



JEE (Main)

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

2021

COMPUTER BASED TEST (CBT) Memory Based Questions & Solutions

Date: 20 July, 2021 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

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PART : PHYSICS

Ans. (2)

Sol. K.E. $\Rightarrow K = \frac{P^2}{2m}$

$$P \propto \sqrt{K}$$

$$P_2 = \sqrt{K_2} = P_1 \sqrt{4K_1}$$

$$P_1 = \sqrt{K_1} \rightarrow P_1 = \sqrt{K}$$

$$\Rightarrow \frac{P_2}{P_1} = 2$$

$$\Rightarrow \frac{P_2 - P_1}{P_1} \% = \left(\frac{P_2}{P_1} - 1 \right) \times 100 = (2 - 1) \times 100 = 100$$

$$\Rightarrow \frac{\Delta P}{P_1} \% = 100\%$$

2. A RLC circuit is in its resonance condition. Its circuit components have value
 $R = 5\Omega$
 $L = 2H$

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- (1) 6kW (2) 10kW (3) 12kW (4) 12.5kW

Ans. (4)

Sol. As circuit is in resonance. Thus

$$X_L = X_C$$

$$\therefore Z = R \text{ so } i_{\text{rms}} = V/Z = V/R$$

$$P = i_{\text{rms}}^2 R$$

$$P = \frac{V^2}{R} = \frac{250 \times 250}{5} = 12500 \text{ J/s} = 12.5 \text{ kW}$$

3. A wheel rotating with an angular speed of 600 rpm is given an constant angular acceleration of 1800 rpm² for 10 sec. Number of revolutions revolved by wheel is :

- (1) 125 (2) 100 (3) 75 (4) 50

Ans. (1)

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Sol. $\omega = 600 \text{ rpm}$

$$\alpha = 1800 \text{ rpm}^2$$

$$t = 10 \text{ sec} = 1/6 \text{ minute}$$

$$\theta = \omega t + \frac{1}{2} \alpha t^2$$

$$= 60 \times 2 + \frac{36}{2}$$

$$= 100 + 25 = 125 \text{ revolution.}$$

4. $|\vec{P}| = |\vec{Q}|$, $|\vec{P} + \vec{Q}| = |\vec{P} - \vec{Q}|$. Find angle between \vec{P} & \vec{Q}

- (1) 45° (2) 90° (3) 135° (4) 150°

Ans. (2)

Sol. $|\vec{P} + \vec{Q}| = |\vec{P} - \vec{Q}|$

$$|\vec{P}|^2 + |\vec{Q}|^2 + 2|\vec{P}||\vec{Q}|\cos\theta = |\vec{P}|^2 + |\vec{Q}|^2 - 2|\vec{P}||\vec{Q}|\cos\theta$$

$$|\vec{P}||\vec{Q}|\cos\theta = 0^\circ$$

$$\text{Thus, } \theta = 90^\circ$$

5. A body is moved from rest along straight line by a machine delivering a constant power. Time taken by body to travel a distance "S" is proportional to

- (1) S^{1/3} (2) S^{2/3} (3) S^{1/2} (4) S^{1/4}

Ans. (2)

Sol. Energy supply = Pt

$$t = \frac{2S}{C}$$

$$V \propto \sqrt{t}$$

$$\frac{dS}{dt} = C\sqrt{t}$$

$$\int_0^S dS = C \int_0^t t^{1/2} dt$$

$$S = \frac{2Ct^{3/2}}{3}$$

$$t^{3/2} = \frac{3S}{2C}$$

$$t = S^{2/3} \left(\frac{3}{2C} \right)^{2/3}$$

$$T \propto S^{2/3}$$

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6. A uniform rod of young's modulus Y is stretched by two tension T_1 and T_2 such that rods get expanded to length L_1 and L_2 respectively. Find initial length of rod ?

(1) $\frac{L_1 T_1 - L_2 T_2}{T_1 - T_2}$ (2) $\frac{L_2 T_1 - L_1 T_2}{T_2 - T_1}$ (3) $\frac{L_1 T_2 - L_2 T_1}{T_2 - T_1}$ (4) $\frac{L_1 \times T_2}{T_1 \times L_2}$

Ans.

(3)

$$As \frac{1}{A} = Y \frac{\Delta L}{L}$$

$$\text{So, } \frac{T_1}{A} = \frac{Y(L_1 - L_0)}{L_0}$$

$$\frac{T_2}{A} = \frac{Y(L_2 - L_0)}{L_0}$$

Dividing

$$\frac{T_1}{T_2} = \frac{L_1 - L_0}{L_2 - L_0} ; T_1 L_2 - T_1 L_0 = T_2 L_1 - T_2 L_0 ; L_0 = \frac{L_1 T_2 - L_2 T_1}{T_2 - T_1}$$

7. Time (T), velocity (C) and angular momentum (h) are chosen as fundamental quantities instead of mass, length and time. In term of these, dimension of mass would be :

(1) $[M] = [T^{-1}C^{-2}h]$ (2) $[M] = [T^{-1}C^2h]$
 (3) $[M] = [T^{-1}C^{-2}h^{-1}]$ (4) $[M] = [T^{-1}C^{-2}h]$

Ans.

(1)

Sol.

$$M \propto T^x C^y h^z$$

$$M^1 L^0 T^0 = T^{x-y-z} L^{y+2z} M^z$$

On comparing powers

$$z = 1 \dots (1)$$

$$x - y - z = 0 \dots (2)$$

$$y + 2z = 0 \dots (3)$$

$$y + 2 \times 1 = 0$$

$$y = -2$$

$$x - (-2) - 1 = 0$$

$$x = -1$$

$$M \propto T^{-1} C^{-2} h^1$$

$$M \propto T^{-1} C^{-2} h$$

$$[M] \propto [T^{-1} C^{-2} h]$$

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8. Find relation between γ (adiabatic constant) and degree of freedom (f)

(1) $f = \frac{2}{\gamma-1}$ (2) $f = \frac{\gamma}{\gamma-1}$ (3) $f = \frac{\gamma-1}{2}$ (4) $f = \frac{\gamma-1}{\gamma}$

Ans. (1)

Sol. $C_V = \frac{fR}{2}$

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$$\Rightarrow \gamma = \frac{C_P}{C_V} = 1 + \frac{f}{2}$$

$$\gamma = 1 + \frac{f}{2}$$

$$f = \frac{2}{\gamma-1}$$

9. Two identical drops of Hg coalesce to form a bigger drop. Find ratio of surface energy of bigger drop to smaller drop.

(1) $2^{3/2}$ (2) $3^{2/5}$ (3) $2^{2/3}$ (4) $5^{2/3}$

Ans. (3)

Sol. $2 \times \frac{4}{3} \pi r^3 = \frac{4}{3} \pi R^3$

$$\frac{R}{r} = 2^{1/3} \quad \dots(1)$$

Now $\frac{U_{\text{bigger}}}{U_{\text{smaller}}} = \frac{S \times 4\pi R^2}{S \times 4\pi r^2} = \left(\frac{R}{r}\right)^2 = 2^{2/3}$

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Ans. (3)

Sol. $PV = nRT$

$$\Rightarrow PV = CT$$

Therefore, PV v/s T graph is straight line.

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11. For a body in pure rolling, its rotational kinetic energy is 1/2 times of its translation kinetic energy. They body should be ?
 (1) solid cylinder (2) Ring (3) solid sphere (4) Hollow sphere

Ans. (1)

Sol. Given

$$\frac{1}{2} I \omega^2 = \frac{1}{2} \times \frac{1}{2} m v^2$$

as $v = R\omega$ (pure rolling)

$$1 \times \frac{1}{2} I \omega^2 = \frac{1}{2} \times \frac{1}{2} m v^2$$

$$I = \frac{1}{2} m R^2$$

Thus, solid cylinder.

12. Magnetic susceptibility of material is 499 & $\mu_0 = 4\pi \times 10^{-7}$. SI unit then find μ_r
 (1) 500 (2) 400 (3) 300 (4) 200

Ans. (1)

Sol. $\mu_r = 1 + \chi$
 $= 1 + 499 = 500$

13. A plane electromagnetic wave travels in free space. Electric field is $\vec{E} = E_0 \hat{i}$ and magnetic field is represented by $\vec{B} = B_0 \hat{k}$. What is the unit vector along the direction of propagation of electromagnetic wave?

- (1) \hat{j} (2) $-\hat{k}$ (3) $-\hat{j}$ (4) \hat{k}

Ans. (3)

$$\begin{aligned} \text{Unit vector in direction } \vec{E} \times \vec{B} &\Rightarrow \frac{\vec{E} \times \vec{B}}{|\vec{E} \times \vec{B}|} \\ &\Rightarrow \frac{E_0 \hat{i} \times B_0 \hat{k}}{E_0 B_0 \sin 90} \\ &\Rightarrow \hat{i} \times \hat{k} \\ &\Rightarrow -\hat{j} \end{aligned}$$

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14. Two satellites of mass M_A and M_B are revolving around a planet of mass M in radius R_A and R_B respectively. Then ?

- (1) $T_A > T_B$ if $R_A > R_B$ (2) $T_A > T_B$ if $M_A > M_B$
 (3) $T_A = T_B$ if $M_A > M_B$ (4) $T_A > T_B$ if $R_A < R_B$

Ans. (1)

Sol. $T \propto r^{3/2}$

$$\frac{T_A}{T_B} \propto \left(\frac{R_A}{R_B} \right)^{3/2}$$

15. If N_0 active nuclei becomes $\frac{N_0}{16}$ in 80 days. Find half life of nuclei ?

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Sol. $N_0 \xrightarrow{t_{1/2}} \frac{N_0}{2} \xrightarrow{t_{1/2}} \frac{N_0}{4} \xrightarrow{t_{1/2}} \frac{N_0}{8} \xrightarrow{t_{1/2}} \frac{N_0}{16}$
 $4 \times t_{1/2} = 80$ days
 $t_{1/2} = 20$ days

16. A satellite is revolving around a planet in an orbit of radius R. Suddenly radius of orbit becomes 1.02 R then what will be percentage change in its time period of revolution ?

Ans. 3

Sol. As $T \propto R^{3/2}$
 $T_1 = kR^{3/2}$
 $\frac{\Delta T}{T} = \frac{3}{2} \times \frac{\Delta R}{R} = 3\%$

17. A person walks up a stationary escalator in the time t_1 . If he remains stationary on the escalator, then it can take him up in time t_2 . Determine the time it would take to walk up on the moving escalator ?

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Ans. (1)

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Sol. Suppose length of escalator = L

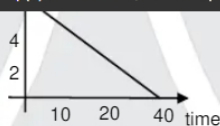
$$\text{Speed of man wrt escalator} = \frac{L}{t_1}$$

$$\text{Speed of escalator} = \frac{L}{t_2}$$

$$\text{Speed of man wrt ground when escalator is moving} = \frac{L}{t_1} + \frac{L}{t_2}$$

$$\text{Time taken by the man to walk on the moving escalator} = \frac{L}{\frac{L}{t_1} + \frac{L}{t_2}} = \frac{t_1 t_2}{t_1 + t_2}$$

18. For given graph between decay rate & time. Find half life (where R = decay rate)



(1) $\frac{10}{3} \ln 2$

(2) $\frac{20}{3} \ln 2$

(3) $\frac{3}{20} \ln 2$

(4) $\frac{20}{3} \ln 2$

Ans. (2)

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Sol. $R = R_0 e^{-\lambda t}$

$\ln R = \ln R_0 - \lambda t$

slope $= -\lambda = \frac{-6}{40}$

$\lambda = \frac{3}{20}$

$t_{1/2} = \frac{\ln 2}{\lambda} = \frac{\ln 2}{3} \times 20 = \frac{20}{3} \ln 2$

time period of oscillation ?

(1) $2\pi \sqrt{\frac{x_2^2 + x_1^2}{v_1^2 - v_2^2}}$ (2) $2\pi \sqrt{\frac{x_2^2 - x_1^2}{v_1^2 + v_2^2}}$ (3) $2\pi \sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$ (4) $2\pi \sqrt{\frac{x_2^2 + x_1^2}{v_1^2 + v_2^2}}$

Ans. (3)

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Sol. $v = \omega \sqrt{A^2 - x^2}$

$v_1 = \omega \sqrt{A^2 - x_1^2}$

$v_2 = \omega \sqrt{A^2 - x_2^2}$

$\left(\frac{v_1}{\omega}\right)^2 - \left(\frac{v_2}{\omega}\right)^2 = x_2^2 - x_1^2$

$\omega^2 = \frac{v_1^2 - v_2^2}{x_2^2 - x_1^2}$

$\omega = \sqrt{\frac{v_1^2 - v_2^2}{x_2^2 - x_1^2}}$

$T = 2\pi \sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$

(1) $3\lambda_0$ (2) $2\lambda_0$ (3) $4\lambda_0$ (4) $8\lambda_0$

Ans. (3)

Sol. $KE = hv - W$

$eV = \frac{hc}{\lambda} - W$

For first case

$e(3V_0) = \frac{hc}{\lambda_0} - W \quad \dots(i)$

For second case

$eV_0 = \frac{hc}{2\lambda_0} - W \quad \dots(ii)$

From equation (i) and (ii)

$W = \frac{hc}{4\lambda_0}$

For λ_{th}

$$\Rightarrow \frac{hc}{4\lambda_0} = \frac{hc}{\lambda_{th}} \Rightarrow \lambda_{th} = 4\lambda_0$$

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(1) $\tan^{-1}\left(\frac{1}{\sqrt{6}}\right)$ (2) $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$ (3) $\tan^{-1}\left(\frac{1}{\sqrt{4}}\right)$ (4) $\tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$

Ans. (1)

Sol. Let vertical and horizontal component of earth's magnetic field at meridian will be V and H.

Angle of dip, $\tan\theta = \frac{V}{H}$... (i)

at angle of 45° from magnetic meridian, angle of dip = 30°

$$\tan 30^\circ = \frac{V}{H \cos 45^\circ} \Rightarrow \frac{1}{\sqrt{3}} = \frac{V}{H \cos 45^\circ}$$

$$\frac{V}{H} = \frac{1}{\sqrt{6}}$$

$$\tan\theta = \frac{V}{H} \Rightarrow \frac{1}{\sqrt{6}}$$

$$\theta = \tan^{-1}\left(\frac{1}{\sqrt{6}}\right)$$

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22. A sodium lamp in space was emitting waves of wavelength 2880 \AA . When observed from a planet, its wavelength was recorded 2886 \AA . Find the speed of planet ?

(1) $4.25 \times 10^5 \text{ m/s}$ (2) $6.25 \times 10^5 \text{ m/s}$ (3) $2.75 \times 10^5 \text{ m/s}$ (4) $3.75 \times 10^5 \text{ m/s}$

Ans. (2)

Sol. $\frac{v_{rel}}{C} = \frac{\Delta\lambda}{\lambda}$

$$v_{rel} = \frac{6}{2880} \times 3 \times 10^8$$

$$= 6.25 \times 10^5 \text{ m/s}$$

23. An electron having de Broglie wavelength λ falls on an X-ray tube. The cut off wave length of emitted X-Ray is

(1) $\frac{2mc\lambda^2}{h}$ (2) $\frac{2h}{mc}$ (3) $\frac{h}{mc}$ (4) $\frac{2}{3} \frac{mc\lambda^2}{h}$

Ans. (1)

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Sol. De-broglie wavelength

$$\lambda_B = \frac{h}{p}$$

$$\Rightarrow P = \frac{h}{\lambda_B}$$

$$\therefore \text{Kinetic energy of electron} \Rightarrow E = \frac{P^2}{2m_e} = \frac{h^2}{2m_e \lambda_B^2}$$

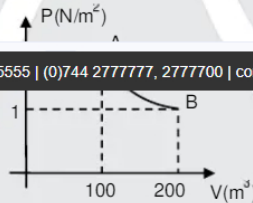
For cut-off wavelength of emitted X-Ray

$$E = \frac{hc}{\lambda}$$

$$\Rightarrow \frac{h^2}{2m_e \lambda_B^2} = \frac{hc}{\lambda}$$

$$\Rightarrow \lambda = \frac{2m_e c \lambda_B^2}{h} = \frac{2m_e c \lambda^2}{h} \text{ where } \lambda_B = \lambda \text{ \& } m_e = m.$$

24. A gas is undergoing change in state by an isothermal process AB as follows. Work done by gas in process AB is



- (1) $100 \ln 2$ Joule (2) $-100 \ln 2$ Joule (3) $200 \ln 2$ Joule (4) $-200 \ln 2$ Joule

Ans. (3)

Sol. $W_{\text{isothermal}} = P_1 V_1 \ln \frac{V_2}{V_1}$

$$V_1 = 100 \text{ m}^3$$

$$V_2 = 200 \text{ m}^3$$

$$P_1 = 2 \text{ N/m}^2$$

$$W = 2 \times 100 \ln \frac{200}{100}$$

$$= 200 \ln 2 \text{ Joule}$$

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25. A block is projected upto a rough plane of inclination 30° . If time of ascending is half the time for descending and the coefficient of friction is $\mu = \frac{3}{5\sqrt{n}}$. Then $n = \dots$



Ans. 3

Sol. $S = \frac{1}{2} a_A t_A^2$ (1)

$$S = \frac{1}{2} a_D t_D^2 \quad \dots\dots(2)$$

From Equation (1) & (2)

$$\frac{t_A^2}{t_D^2} = \frac{a_D}{a_A}$$

$$\Rightarrow \frac{t_A^2}{2} = \frac{g \sin \theta - \mu g \cos \theta}{g \sin \theta + \mu g \cos \theta}$$

$$\Rightarrow \frac{t_A}{t_D} = \sqrt{\frac{g \sin \theta - \mu g \cos \theta}{g \sin \theta + \mu g \cos \theta}}$$

$$\Rightarrow \frac{1}{2} = \sqrt{\frac{1 - \sqrt{3}\mu}{1 + \sqrt{3}\mu}}$$

$$\Rightarrow 1 + \sqrt{3}\mu = 4 - 4\sqrt{3}\mu$$

$$\Rightarrow 5\sqrt{3}\mu = 3$$

$$\Rightarrow \mu = \frac{3}{5\sqrt{3}}$$

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26. I – V characteristic curve of a diode in forward bias is given in fig. find out dynamic resistance -



- (1) 212.3Ω (2) 205.3Ω (3) 245.3Ω (4) 233.3Ω

Ans. (4)

Sol. Dynamic resistance = $\frac{\Delta V}{\Delta I}$
 $= \frac{0.7}{3\text{mA}} = 233.3\Omega$

27. An electron is accelerated through a voltage of 40 kV. What will be its wavelength ?

- (1) 0.061Å (2) 0.011Å (3) 0.021Å (4) 0.161Å

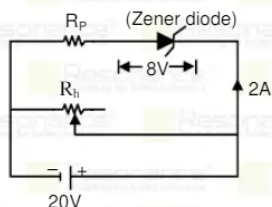
Ans. (1)

Sol. $\lambda_B = \frac{h}{P}$
 h

$$= \sqrt{2\text{meV}}$$

$$= \frac{\sqrt{V}}{\sqrt{40 \times 10^3}} \text{ A} = 0.061 \text{ A}$$

28. Find value of R_P in given ckt ? ($V_Z = 8\text{V}$)



- (1) 4Ω (2) 6Ω (3) 3Ω (4) 5Ω

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Ans. (2)

Sol. Applying KVL

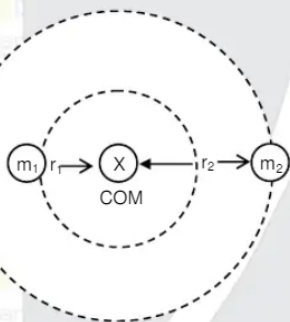
$$20 - 8 - 2R_P = 0$$

$$R_P = 6\Omega$$

29. Two stars of masses m_1 and m_2 are in mutual interaction and revolving in orbits of radii r_1 and r_2 respectively. Time period of revolution for this system will be ?

Ans. (2)

Sol.



Let angular velocity will be ω

For mass m_1

$$Gm_1m_2 = m_1 r_1 \omega^2 = m_2 (r_1 + r_2) \omega^2$$

$$\omega = \frac{\sqrt{G(m_1 + m_2)}}{(r_1 + r_2)^{3/2}}$$

$$T = \frac{2\pi}{\omega}$$

$$= 2\pi \sqrt{\frac{(r_1 + r_2)^3}{G(m_1 + m_2)}}$$

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