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JEE (Main)

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

2022

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 27 June, 2022 (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. ${}_2He^4$ and ${}_6C^{12}$ have same kinetic energy. Find ratio of de-Broglie wave length

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

Ans. (1)

Sol. $\lambda = \frac{h}{\sqrt{2mK}}$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{m_2}{m_1}}$$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{12}{4}}$$

$\lambda_1 : \lambda_2 = \sqrt{3} : 1$

2. A particle experiences a force of 20 N between both the plates of parallel plate capacitor. Find force on the particle when one plate of the capacitor is removed.

(1) 10 N (2) 5N (3) 40 N (4) None of these

Ans. (1)

Sol. Initially force is $F = qE = q\left(\frac{q}{A\epsilon_0}\right) = \frac{q^2}{A\epsilon_0}$

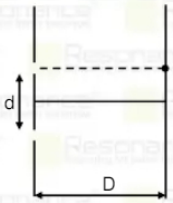
after removing one plate force is

$$F' = qE' = q\left(\frac{q}{2A\epsilon_0}\right) = \left(\frac{q^2}{2A\epsilon_0}\right)$$

$$\Rightarrow F' = \frac{F}{2}$$

$$\Rightarrow F' = \frac{20}{2} = 10N$$

3. In YDSE separation between both the slits is 0.6 mm and separation between both the slits & the screen is 80 cm. Ist dark fringe is observed on the screen in font of one of the slits find wavelength of light :



(1) 4.5×10^{-4} mm (2) 2.6×10^{-3} mm (3) 1.5×10^{-4} mm (4) 6.5×10^{-3} mm

Ans. (1)

Sol. According to question

$$\frac{\beta}{2} = 0.3 \text{ mm} \Rightarrow \beta = 0.6 \text{ mm}$$

$$\Rightarrow \frac{\lambda D}{d} = 0.6 \qquad \Rightarrow \lambda = \frac{0.6d}{D} \qquad \Rightarrow \lambda = \frac{0.6 \times 0.6}{800}$$

$$\Rightarrow \lambda = 4.5 \times 10^{-4} \text{ mm}$$

4. When a photon having energy 10.2 eV is absorbed by Li^{++} ion then find change in angular momentum

(1) $\frac{h}{2\pi}$ (2) $\frac{2h}{2\pi}$ (3) $\frac{3h}{2\pi}$ (4) zero

Ans. **(3)**

Sol. $\Delta E = 13.6 \times z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$$10.2 = 13.6 \times 3^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$n_1 = 3$ & $n_2 = 6$

change in angular momentum $\Delta L = \frac{n_2 h}{2\pi} - \frac{n_1 h}{2\pi} = \frac{3h}{2\pi}$

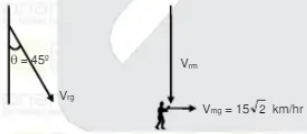
5. A man standing on ground observes that rain is coming at an angle 45° with vertical. When he runs with

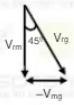
speed $15\sqrt{2}$ km/hr, rain appears to him vertical. Find speed of rain w.r.t. man :

(1) 30 km/hr (2) $\frac{15}{\sqrt{2}}$ km/hr (3) 15 km / hr (4) $15\sqrt{2}$ km/h

Ans. (4)

Sol.





$V_{rm} = V_{rg}\cos 45^\circ$

$V_{mg} = V_{rg}\sin 45^\circ = 15\sqrt{2}$

$V_{rg} = 30$ km/hr

$\therefore V_{rm} = \frac{30}{\sqrt{2}}$ km/hr $= 15\sqrt{2}$ km/h

6. A man running towards stationary source with speed $\frac{C}{5}$. Speed of sound is C then observed % change in frequency of sound heard by observer will be :

(1) 10% (2) 20% (3) 15% (4) 25%

Ans. **(1)**

Sol.

$f' = \frac{V + V_0}{V} f$

$f' = \frac{C + C/5}{C} f$

$f' = \frac{6C}{5C} f$

$f' = \frac{6}{5} f$

$\frac{f'}{f} = \frac{6}{5}$

$\frac{f' - f}{f} = \frac{6-5}{5}$

$\frac{\Delta f}{f} = \frac{1}{5}$

$\frac{\Delta f}{f} \times 100 = \frac{1}{5} \times 100 = 20\%$

7. A capacitor of capacitance C = 50 pF is charged with voltage V = 100 volt. Now another identical uncharged capacitor is connected with this charged capacitor. Find energy loss during the process :

(1) 1.5×10^{-7} J (2) 2.5×10^{-7} J (3) 1.25×10^{-7} J (4) 5×10^{-7} J

Ans. (3)

Sol. Energy loss $H = \frac{1}{2}\frac{C_1C_2}{C_1 + C_2}(V_1 - V_2)^2$

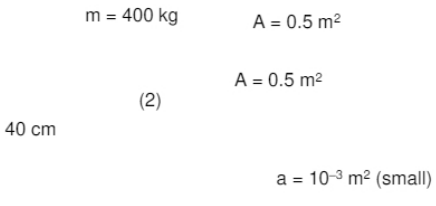
$\Rightarrow H = \frac{1}{2}\frac{C^2}{2C}(V - 0)^2$

$\Rightarrow H = \frac{1}{4}CV^2$

$\Rightarrow \quad H = \frac{1}{4} \times 50 \times 10^{-12} \times 100 \times 100$

$\Rightarrow \quad H = 1.25 \times 10^{-7}$ J

8. Find velocity of leakage liquid :



(1) 24 m/s (2) 20m/s (3) 6 m/s (4) 10 m/s

Ans. (1)

Sol. Apply Bernoulli equation at top and bottom Points (1) and (2)

$$P_0 + \frac{mg}{A} + 0 + \rho.g.h = P_0 + \frac{1}{2}\rho u^2 + 0$$

$$\frac{4000}{5} + 10^3 \times 10 \times 0.4 = \frac{1}{2} \times 10^3 \times 4^2$$

$$8000 + 4000 = \frac{1}{2} \times 1000 \times 4^2$$

$v^2 = 24$

$v = \sqrt{24}$ m/s

9. Current I = 5 sin (120 πt) is flowing AC circuit. Find time in which current reaches to zero to maximum value.

(1) $\frac{1}{120}$ sec (2) $\frac{1}{60}$ sec (3) $\frac{1}{240}$ sec (4) $\frac{\pi}{60}$ sec

Ans. **(3)**

Sol. $T = T = \frac{2\pi}{\omega} = \frac{2\pi}{120\pi} = \frac{1}{60}$

$\frac{T}{4} = \frac{1}{240}$ sec

10. A particle performing SHM with amplitude A if time taken by particle from mean position to A/2 is 3 sec. then time period of SHM will be :

(1) 6 sec (2) 12 sec (3) 18 sec (4) 36 sec

Ans. **(4)**

Sol. $X = A \sin\omega t$

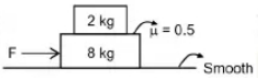
$\frac{A}{2} = A \sin\omega t$

$\omega t = \frac{\pi}{6}$

$t = \frac{T}{12} = 3$ sec.

$T = 36$ sec.

11. Find maximum value of force so that block will not Slide on each other.



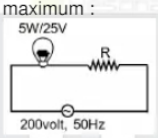
(1) 50 N (2) 100 N (3) 150 N (4) 200 N

Ans. (1)

Sol. maximum acceleration of upper block = $\mu g = 0.5 \times 10 = 5$

$F_{max.} = (2 + 8) \times 5 = 50N$

12. Find R for which brightness in lamp is maximum :



(1) 575 Ω (2) 675 Ω (3) 775 Ω (4) 875 Ω

Ans. (4)

Sol. $i_{rms} = \frac{5}{25} = \frac{200}{R_B + R}$

$R_B + R = 1000$

$R = 100 - R_B$

$= 1000 - \frac{25 \times 25}{5} = 1000 - 125 = 875$

13. O_2 and H_2 is filled in a container of volume 2000 cm^3 at pressure 100 kP_a and temperature 300 K. If mass of gas mixture 0.76 g. Find ratio of moles of O_2 and H_2 :

(1) 1/2 (2) 1/3 (3) 1/4 (4) 1/8

Ans. **(2)**

Sol. $V = 2000\ cm^3$

$P = 100\ kPa$

$T = 300\ K$

Mass of gas mixture = 0.76 g ($O_2 + H_2$)

Find = $\frac{n_1}{n_2} = ?$

$n = \frac{PV}{RT} = \frac{2 \times 10^{-3} \times 100 \times 10^3 \times 3}{25 \times 300}$

$n = \frac{2}{25}$

$n_2 = \frac{0.08(30 - 32 + 0.76)}{30}$

$\frac{n_1}{n_2} = \frac{0.08(32 - 0.76)}{0.08(30 - 32 + 0.76)} = \frac{32 - 0.76}{(-2 + 0.76)}$

$n_1(32) + n_2(2) = 0.76$

$n_2 + 16n_1 = 0.38$

$n_2 + n_1 = 0.08$

$15n_1 = 0.30$

$n_1 = \frac{0.30}{15} = 0.02$

$n_2 = 0.06$

14. A ball of density d_1 and mass M is dropped in glycerine of density d_2. Find viscous force on the ball at terminal velocity of the ball.

(1) $Mg\left(1 - \frac{d_2}{d_1}\right)$ (2) $Mg\left(1 - \frac{d_1}{d_2}\right)$ (3) $Mg\left(1 - \frac{d_1^2}{d_1 d_2}\right)$ (4) None of these

Ans. (1)

Sol. At the time of terminal velocity ball is in equilibrium

i.e. $F_g = F_b + F_v$

$\Rightarrow \quad F_v = F_g - F_b$

$\Rightarrow \quad F_v = Mg - d_2\frac{M}{d_1}g$

$\Rightarrow \quad Mg\left(1-\frac{d_2}{d_1}\right)$

15. In a Carnot's engine temperature heat reservoir is 527°C and temperature of heat sink is 200 K. If heat released by the engine is 12000 kJ, then find heat absorbed by the engine.

(1) 48000 kJ (2) 36000 kJ (3) 60000 kJ (4) 72000 kJ

Ans. (1)

Sol. $\frac{Q_2}{Q_1}=\frac{T_2}{T_1} \Rightarrow \frac{12000\times10^3}{Q_1}=\frac{200}{800}$

$\Rightarrow \quad Q_1 = \frac{12000\times10^3\times800}{200}$

$\Rightarrow \quad Q_1 = 48000 \times 10^3$ J

$\Rightarrow \quad Q_1 = 48000$ kJ

16. A projectile is fired with speed 20 m/s at an angle α from horizontal. If angle made by its velocity vector after 10 sec is β, then value of tan β will be :

(1) $\frac{20\sin\alpha+100}{20\cos\alpha}$ (2) $\frac{20\sin\alpha-100}{20\cos\alpha}$ (3) $\frac{20\cos\alpha-100}{20\sin\alpha}$ (4) 20 tanα – 100

Ans. (2)

Sol. $\tan\beta = v_y/v_x = \frac{20\sin\alpha-100}{20\cos\alpha}$

17. If two antennas of height h_1 = 25 m and h_2 = 49 m are used for transmission and receiver respectively, then distance between them in LOS communication system will be:

(1) $175\sqrt{5}\times10^2$ (2) $185\sqrt{5}\times10^2$ (3) $192\sqrt{5}\times10^2$ (4) $199\sqrt{5}\times10^2$

Ans. **(3)**

Sol. $d = \sqrt{2Rh_1}+\sqrt{2Rh_2}$

$=\sqrt{2R}\ (5+7)$

$=\sqrt{6400\times2\times10^3}\ (12)$

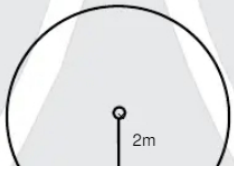
$=12\sqrt{64\times10^4\times20}$

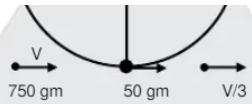
$= 12\times800\times2\sqrt{5} = 24\times800\sqrt{5} = 19200\sqrt{5}$

$= 192\sqrt{5}\times10^2$

K = 192

18. Mass of bob in a pendulum is 50 gram. A bullet of 75 gram strikes with speed v and emerges with speed v/3 as shown in figure. If pendulum bob just complete the vertical circle then speed of bullet will be:





(1) 10 m/s (2) 20 m/s (3) 5 m/s (4) 25 m/s

Ans. **(1)**

Sol. Pendulum length 2m

$$75\,V = 50\sqrt{5Rg} + 75(V/3)$$

$$75\left(\frac{2V}{3}\right) = 50\sqrt{5\times 2\times 10}$$

$$75\left(\frac{2V}{3}\right) = 50\times 10$$

$$V = \frac{500\times 3}{150} = \frac{500}{50} = 10 \text{ m/s}$$

19. Two blocks of 10 kg and 30 kg are placed at (0, 0) and (x, 0) respectively. If 10 kg block is shifted by 6 cm towards 30 kg block than by how much distance 30 kg is to be shifted so that COM will not shift.

(1) 2 cm left (2) 4 cm left (3) 4 cm right (4) 0.5 cm left

Ans. **(1)**

Sol. $$\frac{m_1\Delta x + m_2\Delta x_2}{m_1 + m_2} = \Delta x_{cm}$$

$10\,(6) + 30\,(\Delta x_2) = 0$

$\Delta x_2 + 30\,(\Delta x_2) = 2$ cm

20. Match the Following option

(A) Infrared waves	**1.** Radar
(B) UV Rays	**2.** Sterilizing
(C) x-Rays	**3.** Crystal structure
(D) Microwaves	**4.** Green house effect

(1) A – 4, B – 2, C – 3, D – 1 (2) A – 3, B – 4, C – 3, D – 1

(3) A – 2, B – 2, C – 3, D – 4 (4) A – 1, B – 2, C – 3, D – 4

Ans. (1)

21. Light ray is incident at angle double of angle of refraction from air to medium of refractive index $\sqrt{2n}$ then find angle of incidence

(1) $\sin^{-1}\sqrt{\frac{n}{2}}$ (2) $2\sin^{-1}\sqrt{\frac{n}{2}}$ (3) $\cos^{-1}\sqrt{\frac{n}{2}}$ (4) $2\cos^{-1}\sqrt{\frac{n}{2}}$

Ans. (4)

Sol. $1 \sin 2r = \sqrt{2n}\ \sin r$

$2 \sin r \cos r = \sqrt{2n}\ \sin r$

$$\cos r = \sqrt{\frac{n}{2}}$$

$\sqrt{n}$

$r = \cos^{-1}\sqrt{\frac{\mu}{2}}$

$i = 2r = 2\cos^{-1}\sqrt{\frac{n}{2}}$

22. A cell is shorted with a resistance of 8 Ω . Balanced length for potential difference across the cell is 3cm. If the cell is shorted with 4Ω resistance balance length becomes 2 cm. find internal resistance of the cell.

(1) 8 Ω (2) 4 Ω (3) 2 Ω (4) 1 Ω

Ans. (1)

Sol. $iR = x\ell$

$$\Rightarrow \frac{\varepsilon}{R_1 + r} R_1 = x\ell_1$$

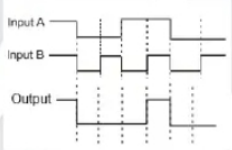
$$\Rightarrow \frac{\varepsilon}{1+\frac{r}{R_1}} = x\ell_1 \ \& \ \frac{\varepsilon}{1+\frac{r}{R_2}} = x\ell_2$$

Dividing the Equation,

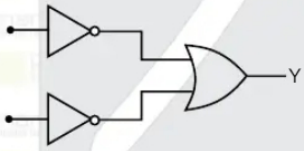
$$\frac{1+\frac{r}{R_1}}{1+\frac{r}{R_2}} = \frac{\ell_2}{\ell_1} = \frac{2}{3} \Rightarrow 3+\frac{3r}{8} = 2+\frac{2r}{4} \Rightarrow \frac{r}{2} - \frac{3r}{8} = 1$$

$\Rightarrow r = 8\ \Omega$

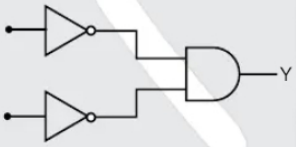
23. The logic circuit shown below has the input waveforms 'A' and 'B' as shown. Pick out the correct out put waveform.



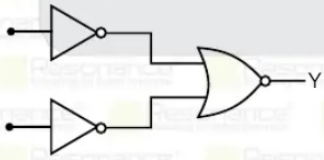
(1)



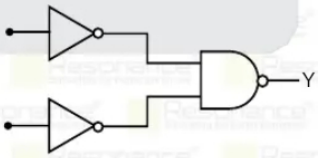
(2)



(3)



(4)



Ans. **(3)**

Sol. $Y = (\overline{\bar{A} + \bar{B}}) = A.B$

it is AND gate.