



# JEE (Main)

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

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# 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)

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### SUBJECT: PHYSICS

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### PART : PHYSICS

1. If kinetic energy of particle becomes four times, then % change in momentum will be :

(1) 200                    (2) 100                    (3) 150                    (4) 50

Ans. (2)

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

$P \propto \sqrt{K}$

$P_2 \propto \sqrt{K_2} \quad P_2 \propto \sqrt{4K}$

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

$$\Rightarrow \frac{\overline{P}_2}{\overline{P}_1} = 2$$

$$\Rightarrow \frac{\overline{P}_2 - \overline{P}_1}{\overline{P}_1} \% = \left( \frac{\overline{P}_2}{\overline{P}_1} - 1 \right) \times 100 = (2 - 1) \times 100 = 100$$

$$\Delta P_{\%} = 100\%$$

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2. A RLC circuit is in its resonance condition. Its circuit components have value

$$R = 5\Omega$$

$$L = 2H$$

$$C = 0.5 \text{ mF}, V = 250V$$

Then find power in circuit ?

$$(1) 6kW$$

$$(2) 10kW$$

$$(3) 12kW$$

$$(4) 12.5kW$$

**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

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**Ans.** (1)

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**Sol.**  $\omega_0 = 600 \text{ rpm}$

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

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

$$\theta = \omega_0 t + \frac{1}{2} \alpha t^2$$

$$= 600 \times \frac{10}{60} + \frac{1}{2} \times 1800 \times \frac{1}{36}$$

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

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

$$(1) 45^\circ$$

$$(2) 90^\circ$$

$$(3) 135^\circ$$

$$(4) 150^\circ$$

**Ans.** (2)

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

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

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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

in t sec

$$Pt = \frac{1}{2} mv^2$$

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

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

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

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

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

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

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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)

**Sol.** Let initial length of rod be  $L_0$  and Area A.

As  $\frac{T}{A} = Y \frac{\Delta l}{l}$

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

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

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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<sup>-1</sup>C<sup>-2</sup>h]      (2) [M] = [T<sup>-1</sup>C<sup>2</sup>h]  
 (3) [M] = [T<sup>-1</sup>C<sup>-2</sup>h<sup>-1</sup>]      (4) [M] = [T<sup>-1</sup>C<sup>-2</sup>h]

**Ans.** (1)

**Sol.**  $M \propto T^x C^y h^z$

$$M^0 L^0 T^0 = T^x [LT^{-1}]^y [ML^2 T^{-1}]^z$$

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

On comparing powers

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

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

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

$$y = -2$$

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

$$x = -1$$

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8. Find relation between  $\gamma$  (adiabatic constant) and degree of freedom ( $f$ )

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

Ans. (1)

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

$$\Rightarrow C_P = \left( \frac{f}{2} + 1 \right) R \\ \Rightarrow \gamma = \frac{C_P}{C_V} = 1 + \frac{2}{f}$$

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

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

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

Ans. (3)

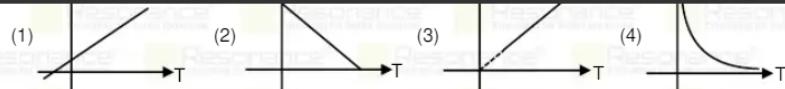
$$\text{Sol. } 2 \times \frac{4}{3} \pi r^3 = \frac{4}{3} \pi R^3$$

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

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

10. Identify correct graph between PV and T for an ideal gas.

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Ans. (3)

$$\text{Sol. } PV = nRT$$

$$\Rightarrow PV = CT$$

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. Then 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)

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

Thus, solid cylinder.

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

**Ans.** (1)

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

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?

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**Sol.** Direction of EM wave is given by direction of  $\vec{E} \times \vec{B}$ .

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

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

15. If  $N_0$  active nuclei becomes  $\frac{N_0}{16}$  in 80 days. Find half life of nuclei ?  
 (1) 40 days      (2) 20 days      (3) 60 days      (4) 30 days

**Ans.** (2)

**Sol.**  $N_0 \xrightarrow{t_{1/2}} \frac{N_0}{2} \xrightarrow{t_{1/2}} \frac{N_0}{4} \xrightarrow{t_{1/2}} \frac{N_0}{8} \xrightarrow{t_{1/2}} \frac{N_0}{16}$

$$4 \times t_{1/2} = 80 \text{ days}$$

$$t_{1/2} = 20 \text{ days}$$

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

$$T_1 = kR^{3/2}$$

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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 ?

$$(1) \frac{t_1 t_2}{t_1 + t_2}$$

$$(2) \frac{t_1 t_2}{t_1 - t_2}$$

$$(3) \frac{2t_1 t_2}{t_1 + t_2}$$

$$(4) \frac{2t_1 t_2}{t_1 - t_2}$$

**Ans.** (1)

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**Sol.** Suppose length of escalator = L

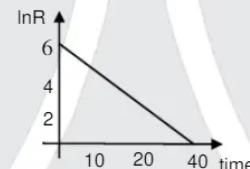
$$\text{Speed of man wrt escalator} = \frac{L}{t_1}$$

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

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

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)

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

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

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

19. The velocities of particle performing SHM at a distance  $x_1$  &  $x_2$  from mean position are  $v_1$  &  $v_2$  find the 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.  $v = \omega\sqrt{A^2 - x^2}$

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

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

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

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

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

20. In photoelectric effect stopping potential is  $3V_0$  for incident wave length  $\lambda_0$  and stopping potential  $V_0$  for incident wavelength  $2\lambda_0$ . Find threshold wavelength.

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

Ans. (3)

Sol.  $KE = h\nu - W$

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  $\lambda_{\text{th}}$

$$W = \frac{hc}{\lambda_{\text{th}}}$$

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

21. At  $45^\circ$  of magnetic meridian angle of dip is  $30^\circ$  then find the angle of dip in vertical plane at  $45^\circ$  ?

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

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

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

at angle of  $45^\circ$  from magnetic meridian, angle of dip =  $30^\circ$

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

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

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

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

22. A sodium lamp in space was emitting waves of wavelength  $2880\text{\AA}$ . When observed from a planet, its

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

**Ans.** (2)

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

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

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

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

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

**Ans.** (1)

Sol. De-broglie wavelength

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

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

For cut-off wavelength of emitted X-Ray

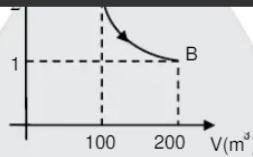
$$E = \frac{hc}{\lambda}$$

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

$$\Rightarrow \lambda = \frac{2m_e c \lambda_B^2}{h} = \frac{2mc\lambda^2}{h} \text{ where } \lambda_B = \lambda \text{ & } m_0 = m.$$

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

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- (1) 100 ln2 Joule      (2) – 100 ln2 Joule      (3) 200 ln2 Joule      (4) – 200 ln2 Joule

Ans. (3)

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

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

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

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

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

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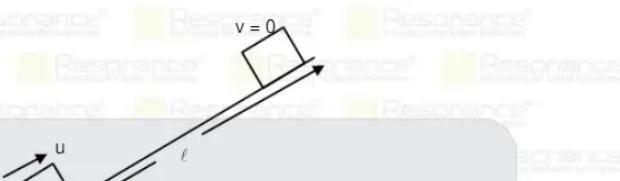
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descending and the coefficient of friction is  $\mu = \frac{3}{5\sqrt{n}}$ . Then  $n = \dots$



**Ans. 3**

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

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

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

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

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

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

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

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

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

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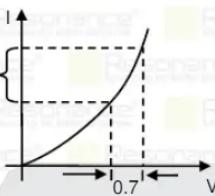
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**26.** I – V characteristic curve of a diode in forward bias is given in fig. find out dynamic resistance -



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

**Ans.** (4)

**Sol.** Dynamic resistance =  $\frac{\Delta V}{\Delta I}$

$$= \frac{0.7}{3mA} = 233.3\Omega$$

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**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)

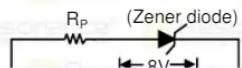
**Sol.**  $\lambda_B = \frac{h}{P}$

$h$

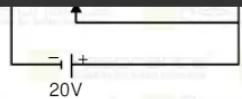
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$$\begin{aligned}
 &= \sqrt{2m\epsilon V} \\
 &= \frac{12.27}{\sqrt{V}} \text{ Å} \\
 &= \frac{12.27}{\sqrt{40 \times 10^3}} \text{ Å} = 0.061 \text{ Å}
 \end{aligned}$$

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



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- (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 ?

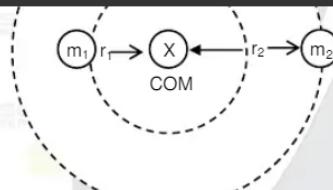
$$(1) 2\pi\sqrt{\frac{(r_1 - r_2)^3}{G(m_1 + m_2)}} \quad (2) 2\pi\sqrt{\frac{(r_1 + r_2)^3}{G(m_1 + m_2)}} \quad (3) 2\pi\sqrt{\frac{(r_1 - r_2)^3}{G(m_1 - m_2)}} \quad (4) 2\pi\sqrt{\frac{(r_1 + r_2)^3}{G(m_1 - m_2)}}$$

Ans. (2)

Sol.



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Let angular velocity will be  $\omega$

For mass  $m_1$

$$\frac{Gm_1m_2}{(r_1 + r_2)^2} = m_1 r_1 \omega^2 = m_1 \times \frac{m_2(r_1 + r_2)}{m_1 + m_2} \omega^2$$

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

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

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

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