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JEE (Main)

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

2022

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 25 July, 2022 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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PART : PHYSICS

1. Deuteron & proton are accelerated by accelerating potential V_D & V_P. Ratio of their de-broglie wavelength is $\frac{\lambda_D}{\lambda_P} = \frac{\sqrt{2}}{1}$ then find the ratio $\frac{V_P}{V_D}$?

(1) 4 (2) 6 (3) 8 (4) 9

Ans. **(1)**

Sol. $\lambda_D = \frac{h}{\sqrt{2m_D qV_}}$

$\sqrt{2mqV_a}$

$$\frac{\sqrt{2}}{1}=\frac{\lambda_{D_1}}{\lambda_{P_2}}=\frac{\sqrt{m_Pq_PV_P}}{\sqrt{m_Dq_DV_D}}$$

$$2=\frac{m_Pq_PV_P}{m_Dq_DV_D}$$

$$\frac{V_P}{V_D}=4$$

2. An electron makes a transition from n^{th} state to ground state emitting wavelength λ then the value of n is :

(1) $\sqrt{\frac{xR}{3\lambda R-1}}$ (2) $\sqrt{\frac{2\lambda R}{2\lambda R-1}}$ (3) $\sqrt{\frac{\lambda R}{\lambda R-1}}$ (4) $\sqrt{\frac{6\lambda R}{\lambda R-1}}$

Ans. **(3)**

Sol. electron $n^{th} \rightarrow n = 1$

n is term of > & R

$$\frac{1}{\lambda}=R\left[1-\frac{1}{n^2}\right]$$

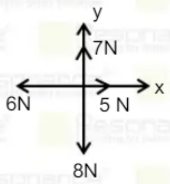
$$\frac{1}{\lambda R}=1-\frac{1}{n^2}$$

$$\frac{1}{n^2}=1-\frac{1}{\lambda R}$$

$$\frac{1}{n^2}=\frac{\lambda R-1}{\lambda R}$$

$$n=\sqrt{\frac{\lambda R}{\lambda R-1}}$$

3. Force required to balance all the forces given in above diagram is



(1) $\sqrt{2}$ at 45° with x-axis (2) $\sqrt{3}$ at 45° with x-axis

(3) $\sqrt{2}$ at 60° with x-axis (4) $\sqrt{3}$ at 60° with x-axis

Ans. **(1)**

Sol. Given forces in diagram are

$\vec{F}_1 = 5\hat{i}$

$\vec{F}_2 = -6\hat{i}$

$\vec{F}_3 = 7\hat{j}$

$\vec{F}_4 = -8\hat{j}$

Let $\vec{F}_5$ is required force then

$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 + \vec{F}_5 = 0$

$-\hat{i}-\hat{j}+\vec{F}_5=0$

$\therefore \vec{F}_5=\hat{i}+\hat{j}$

$\therefore \left|\vec{F}_5\right| = \sqrt{2}N$ & at 45° with +ve x–axis

4. Flax passing thing a coil is $\phi = 8t^2 - 9t + 2$. Resistance of coil is 20Ω find current in loop t = 0.25 sec in ampere :

(1) $\frac{1}{3}$ (2) $\frac{1}{5}$ (3) $\frac{1}{6}$ (4) $\frac{1}{4}$

Ans. **(4)**

Sol. $\phi = 8t^2 - 9t + 2$

R = 20Ω

I = ?

$$|e| = \left|\frac{d\phi}{dt}\right|$$

$|e| = 16t - 9$

at t = 0.25 s

$|e| = |16 \times 0.25 - 9| = 5V$

$\therefore I = \frac{5}{20} = \frac{1}{4}$ A.

5. Electric field of EM wave is $E(x, t) = 54 \cos(2 \times 10^7 x + 6 \times 10^{15} t)$ v/m

Maximum value of magnetic field will be

(1) 6×10^{-7} T (2) 12×10^{-7} T (3) 18×10^{-7} T (4) 4×10^{-7} T

Ans. **(3)**

Sol. $B_0 = \frac{E_0}{C}$

$= \frac{54}{3 \times 10^{10}}$

$= 18 \times 10^{-7}$ T

6. Maximum height and range of a projectile thrown at an angle θ with horizontal are equal. Then the value of θ is :

(1) $\tan^{-1}2$ (2) $\tan^{-1}4$ (3) $\tan^{-1}3$ (4) $\tan^{-1}5$

Ans. **(2)**

Sol. $H = H = \frac{u^2 \sin^2\theta}{2g}$

and $R = \frac{u^2 \sin 2\theta}{g}$

$\therefore \frac{H}{R} = \frac{\tan\theta}{4}$

but given H = R

$\therefore \frac{\tan\theta}{4} = 1$

$\tan\theta = 4$

$\theta = \tan^{-1}4$

7. In a rectilinear motion speed of particle is increasing at the rate of 5 m/s per metre. Determine acceleration in m/s^2 at the instant when velocity is 20 m/s.

(1) 50 m/s^2 (2) 100 m/s^2 (3) 200 m/s^2 (4) 40 m/s^2

Ans. **(2)**

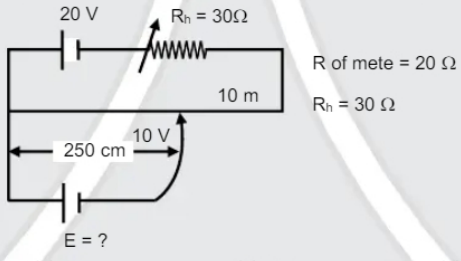
Sol. $a = a = \frac{vdv}{ds}$

$\frac{dv}{ds} = 5$

$a = 20 \times 5$

$= 100$ m/s^2

8. In potentiometer circuit. A cell of end E was balanced for balance length of 250 cm. Resistance of potentiometer wire = 20 Ω. Length of potentiometer wire = 10 m. Determine emf E.



R of mete = 20 Ω

R_h = 30 Ω

(1) 2 V (2) 3 V (3) 4 V (4) 5 V

Ans. **(1)**

Sol. $i = \frac{20}{R + R_h} = \frac{20}{20 + 30} = \frac{20}{50} = \frac{2}{5}$ Amp.

y = potential gradient = $\frac{iR}{L} = \frac{2}{5} \times \frac{20}{10} = \frac{4}{5}$ V/m

Balance length = 250 cm = 2.5 metre

$E = y \times$ Balance length = $\frac{4}{5} \times 2.5 =$ 2 volt

Ans 2 volt

9. Maximum and minimum Amplitude of modulated signal are 6V & 2V then modulation index will be

(1) 50% (2) 60% (3) 80% (4) 20%

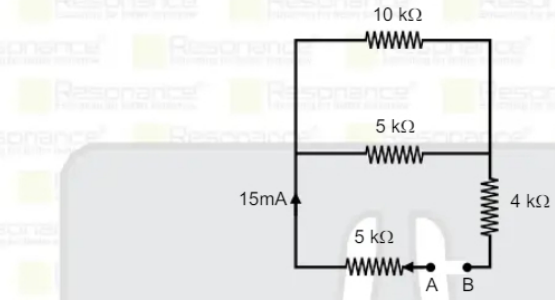
Ans. **(1)**

Sol. $\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}}$

$\mu = \frac{6-2}{6+2} = \frac{4}{8} = \frac{1}{2}$

50%

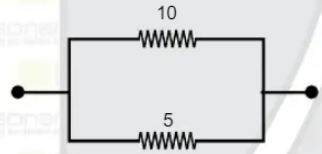
10. In a electric circuit shown in figure. Determine $V_A - V_B$ in volt ?



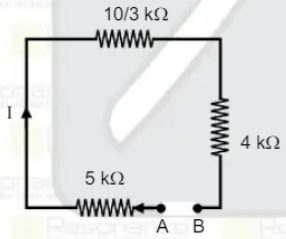
(1) 150 V (2) 185 V (3) 170 V (4) 200 V

Ans. **(2)**

Sol.



$\Rightarrow R_{eq} = \frac{10\times5}{10+5} \Rightarrow \frac{50}{15} \Rightarrow \frac{10}{3}k\Omega$



$V_A - V_B = 15 \times 10^{-3} \times 5 \times 10^3 + 15 \times 10^{-3} \times \frac{10\times10^3}{3} + 4 \times 10^3 \times 15 \times 10^{-3}$

$\Rightarrow 75 + 50 + 60$

$\Rightarrow 185$ volt

11. There is a mixture of two gases, 2 moles of He and n moles of H_2. If Rms speed of gas atoms is $\sqrt{2}$ times the speed of sound wave in this mixture. Determine the value of n.

Ans. **2**

Sol. $V_{rms} = \sqrt{\frac{3RT}{M_{mix}}}$

$V_{sound} = \sqrt{\frac{Y_{mix}RT}{M_{mix}}}$

$V_{rms} = \sqrt{2}\, V_{sound}$

$\sqrt{\frac{3RT}{M_{mix}}} = \sqrt{2}\sqrt{\frac{Y_{mix}RT}{M_{mix}}}$

$\sqrt{3} = \sqrt{2}\sqrt{Y_{mix}}$

$Y_{mix} = \frac{3}{2}$

$\frac{n_1Cp_1 + n_2Cp_2}{n_1Cv_1 + n_2Cv_2} = \frac{3}{2}$

Put Cp_1 = Cp of He = $\frac{5R}{2}$ & Cp_2 = Cp of $H_2 \Rightarrow \frac{7R}{2}$

CV_1 = CV of He = $\frac{3R}{2}$ & Cv_2 = Cv of $H_2 \Rightarrow \frac{5R}{2}$

$\frac{2\times\frac{5R}{2} + n\times\frac{7R}{2}}{2\times\frac{3R}{2} + n\times\frac{5R}{2}} = \frac{3}{2}$

$\frac{10+7n}{6+5n} = \frac{3}{2} \quad \therefore n = 2$

12. Length of second's pendulum at height h = 2R from the surface of earth : (Take $\pi^2 = 10$ Rg = 10 m/s^2)

(1) $\frac{1}{3}$m (2) $\frac{1}{4}$m (3) $\frac{1}{9}$m (4) $\frac{1}{6}$m

Ans. **(3)**

Sol. $g' = \frac{GM}{r^2} = \frac{GM}{(R+h)^2}$

$g' = \frac{GM}{(3R)^2}$

$= \frac{g}{9}$

$T = 2\pi\sqrt{\frac{\ell}{g}} = 2\pi\sqrt{\frac{\ell'}{(g/9)}}$

$2\pi\sqrt{\frac{9\ell'}{g}}$

$\ell' = \frac{g}{9\pi^2} = \frac{1}{9}$

13. Radium of isolated spherical capacitor is R_1 and another spherical capacitor having inner and outer radium R_1 & R_2. If capacity of spherical capacitor is u times of capacity of isolated capacitor then ratio of R_1R_2 will be.

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

Ans. **(2)**

Sol. $n \times 4\pi\in_0 R_1 = \left[\frac{4\pi\in_0 (R_2R_1)}{R_2 - R_1}\right]$

$n = \frac{R_2}{R_2 - R_1}$

$\therefore \frac{R_2 - R_1}{R_2} = \frac{1}{n} \Rightarrow 1 - \frac{R_1}{R_2} = \frac{1}{n} \Rightarrow \frac{R_1}{R_2} = 1 - \frac{1}{n}$

14. Ratio of efficiency of Carnot cycle. Where temp of source and sink are 447°C, 147°C and 947°C & 47°C respectively

Ans. **0.565**

Sol. $\eta_1 = 1 - \frac{147+273}{447+273} = 1 - \frac{420}{720} = 0.417$

$\eta_2 = 1 - \frac{47+273}{947+273} = 1 - \frac{320}{720} = 0.734$

$\therefore \frac{\eta_1}{\eta_2} = 0.565$

15. A coil have two turns, when current flows in it magnetic field at center is B_1, when coil is again reconstructed and number of turns be comes 5 and same current flow in it. Then magnetic field at center will be B_2 then ratio of B_1 & B_2 is :

(1) $\frac{2}{25}$ (2) $\frac{1}{25}$ (3) $\frac{4}{25}$ (4) $\frac{6}{25}$

Ans. **(3)**

Sol. $B_1 = 2\times\frac{\mu_0 I}{2R_1}$

and $B_2 = 5\times\frac{\mu_0 I}{2R_2}$

$\therefore \frac{B_1}{B_2} = \frac{2}{5}\times\frac{R_2}{R_1}$ ....(1)

Now

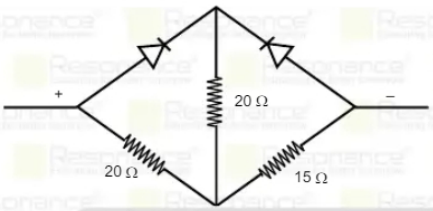
$2 \times 2\pi R_1 = 5 \times 2\pi R_2$

$2R_1 = 5R_2$ ....(2)

from (1) & (2)

$\frac{B_1}{B_2} = \frac{4}{25}$

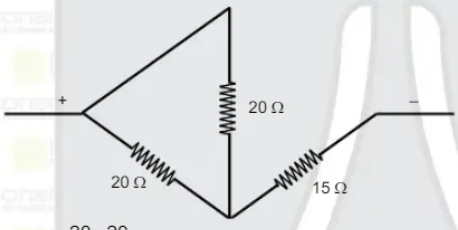
16. Equivalent resistance of circuit will be :



(1) 15 Ω (2) 20 Ω (3) 25 Ω (4) 40 Ω

Ans. **(3)**

Sol. equivalent ckt will be



$\therefore R_{eq} = \frac{20\times20}{20+20} + 15 = 25\Omega$

17. When object is raised to height $\frac{5R}{4}$ above earth surface. Determine the percentage charge in weight of

object on raising it to that height.

Ans. **80.25%**

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

$g' \frac{g}{\left(1+\frac{5R}{4R}\right)^2}$

$g' = \frac{g \times 16}{81}$

$\frac{g'}{g} = \frac{16}{81}$

% decrease in height $= \left(\frac{g-g'}{g}\right) \times 100$

$= \left(1-\frac{16}{81}\right) \times 100$

$\frac{65}{81} \times 100$

80.25%

18. Two capacitor of capacitance 3C and C are connected in parallel with battery of 6 volt. Now battery is disconnected and dielectric slab of k = 6 is filled in capacitor of capacitance C. Now find the common potential of combination.

Ans. **2.66**

Sol.

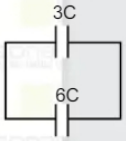
charge on 3C $\Rightarrow$ 3C × 6

$\Rightarrow$ 18C

charge on C = C × 6

$\Rightarrow$ 6C

Now Battery is disconnected and k = 6 is filled in C $\therefore$ New value of capacitance = kC = 6C



$V_{common} = \frac{Q_1+Q_2}{C_1+C_2}$

$= \frac{18C+6C}{3C+6C}$

$\Rightarrow \frac{24}{9}$

$\Rightarrow$ 2.66 volt

19. Ratio of energy of photon when electron in hydrogen atom comes from 3rd excited state to 2nd excited state and energy of photon having maximum possible energy when electron in H atom comes in ground state will be $\frac{x}{x+4}$ then find value of x.

Ans. **0.2**

Sol. In first case $E_1 = \left(-\frac{13.6}{4^2}\right) - \left(\frac{-13.6}{3^2}\right) = \frac{7}{144} \times 13.6$

In second case $E_2 = 13.6$

$\frac{E_1}{E_2} = \frac{7}{144}$

$$\frac{x}{x+4} = \frac{7}{144}$$

$144x = 7x + 28$

$x = \frac{28}{137} = 0.2$

20. A liquid drop of radius r and density σ floats in a liquid of density ρ. If drop is half imersed in liquid then find radius of drop 'r' if surface tension of liquid is T.

(1) $\sqrt{\frac{5T}{(2\sigma-\rho)g}}$ (2) $\sqrt{\frac{2T}{(3\sigma-\rho)g}}$ (3) $\sqrt{\frac{3T}{(\sigma-\rho)g}}$ (4) $\sqrt{\frac{3T}{(2\sigma-\rho)g}}$

Ans. **(4)**

Sol. weight = force of bouncy + force of S.T.

$$\sigma \times \frac{4}{3}\pi r^3 \times g = \rho \times \frac{2}{3}\pi r^3 \times g + T \times 2\pi r$$

$$\sigma \times \frac{2r^2}{3} g = \frac{\rho r^2 g}{3} + T$$

$$\frac{r^2}{3}(2\sigma g - \rho g) = T$$

$$r = \sqrt{\frac{3T}{(2\sigma-\rho)g}}$$