio of magnetic field at the centre and at the axis at a distance R from the centre of a current carrying circular loop of radius R.

(1) $3\sqrt{2}$ (2) $\sqrt{2}$ (3) $\frac{1}{\sqrt{2}}$ (4) $2\sqrt{2}$

Ans. **(4)**

Sol.



$B_1 = \frac{\mu_0 I R^2}{2R^3} = \frac{\mu_0 I}{2R}$

on the axis at a distance R.

$B_2 = \frac{\mu_0 I R^2}{2(R^2+R^2)^{3/2}} = \frac{\mu_0 I R^2}{2\times 2^{3/2} R^3} = \frac{\mu_0 I}{4\sqrt{2}R}$

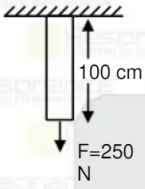
$\frac{B_1}{B_2} = \frac{\mu_0 I}{2R} \times \frac{4\sqrt{2}R}{\mu_0 I} = 2\sqrt{2}$

12. If 250 N of force is applied at the one end of a vertically hanging rod. Length of rod is 100 cm and cross-sectional area of rod is 6.25×10^{-4} m^2. Then find elongation in rod. (Y rod = 10^{10} N/m^2)

(1) 0.04 mm (2) 0.02 mm (3) 0.01 mm (4) 0.025 mm

Ans. **(1)**

Sol.



$$Y = \frac{F/A}{\Delta L/L}$$

$$\frac{F}{A} = Y\frac{\Delta L}{L} \quad ; \quad \Delta L = \frac{F \times L}{YA}$$

$$\Delta L = \frac{250 \times 1}{10^{10} \times 6.25 \times 10^{-4}} \Rightarrow \Delta L = \frac{250 \times 100}{625} \times 10^{-6}$$

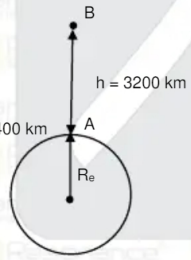
$$\Delta L = 0.04 \text{ mm}$$

13. Weight of an object at the surface of the earth is 18N. Find the weight of the object at height of 3200 km above the surface of the earth ?

(1) 6N (2) 4N (3) 9N (4) 8N

Ans. **(4)**

Sol.



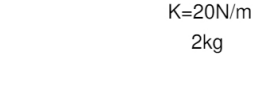
$W_A = 18$ N, $W_B = ?$

$$g_{eff} = \frac{g}{\left[1+\frac{h}{R}\right]^2} \Rightarrow \frac{4g}{9}$$

$$W_B = m \times \frac{4g}{9}$$

$$\frac{W_A}{W_B} = \frac{mg}{m \times \frac{4}{9}g} = \frac{18}{W_B} \Rightarrow W_B = \frac{4}{9} \times 18 = 8\text{N}$$

14. K for each spring is same. Time period of system is $\frac{\pi}{x}$ then x = ?



(1) 2 (2) 3 (3) 4 (4) 5

Ans. **(4)**

Sol. spring are is parallel.

$K_{net} = K_1 + K_2 = 40$

$$\omega = \sqrt{\frac{K}{m}} = \sqrt{\frac{40}{2}} = \sqrt{20} \Rightarrow T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{20}} = \frac{\pi}{\sqrt{x}}$$

x = 5

15. Graph of modulating wave is shown & Equation of carrier wave is $y_c = 2\sin \omega_c t$. Find the modulation index

(1) 2 (2) 1.5 (3) 0.5 (4) 1

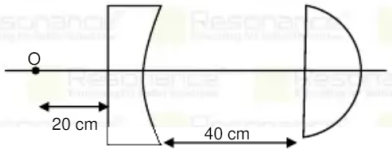
Ans. **(3)**

Sol. $\mu = \frac{A_m}{A_c} = \frac{1}{2} = 0.5$

16. Which of the following is correct about photoelectric effect ?
(i) K.E. of electron depends on intensity of light
(ii) Photoelectric effect is explained by wave nature of light
(iii) Photoelectric effect is defined by particle nature of light.
(iv) Stopping potential depends on intensity.
(1) (i) (2) (ii) (3) (iii) (4) (iv)

Ans. **(3)**

17. A plano-convex lens and a plano-concave lens of same radius of curvature 30 cm and refractive index 1.75 separated by a distance 40cm a point object is placed at a distance of 20 cm from the plano concave lens. Find distance of final image from plano convex lens



(1) 120 cm (2) 150 cm (3) 110 cm (4) 160cm

Ans. **(4)**

Sol. $\frac{1}{f_1} = 0.75 \times \left(\frac{-1}{30}\right) \Rightarrow \frac{3}{4} \times \frac{1}{30} \Rightarrow f_1 = -40$ cm

$\frac{1}{f_2} = 0.75 \times \frac{1}{30} \Rightarrow f_2 = 40$

For L

For L_1

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

$$\frac{1}{v}+\frac{1}{20}=\frac{-1}{40} \qquad \Rightarrow \frac{1}{v}=\frac{-1}{40}-\frac{1}{20}=\frac{-1-2}{40} \Rightarrow v=\frac{-40}{3}$$

For L_2

$$u=-40-\frac{40}{3}=\frac{-160}{3}$$

$$\Rightarrow \quad \frac{1}{v_2}+\frac{3}{160}=\frac{1}{40} \Rightarrow \qquad \frac{1}{v_2}=\frac{1}{40}-\frac{3}{160} \Rightarrow \qquad v_2 = 160 \text{ cm}$$

18. Two long current carrying wires are placed parallel and distance between them is 10 cm. If I current is flowing in each wire, the force acting on 10 cm length of a wire is F_0. If current in both the wires is doubled and distance between them is halved, then find the magnetic force on the 10 cm length of the wire :

(1) $4F_0$ (2) $\frac{F_0}{4}$ (3) $8\,F_0$ (4) $\frac{F_0}{8}$

Ans. **(3)**

Sol. $\frac{F_m}{\ell}=\frac{\mu_0 i_1 i_2}{2\pi r}$

$$\Rightarrow \quad F_m \propto \frac{(2)(2)}{(1/2)} = 8 \text{ times}$$

19. Two charges (both at rest initially) having a charge Q and –Q are released from the situation shown.

The K.E. of the system, when the separation between them becomes half is $\frac{1}{4\pi\epsilon_0}.\frac{Q^2}{nr_0}$. Find n ?

(1) 0 (2) 2 (3) 1 (4) –1

Ans. **(3)**

Sol. $U_i + K_i = U_f + KE_f$

$$\Rightarrow \quad \frac{1}{4\pi\epsilon_0}\left(\frac{-Q^2}{r_0}\right)+0=\frac{1}{4\pi\epsilon_0}\left(\frac{-Q^2}{r_0/2}\right)+KE_f$$

$$\Rightarrow \quad KE_f=\frac{1}{4\pi\epsilon_0}[2-1]\frac{Q^2}{r_0} \quad \Rightarrow \quad KE_f=\frac{1}{4\pi\epsilon_0}\frac{Q^2}{r_0} \quad \therefore \quad n=1$$

20. **Assertion (A):** Elevator can move with constant velocity if its weight is balanced by tension in cable

Reason (R) : Force by elevators floor on a man is more than his weight, while accelerating downwards.

(1) Both (A) and (R) are true and (R) is the correct explanation of (A)
(2) Both (A) and (R) true but (R) is NOT the correct explanation of (A)
(3) (A) is true but (R) is false.
(4) (A) is false but (R) is true.

Ans. **(3)**

Sol. Assertion is true but Reason is wrong

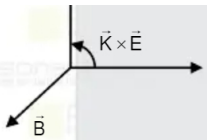
21. If ω is angular velocity then direction of $\vec{B}$

(1) $\frac{1}{\omega}\left(\vec{E}\times\vec{K}\right)$ (2) $\omega\left(\vec{E}\times\vec{K}\right)$ (3) $\frac{1}{\omega}\left(\vec{K}\times\vec{E}\right)$ (4) $\omega\left(\vec{K}\times\vec{E}\right)$

Ans. **(3)**

Sol.

$\vec{E}$



$\vec{K} \parallel \vec{E}\times\vec{B}$

$\vec{K}\times\vec{E} \parallel \vec{B}$

22. A uniform rectangular plates has circular hole of diameter 'd' as shown. If coefficient of linear expansion of plate is α. Find the charge in diameter of hole, if temperature of plate increased by ΔT

(1) $2d\alpha\Delta T$ (2) $d\alpha\Delta T$ (3) $\frac{d}{2}\alpha\Delta T$ (4) $3d\alpha\Delta T$

Ans. **(2)**

Sol. as are know

$\Delta\ell = \ell_0\alpha\Delta T$

$\Delta d = d\alpha\Delta T$

23. **Statement -1 :** If temperature of a gas is increased from – 73ºC to 527ºC then it rms velocity becomes double.

Statement -2 : Product of pressure and volume is equal to translational energy of an ideal gas

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

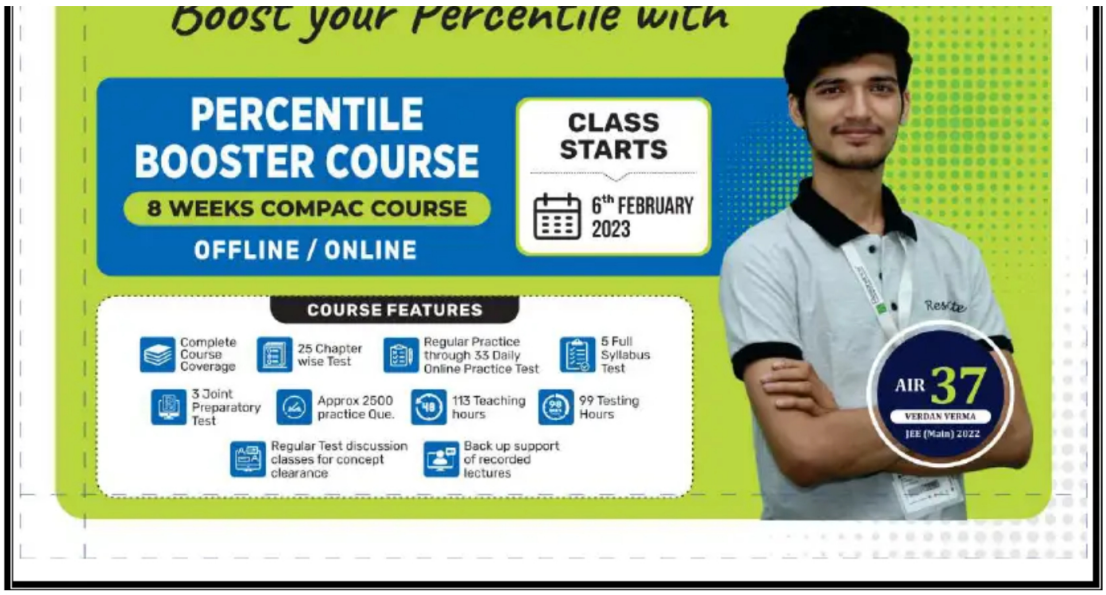
(4) Statement-1 is False, Statement-2 is True.

Ans. **(3)**

Sol. **Statement -1 :** $V_{rms} = \sqrt{\frac{3RT}{M_0}}$

$\frac{vr.m.s_1}{vr.m.s_2} = \sqrt{\frac{T_1}{T_2}} = \sqrt{\frac{200}{800}} = \frac{1}{2}$

Statement -2 : $KE + = \frac{3}{2}PV$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