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JEE
(Main)
PAPER-1 (B.E./B. TECH.)
2022

COMPUTER BASED TEST (CBT)
Memory Based Questions & Solutions

Date: 24 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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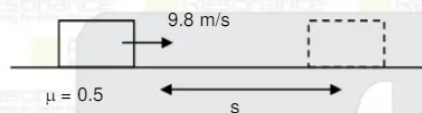
PART : PHYSICS

1. A block is projected over a rough surface with speed 9.8 m/s. If friction coefficient of surface-block interface is 0.5, Find distance after which block stops.

(1) 4.9 m (2) 9.8 m (3) 14.7 m (4) 19.6

Ans. (2)

Sol.



$$v^2 = u^2 + 2as$$

$$0 = (9.8)^2 - 2 \times 0.5 \times 9.8 \times s$$

$$s = 9.8 \text{ m}$$

2. Two waves propagating along x-axis are given by
 $y_1 = 5 \sin(\omega t - kx)$; $y_2 = 3 \sin(\omega t - kx + 1.57)$
 Find resultant amplitude due to superposition of two waves

- (1) 8 (2) 2 (3) 4 (4) $\sqrt{34}$

Sol. $A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2 \cos \phi}$
 $A = \sqrt{25 + 9 + 0}$
 $A = \sqrt{34}$

3. Space between two convex lens of refractive index $\mu = \frac{3}{2}$ each and focal length $f = 40 \text{ cm}$ is filled with water of refractive index $\mu = \frac{4}{3}$. Find focal length of the new system

- (1) 20 cm (2) 30 cm (3) 45 cm (4) 60 cm

Ans. (2)

Sol.

$$f = \frac{3}{2} \quad f = \frac{3}{2}$$



4/3

$f = ?$

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PAGE # 1

$$\frac{1}{f} = \left(\frac{3}{2} - 1\right) \left(\frac{2}{R}\right) = \frac{1}{R}$$

$$f = R$$

$$R = 40 \text{ cm}$$

$$\frac{1}{f_w} = \left(\frac{4}{3} - 1\right) \left(\frac{1}{-R} - \frac{1}{+R}\right)$$

$$f_w = -\frac{2}{3}R$$

$$\frac{1}{f'} = \frac{1}{f} + \frac{1}{f_w} + \frac{1}{f}$$

$$\frac{1}{f'} = \frac{1}{R} - \frac{2}{3R} + \frac{1}{R}$$

$$f' = 30 \text{ cm}$$

4. Liquid drop having mass m is in equilibrium in air in presence of electric field E in vertically upward direction. Find charge on drop.

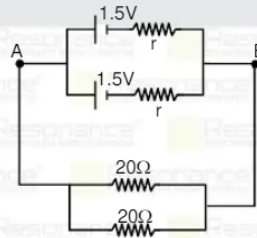
- (1) $\frac{mg}{E}$ (2) $\frac{2mg}{E}$ (3) $\frac{2mg}{4E}$ (4) zero

Ans. (1)

Sol.

$$\begin{aligned} & \uparrow qE \\ & \downarrow mg \\ & mg = qE \\ & q = \frac{mg}{E} \end{aligned}$$

5. The potential difference between point A and B is 12 V as shown in figure, find internal resistance r .



- (1) $17/2 \Omega$ (2) $9/2 \Omega$ (3) $21/4 \Omega$ (4) $35/2 \Omega$

Ans. (4)

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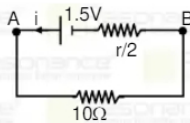
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PAGE # 2

Sol.



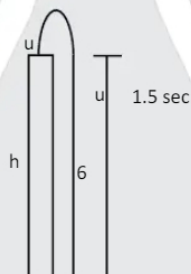
$$i = \frac{1.5}{10 + \frac{r}{2}}$$

$$V_{AB} = i \times 10 = \frac{15}{10 + \frac{r}{2}} = 12$$

$$120 + 6r = 15$$

$$\Rightarrow 6r = 105 \Rightarrow r = 105/6 = 35/2$$

6. A ball takes 6 sec. to reach ground when projected up from the top of a tower. If it is thrown down ward with same speed, it takes 1.5 second to reach ground. Find time taken to reach ground if it is just released from the top.



- (1) 2 (2) 3 (3) 4.5 (4) 5

Ans. (2)

Sol. $+h = -u \times 6 + \frac{1}{2}g \times 6^2$ (1)

$+h = u \times 1.5 + \frac{1}{2}g(1.5)^2$ (2)

$$= h = \frac{1}{2} g \times t^2 \quad \dots\dots\dots (3)$$

After solving $t = \sqrt{t_1 t_2} = 3 \text{ Sec.}$

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PAGE # 3

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7. A particle of mass 100g is in horizontal circular motion with the help of 2m string fixed at one end over a smooth table. Maximum tension possible in string is 80 N. If maximum revolution per minute for the particle is given by k/π then find the value of k.

Ans. 600

Sol. $T = m\omega^2 r$

$$\omega = \sqrt{\frac{T}{mr}} = \sqrt{\frac{80}{0.1 \times 2}} = 20 \text{ rad/sec.}$$

$$= \frac{20 \times 60}{2\pi} = \frac{600}{\pi} \text{ rev/minutes}$$

8. What height weight of object is $\frac{1}{3}$ rd of weight at surface of earth.

(1) R

(2) 2R

(3) $(\sqrt{3} - 1)R$

(4) $(\sqrt{5} - 1)R$

Ans. (3)

Sol.

$$g^1 = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$

$$\frac{1}{3} = \frac{1}{\left(1 + \frac{g}{R}\right)^2}$$

$$1 + \frac{h}{R} = \sqrt{3}$$

$$h = (\sqrt{3} - 1)R$$

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PAGE # 4

9. Maximum speed of emitted electron during photo electric effect from metal for light of frequency of two times of threshold frequency is v_1 and for another light of frequency five times of threshold frequency is v_2 , then find ratio of $\frac{V_2}{V_1}$.

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

Ans. (2)

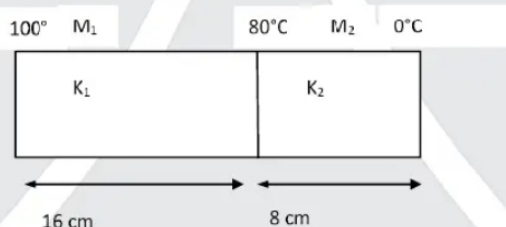
Sol. $\frac{1}{2}mv_1^2 = h(2\nu_{th}) - h(\nu_{th}) \dots (1)$ $\frac{1}{2}mv_2^2 = h(5\nu_{th}) - h(\nu_{th}) \dots (2)$

From (2)/(1)

$$\left(\frac{V_2}{V_1}\right)^2 = \frac{4}{1}$$

$$\left(\frac{V_2}{V_1}\right) = 2$$

10. Two metals M_1 and M_2 of thermal conductivity K_1 & K_2 are joined end to end as shown in figure. Temperature are shown in figure then find K_2 . Given $K_1 = 160$ SI unit



(1) 20 (2) 40 (3) 60 (4) 80

Ans. (1)

Sol. $\frac{K_1 A}{16} (100 - 80) = \frac{K_2 A}{8} (80)$

$$K_2 = \frac{K_1 20}{80 \times 2} = \frac{160}{8} = 20$$

11. A particle starting from rest moves from point (1, 2) to (2, 3) under the influence of force $\vec{F} = 4x\hat{i} + 3y^2\hat{j}$. Find its final kinetic energy.

(1) 5 (2) 8 (3) 15 (4) 25

Ans. (4)

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Sol. Using work energy theorem

$$W_F = K_F - K_i$$

$$\int_1^2 4x dx + \int_2^3 3y^2 dy = K_f - 0$$

$$4 \left[\frac{x^2}{2} \right]_1^2 + 3 \left[\frac{y^3}{3} \right]_2^3 = K_f - 0$$

$$\Rightarrow K_f = 4 \left[\frac{x^2}{2} \right]_1^2 + 3 \left[\frac{y^3}{3} \right]_2^3$$

$$= 2(4 - 1) + (27 - 8) = 6 + 19 = 25 \text{ Joule}$$

12. Find distance between 1st maxima in single slit diffraction pattern when light of wavelength λ_1 & λ_2 passed through the slit. Here slit width is a & screen is at a distance D from slit.

(1) $\frac{1}{2}(\lambda_2 - \lambda_1) \frac{D}{a}$ (2) $\frac{2}{3}(\lambda_2 - \lambda_1) \frac{D}{a}$ (3) $2(\lambda_2 - \lambda_1) \frac{D}{a}$ (4) $\frac{3}{2}(\lambda_2 - \lambda_1) \frac{D}{a}$

Ans. (4)

Sol. $a \sin \theta = \frac{3}{2} \lambda$

$$\frac{ay}{D} = \frac{3}{2} \lambda$$

$$y = \frac{3 \lambda D}{2 a}$$

$$y_2 - y_1 = \frac{3}{2}(\lambda_2 - \lambda_1) \frac{D}{a}$$

13. In a nuclear reaction $U^{220} \rightarrow x^{105} + y^{115}$ binding energy per nucleon of U^{220} , X^{105} & Y^{115} is 5 MeV/ Nucleon, 6.4 MeV/Nucleon and 5.6 MeV/nucleon then find energy released (in MeV) in the reaction :

(1) 100 (2) 116 (3) 150 (4) 178

Ans. (2)

Sol. Energy released = $115 \times 5.6 + 105 \times 6.4 - 220 \times 5 = 644 + 672 - 1100 = 116 \text{ MeV}$

14. In a potentiometer setup a cell of emf E_1 is balanced by length 75 cm. If the above cell is changed by another cell of emf E_2 ($E_1/E_2 = 3/2$) then find difference of balancing length,

(1) 25 (2) 30 (3) 15 (4) 50

Ans. (1)

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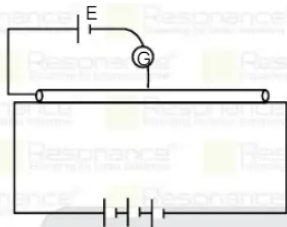
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Sol.



$$E_1 = K \times 75$$

$$E_1 = K \times x$$

$$\frac{E_1}{E_2} = \frac{3}{2} = \frac{75}{x} \Rightarrow x = 50 \text{ cm}$$

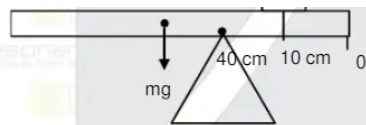
$$\text{Difference} = 75 - 50 = 25 \text{ cm}$$

15. A scaled rod of length 1m is balanced at 40 cm mark as shown in figure. A coin of mass 10 gram is kept at 10 cm mark in the balance situation. Find mass of rod.

Ans. 30

Sol.

$$m_1 = 10 \text{ g}$$



$$\begin{aligned} mg \cdot 10\text{cm} &= (m \cdot g) \times 30\text{cm} \\ mg &= m \cdot g \cdot 3 \\ m &= 30\text{ gram} \end{aligned}$$

16. A capacitor with plate area $9\pi\text{ cm}^2$ and separation 6 mm filled with dielectric is charged with $7 \times 10^{-6}\text{ C}$. If E at inside point is $3.6 \times 10^7\text{ V/m}$, find dielectric constant of dielectric

Ans. 7.77

Sol. $E = \frac{\sigma}{K\epsilon_0} = \frac{q}{AK\epsilon_0}$

$$\Rightarrow K = \frac{q}{A\epsilon_0} \times \frac{1}{E}$$

$$= \frac{7 \times 10^{-6}}{(9\pi \times 10^{-4}) \times 8.85 \times 10^{-12} \times 3.6 \times 10^7} = \frac{7}{9\pi \times 8.85 \times 3.6} \times 10^3 = \frac{7}{900.366} \times 10^3 = 7.77$$

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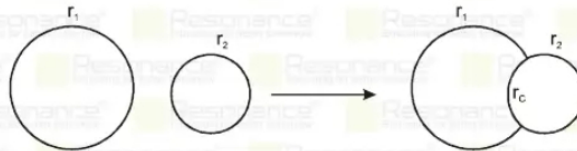
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PAGE # 7

17. Two soap bubbles of radius r_1 and r_2 combine. Find radius of curvature of the common surface separating them.



(1) $\frac{r_1 r_2}{r_1 - r_2}$ (2) $\frac{r_1 r_2}{r_1 + r_2}$ (3) $\frac{r_1 - r_2}{2}$ (4) $r_1 - r_2$

Ans. (1)

Sol. $P_0 + \frac{4T}{r_2} - \frac{4T}{r_c} - \frac{4T}{r_1} = P_0$

$$\frac{1}{r_c} = \frac{1}{r_2} - \frac{1}{r_1}$$

$$P_0 + \frac{4T}{r_2} - \frac{4T}{r_c} - \frac{4T}{r_1} = P_0$$

$$r_c = \frac{r_1 r_2}{r_1 - r_2}$$

18. **Statement-1** : In uniform magnetic field speed and energy of a charge particle remains constant.

Statement-2 : Magnetic force is perpendicular to velocity :

- (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. (1)

19. A projectile is fired from ground with some speed at angle θ from horizontal, after time t its velocity becomes parallel to horizontal. If its Horizontal range is R then find θ in the terms of t and R .

(1) $\theta = \tan^{-1}\left(\frac{gt^2}{R}\right)$ (2) $\theta = \tan^{-1}\left(\frac{3gt^2}{2R}\right)$ (3) $\theta = \tan^{-1}\left(\frac{2gt^2}{R}\right)$ (4) $\theta = \tan^{-1}\left(\frac{gt^2}{2R}\right)$

Ans. (3)

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Sol. $t = \frac{u \sin \theta}{g}$

$R = u \cos \theta (2t)$

$\frac{t}{R} = \frac{\tan \theta}{g(2t)}$

$\tan \theta = \frac{2gt^2}{R}$; $\theta = \tan^{-1}\left(\frac{2gt^2}{R}\right)$

20. The body is projected with speed 10 m/sec. The angle of projection with inclined plane is 30° . Find range along inclined plane.

(1) $\frac{10}{3}$ (2) $\frac{20}{3}$ (3) 10 (4) $\frac{40}{3}$

Ans. (2)

Sol. $T = \frac{2u \sin \theta}{g \cos \alpha} = \frac{2 \times 10 \times \frac{1}{2}}{10 \times \frac{\sqrt{3}}{2}} = \frac{2}{\sqrt{3}}$

$R = 10 \times \frac{\sqrt{3}}{2} \times \frac{2}{\sqrt{3}} - \frac{1}{2} \times (5) \times \left(\frac{4}{3}\right) = 10 - \frac{10}{3} = \frac{20}{3}$

21. In a medium electric field of any E.M. wave is 7×10^{-3} V/m. If relative permittivity & relative permeability of medium is 4 & 9 respectively, find magnetic field in the medium :

(1) 1.4×10^{-5} (2) 1.4×10^{-2} (3) 1.4×10^5 (4) 1.4×10^{-10}

Ans. (4)

Sol. $\frac{E}{B} = v = \frac{c}{\sqrt{\mu_r \epsilon_r}} = \frac{c}{6}$

$B = \frac{6E}{c} = \frac{6 \times 7 \times 10^{-3}}{3 \times 10^8}$
 $= 14 \times 10^{-11}$
 $= 1.4 \times 10^{-10}$

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22. Efficiency of carnot cycle is 25% when temperature of sink is 27°C. Find change in temperature of source if efficiency is increased by 100%.

- (1) 100 K (2) 200 K (3) 300 K (4) 400 K

Ans. (2)

Sol. $n = 1 - \frac{T_2}{T_1}$

$$0.25 = 1 - \frac{T_2}{T_1} \quad T_2 = 300 \text{ K (sink)}$$

$$\frac{1}{4} = 1 - \frac{300}{T_1}$$

$$T_1 = 400 \text{ K}$$

Efficiency increased by 100%, so new efficiency $\eta = 50\%$

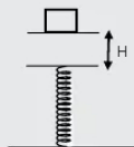
$$0.5 = 1 - \frac{300}{T_1'}$$

$$\frac{300}{T_1'} = 0.5$$

$$T_1' = 600$$

So change in temperature = 600 - 400 = 200 K

23. A block of mass $m = 10 \text{ gm}$ is released from height $H = 10 \text{ cm}$ on a vertical spring as shown in figure. If maximum compression in spring is $H/2$, then spring constant k of spring is : (Use $g = 10 \text{ m/sec}^2$)



- (1) 6 N/m (2) 12 N/m (3) 16 N/m (4) 20 N/m

Ans. (2)

Sol. From work energy theorem

$$\sum W = \Delta K$$

$$mg \left(H + \frac{H}{2} \right) - \frac{1}{2} k \left(\frac{H}{2} \right)^2 = 0$$

$$K = \frac{12mg}{H} = \frac{12 \times 10 \times 10}{1000 \times 0.1}$$

$$K = 12 \text{ N/m}$$

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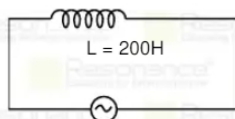
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PAGE # 10

24.



220 V, 50Hz

An Inductor of 200 H is connected across a A.C. source of 220 volt rms value of 50 Hz of Frequency. Find the rms value of current in the inductor.

- (1) 15 mA (2) 25 mA (3) 35 mA (4) 45 mA

Ans. (3)

Sol. $X_C = \omega L = (2\pi f)L$

$$= (2\pi \times 50) (200) = 2000\pi$$

$$I_{rms} = \frac{V_{rms}}{X_L} = \frac{220}{2000\pi} = \frac{11}{\pi} \times 10^{-2} = 35\text{mA}$$

25. Calculate volumetric stress required, to change the volume of a substance by 2%. Given that bulk modulus of elasticity of the substance is 10^9 N/m^2 .

- (1) $2 \times 10^7 \text{ N/m}^2$ (2) $3 \times 10^7 \text{ N/m}^2$ (3) $2 \times 10^9 \text{ N/m}^2$ (4) $5 \times 10^7 \text{ N/m}^2$

Ans. (1)

Sol. stress = B (strain)

$$\text{stress} = 10^9 \left(\frac{2}{100} \right) = 2 \times 10^7 \text{ N/m}^2$$

26. Stopping potential for electrons when light of wavelength 491 nm is incident is 0.410V. When the wavelength is changed the new stopping potential is 1.02V. Find the new wavelength.

- (1) 390 nm (2) 490 nm (3) 590 nm (4) 690 nm

Ans. (1)

Sol. $KE_{\max} = E - w$

$$eV_1 = \frac{hc}{\lambda_1} - w ; eV_2 = \frac{hc}{\lambda_2} - w$$

$$e(V_2 - V_1) = hc \left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1} \right)$$

$$e(1.02 - 0.41) = 1240\text{nm} \left(\frac{1}{\lambda_2} - \frac{1}{491} \right)$$

$$\lambda_2 = 390 \text{ nm}$$

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PAGE # 11

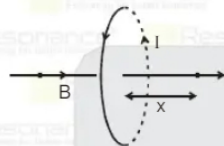
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27. If at the centre of circular current carrying coil, magnetic field is B_0 , then the magnetic field at distance $R/2$ from the centre on the axis of a coil is (R is the radius)

- (1) $\frac{8B_0}{5\sqrt{5}}$ (2) $\frac{4B_0}{5\sqrt{5}}$ (3) $\frac{2B_0}{5\sqrt{5}}$ (4) $\frac{6B_0}{5\sqrt{5}}$

Ans. (1)

Sol.



$$\text{Magnetic field on the axis of the loop : } B = \frac{\mu_0 N I R^2}{2(R^2 + x^2)^{3/2}}$$

$$x = R/2$$

$$B = \frac{\mu_0 N I R^2}{2 \left(\frac{R^2}{4} + R^2 \right)^{3/2}}$$

$$B = \frac{\mu_0 N I R^2}{2 \left(\frac{5}{4} R^2 \right)^{3/2}} = \frac{\mu_0 N I R^2}{2 R^3 \left(\frac{5}{4} \right)^{3/2}}$$

$$B = \frac{\mu_0 I}{2R \left(\frac{5}{4}\right)^{3/2}} = \frac{B_0}{\left(\frac{5}{4}\right)^{3/2}} = \frac{8B_0}{5\sqrt{5}}$$

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