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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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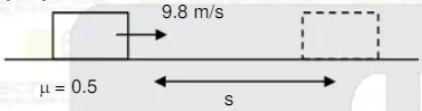
PART : PHYSICS

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.



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

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

$s = 9.8$ 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 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.

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

$f = R$

$R = 40$ cm

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

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

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

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

$f' = 30$ 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

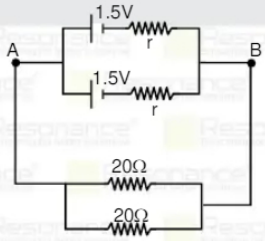
Ans. (1)

Sol.

$mg = qE$

$q = \frac{mg}{E}$

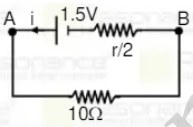
5. The potential difference between point A and B is 12 V as shown in figure, find internal resistance r.



(1) 17/2 Ω (2) 9/2 Ω (3) 21/4 Ω (4) 35/2 Ω

Ans. **(4)**

Sol.



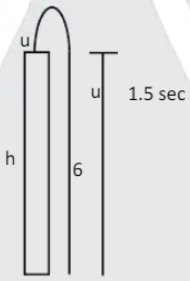
$i = \frac{1.5}{10 + \frac{r}{2}}$

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

$120 + 6r = 15$

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

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)

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

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

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. $T = m\omega^2 r$

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

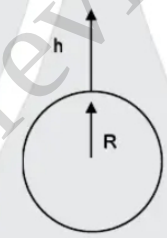
$= \frac{20 \times 60}{2\pi} = \frac{600}{\pi}$ rev/minutes

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.



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

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

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

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

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)**

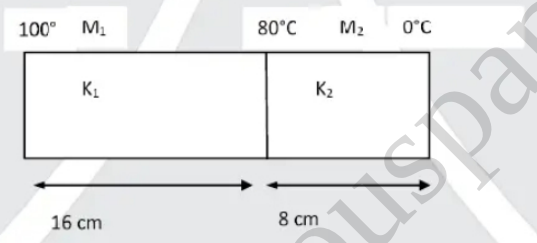
Sol. $\frac{1}{2}mv_1^2 = h(2v_{th}) - h(v_{th})$.....(1) $\frac{1}{2}mv_2^2 = h(5v_{th}) - h(v_{th})$.....(2)

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. $\frac{K_1A}{16}(100-80) = \frac{K_2A}{8}(80)$

$K_2 = \frac{k_1 20}{80\times 2} = \frac{160}{8} = 20$

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)**

Sol. Using work energy theorem

$W_F = K_F - K_i$

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

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

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

$= 2(4 - 1) + (27 - 8) = 6 + 19 = 25$ Joule

12. Find distance between I[st] 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. $a\sin\theta = \frac{3}{2}\lambda$

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

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

$y_2 - y, \frac{3}{2}(\lambda_2 - \lambda_1)\frac{D}{a}$

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)**

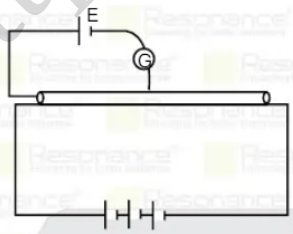
Sol. Energy released = $115 \times 5.6 + 105 \times 6.4 - 220 \times 5 = 644 + 672 - 1100 = 116$ MeV

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)**

Sol.



$E_1 = K \times 75$

$E_1 = K \times x$

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

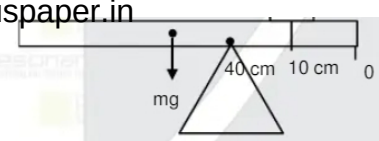
Difference = 75 – 50 = 25 cm

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.

$m_1 = 10g$



mg. 10cm = (m_1g) × 30 cm

mg = m_1 . 3

m = 30 gram

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

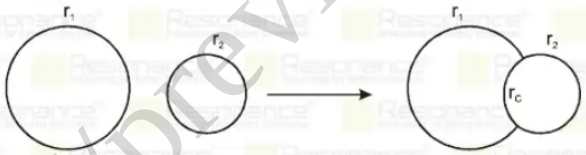
Ans. **7.77**

Sol. $E = \frac{\sigma}{K\varepsilon_0} = \frac{q}{AK\varepsilon_0}$

$\Rightarrow \quad K = \frac{q}{A\varepsilon_0} \times \frac{1}{E}$

$= \frac{7\times10^{-6}}{(9\pi\times10^{-4})\times8.85\times10^{-12}\times3.6\times10^{7}} = \frac{7}{9\pi\times8.85\times3.6}10^{3} = \frac{7}{900.366}\times10^{3} = 7.77$

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

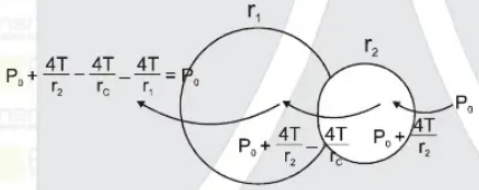


(1) $\frac{r_1r_2}{r_1-r_2}$ (2) $\frac{r_1r_2}{r_1+r_2}$ (3) $\frac{r_1-r_2}{2}$ (4) $r_1 - r_2$

Ans. **(1)**

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

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



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

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)**

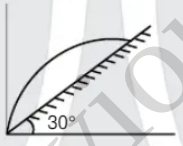
Sol. $t = \frac{u\sin\theta}{g}$

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

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

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

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. $T = \frac{2u_\perp}{g_\perp} = \frac{2\times10\times\frac{1}{2}}{10\times\frac{\sqrt{3}}{2}} = \frac{2}{\sqrt{3}}$

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

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. $\frac{E}{B} = v = \frac{C}{\sqrt{\mu_r\varepsilon_r}} = \frac{C}{6}$

$B = \frac{6E}{C} = \frac{6\times7\times10^{-3}}{3\times10^{8}}$

$= 14\times10^{-11}$

$= 1.4\times10^{-10}$

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. $n = 1-T_2/T_1$

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

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

$T_1 = 400K$

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

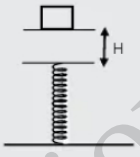
$0.5 = 1-\frac{300}{T_1'}$

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

$T_1' = 600$

So change in temperature = 600 – 400 = 200K

23. A block of mass m = 10 gm is released from height H = 10 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 = 10m/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

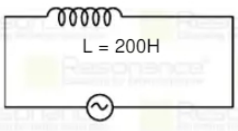
$\sum W = \Delta k$

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

$K = \frac{12mg}{H} = \frac{12\times10\times10}{1000\times0.1}$

$K = 12$ N/m

24.



An Inductor of 200 Hennery 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. $X_C = \omega L = (2\pi f)L$

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

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

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) 2×10^7 N/m^2 (2) 3×10^7 N/m^2 (3) 2×10^9 N/m^2 (4) 5×10^7 N/m^2

Ans. **(1)**

Sol. stress = B (strain)

stress = $10^9\left(\frac{2}{100}\right) = 2 \times 10^7$ 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. $KE_{max} = E - w$

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

$e(V_{02} - V_{01}) = hc\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right)$

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

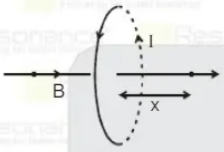
$\lambda_2 = 390$ nm

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.



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

$x = R/2$

$B = \frac{\mu_2}{2} \frac{IR^2}{\left(\frac{R^2}{4} + R^2\right)^{3/2}}$

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

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