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JEE (Main)

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

2022

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 26 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 plane flying horizontally at a height of 1500 m with a velocity of 200 ms^{-1} passes directly overhead an antiaircraft gun. Then the angle with the horizontal at which the gun should be fired for the shell with a muzzle velocity of 400 m s^{-1} to hit the plane, is -

(1) 90º (2) 60º (3) 30º (4) 45º

Ans. (2)

Sol.

u = 200 m/s

To hit 400 cos θ = 200

{∴ Both travel equal distance along horizontal, of their start and coordinates an x axis are same}

⇒ θ = 60º **Ans.**

2. A particle is projected in vertical direction with speed u. Which of the quantity is zero at top most position.

(1) momentum (2) acceleration (3) force (4) potential energy

Ans. (1)

3. A capacitor of capacitance C_1 is charged with the help of battery of potential V. After fully charged, battery is removed and this capacitor C_1 is connect with another uncharged capacitor of capacitance C_2 in parallel combination then in equilibrium charge on capacitor C_2 is

(1) $\frac{VC_1C_2}{C_1+C_2}$ (2) $\frac{VC_2C_2}{C_1+C_2}$ (3) $\frac{VC_2C_2}{C_1-C_2}$ (4) $\frac{VC_1C_1}{C_1+C_2}$

Ans. **(1)**

Sol. common potential $V = \frac{V_1C_1}{C_1+C_2}$

So, charge on capacitor C_2

$Q_2 = C_2V = C_2\left(\frac{V_1C_1}{C_1+C_2}\right)$

4. Initial angular velocity of a circular disc of mass M is ω_1. Now two small spheres of mass m are attached gently to the diametrically opposite points on the edge of the disc. What is the final angular velocity of the disc ?

(1) $\left(\frac{M+m}{M}\right)\omega_1$ (2) $\left(\frac{M+m}{m}\right)\omega_1$ (3) $\left(\frac{M}{M+4m}\right)\omega_1$ (4) $\left(\frac{M}{M+2m}\right)\omega_1$

Ans. **(3)**

Sol. Conservation of angular momentum gives

$\Rightarrow \frac{1}{2}MR^2\omega_1 = \frac{1}{2}R^2(M+4m)\omega_2$ $\therefore$ $\omega_2 = \left(\frac{M}{M+4m}\right)\omega_1$

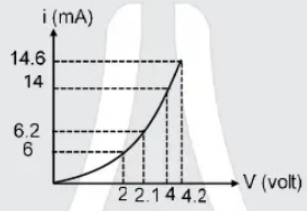
5. An ideal gas of molar weight M_0 is filled in a non-conducting closed container, and the container is initially moving with a speed of V. If the container is suddenly stopped, then the increase in temperature of the gas will be: (γ_{gas} = 1.5)

(1) $\frac{M_0V^2}{2R}$ (2) $\frac{M_0V^2}{3R}$ (3) $\frac{M_0V^2}{4R}$ (4) $\frac{M_0V^2}{5R}$

Ans. (4)

Sol. $\frac{1}{2}MV^2 = n\left(\frac{f}{2}R\right)\Delta T$; $\frac{1}{2}(nM_0)V^2 = n\frac{5}{2}R\Delta T$; $\Delta T = \frac{M_0V^2}{5R}$

6. Characteristic curve of a diode is as shown below. Its dynamic resistance at v = 2 volt and v = 4 volt will be respectively:



(1) 500Ω, 333.33Ω (2) 333.33Ω, 500Ω (3) 800Ω, 667Ω (4) 667Ω, 800Ω

Ans. **(1)**

Sol. $R = \frac{\Delta V}{\Delta i}$

Dynamic resistance at V = 2V

$$R = \frac{\Delta V}{\Delta i} = \frac{0.1}{0.2\times10^{-3}} = 500\Omega$$

Dynamic resistance at V = 4V

$$R = \frac{\Delta V}{\Delta i} = \frac{0.2}{0.6\times10^{-3}} = 333.33\Omega$$

7. Proton and α-particle are projected with same speed in uniform magnetic field in the direction perpendicular to the magnetic field. Then ratio of radii in magnetic field is :

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

Ans. **(2)**

Sol. For circular path in magnetic field.

$$r = \frac{mV}{qB}$$

So,

	p	α
m	1	4
q	+e	2e

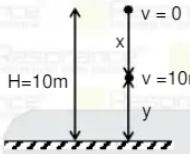
$$r_1 : r_2 = \frac{1}{e} : \frac{4}{2e} = \frac{1}{2} = 1 : 2$$

8. A particle is released from rest from height 10m. Find height of particle form ground when speed of particle becomes 10 m/s : (Use g = 10 m/s^2)

(1) 10 m (2) 8 m (3) 4 m (4) 5 m

Ans. (4)

Sol.



From equation of motion from top

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

$10^2 = 0 + 2gx$

x = 5 m

So, height from ground y = H – x = 10 – 5 = 5 m

9. The efficiency of an ideal heat engine working between the freezing point and boiling point of water is

(1) 26.8 % (2) 12.5 % (3)6.25 % (4) 20 %

Ans. **(1)**

Sol. $\eta = 1 - \frac{T_{less}}{T_{more}} = 1 - \frac{273}{373} = 26.8\ \%$

10. The dependence of acceleration due to gravity g on the distance r from the centre of the earth, assumed to be a sphere of radius R of uniform density is as shown in figures below. The correct figure is :

(1) 

(2) 

(3) 

(4) 

Ans. **(4)**

Sol. The acceleration due to gravity at a depth d below surface of earth is

$$g' = \frac{GM}{R^2}\left(1-\frac{d}{R}\right) = g\left(1-\frac{d}{R}\right)$$

g' = 0 at d = R

i.e., acceleration due to gravity is zero at the centre of earth.

Thus, the variation in value g with r is

for, r > R,

$g = \frac{\rho R^2}{r}$

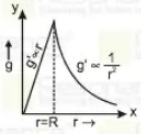
$$g' = \frac{g}{\left(1+\frac{h}{R}\right)^2} = \frac{gR^2}{r^2} \quad \Rightarrow g' \propto \frac{1}{r^2}$$

Here, R + h = r

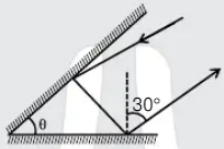
For $r < R$, $g' = g\left(1-\frac{d}{R}\right) = \frac{gr}{R}$

Here, $R - d = r \Rightarrow g' \propto r$

Therefore, the variation of g with distance from centre of the earth will be as shown in the figure.



11. Two mirrors are inclined at an angle $\theta = 75°$ as shown in the figure. Light ray is incident as shown in figure total deviation of light will be :



(1) 195° (2) 210° (3) 160° (4) 200°

Ans. **(2)**

Sol. $d = 360° - 2\theta = 360° - 150° = 210°$

12. Choose the correct statement for in amplitude modulation:
(1) The amplitude of the modulated wave varies according to the massage signal
(2) The amplitude of the modulating wave varies according to the massage signal
(3) The frequency of the modulated wave varies according to the massage signal
(4) The frequency of the modulating wave varies according to the massage signal

Ans. **(4)**

13. Flux passing through a coil varies with time according to $\phi(t) = 5t^3 + 18t$. If resistance of the coil is $5k\Omega$, then the current through the coil at t = 2 will be :
(1) 10.2 mA (2) 15.6 mA (3) 25.3 mA (4) 78 mA

Ans. (2)

Sol. $\phi = 5t^3 + 18t$

$|Emf| = \frac{d\phi}{dt} = 15t^2 + 18$

$|Emf|_{at\ t=2} = 15(2)^2 + 18 = 78$ volt

$I = \frac{|Emf|}{R} = \frac{78}{5\times10^3} = 15.6$ mA

14. $_{92}U^{238}$ decays into Pb^{206}. How many $\propto$ and β^{-1} particles will be emitted
(1) 4 $\propto$ and 7 β particles (2) 8 $\propto$ and 4 β particles
(3) 8 $\propto$ and 6 β particles (4) 6 $\propto$ and 8 β particles

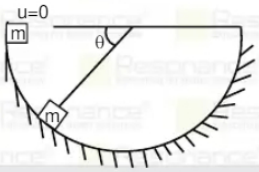
Ans. (3)

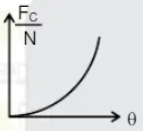
Sol. $_{92}U^{238} \longrightarrow {}_{82}Pb^{206} + n_1\left({}_2\propto^4\right) + n_2\left({}_{-1}\beta^0\right)$

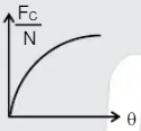
$238 \approx 206 + 4n_1 + n_2\,(0) \Rightarrow n_1 = 8$

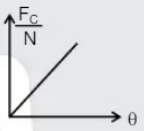
$92 = 82 + (n_1)\,(2) + (n_2)\,(-1) \Rightarrow n_2 = 6$

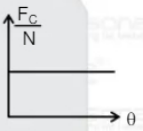
15. A block of mass m is released from the top-most point of a vertical cylindrical surface of radius R. If the magnitude of centripetal force and normal reaction at a general θ are respectively F_C and N, then correct graph of F_C/Nverses θ will be :



(1) 

(2) 

(3) 

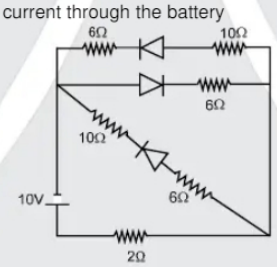
(4) 

Ans. (3)

Sol. $V = \sqrt{2gh} = \sqrt{2gR\sin\theta}$, $F_C = \frac{mv^2}{R} = 2mg\sin\theta$

$N = mg\sin\theta + \frac{mv^2}{R} = 3mg\sin\theta$, $\frac{F_C}{N} = \frac{2}{3} = \text{const.}$

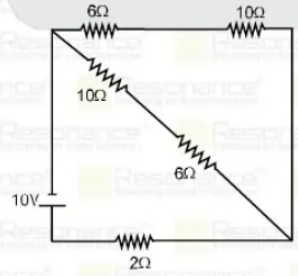
16. In the given diagram find the current through the battery



(1) 1A (2) 2A (3) 3A (4) 4A

Ans. (1)

Sol. Effective CKt is



$i = \frac{10}{10} = 1A$

17. The length of a wire is increased by 0.4% by starching it. What will the % change in resistance is

(1) 0.5% (2) 0.8% (3) 0.3% (4) 0.2%

Ans. (2)

Sol. $R = \frac{SL}{A}$ but volume LA = constant so $A \propto \frac{1}{L}$

so $R \propto L^2$

$\frac{\Delta R}{R} \times 100 = 2\left(\frac{\Delta L}{L} \times 100\right) = 2 \times (0.4) = 0.8\%$

18. 2A steady current is following in a inductor, of inductance L = 50 μH. Now it is reduced upto zero in 100μ sec. Induced emf in inductor in this interval is :

(1) 1 volt (2) 3 volt (3) 5 volt (4) 7 volt

Ans. **(1)**

Sol. $\varepsilon = \frac{\Delta\phi}{\Delta t} = \frac{L\Delta i}{\Delta t} = \frac{50\times10^{-6}\times2}{100\times10^{-6}}$

ε = 1 volt

19. Radiations of wave length λ is incident on particles of dimensions $\lambda/100$, which type of phenomenon will take place :

(1) Reflection (2) Refraction (3) Scattering (4) Diffraction

Ans. **(3)**

Sol. If size of particle is very small then wave length of light then scattering will happen.

20. An electromagnetic wave is travelling in vacuum and its equation in the form of electric field is given by: $\vec{E} = -a\sin(kz-\omega t)\hat{i} - b\sin(kz-\omega t)\hat{j}$, then its equation in the form of magnetic field will be

(1) $\vec{B} = \frac{\hat{bi}-\hat{aj}}{c}\sin(kz-\omega t)$ (2) $\vec{B} = \frac{\hat{bi}+\hat{aj}}{c}\sin(kz-\omega t)$

(3) $\vec{B} = \frac{-\hat{bi}-\hat{aj}}{c}\sin(kz-\omega t)$ (4) $\vec{B} = \frac{-\hat{bi}+\hat{aj}}{c}\sin(kz-\omega t)$

Ans. **(1)**

Sol. $\vec{E} = -(-a\hat{i}-b\hat{j})\sin(kz-\omega t)\hat{i} \Rightarrow E_0 = \sqrt{a^2+b^2}$

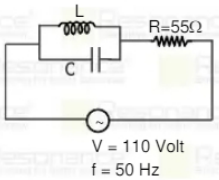
$\frac{E_0}{B_0} = C \Rightarrow B_0 = \frac{E_0}{c} = \frac{\sqrt{a^2+b^2}}{c} \Rightarrow |B| = \frac{\sqrt{a^2+b^2}}{c}\sin(kz-\omega t)$

$\hat{B} = \hat{C}\times\hat{E} = (\hat{k})\times\left(\frac{a\hat{i}+b\hat{j}}{\sqrt{a^2+b^2}}\right) = \frac{\hat{bi}-\hat{aj}}{\sqrt{a^2+b^2}}$

$\vec{B} = |B|\hat{B} = \frac{\sqrt{a^2+b^2}}{c}\sin(kz-\omega t)\times\frac{\hat{bi}-\hat{aj}}{\sqrt{a^2+b^2}}$

$\vec{B} = \frac{\hat{bi}-\hat{aj}}{c}\sin(kz-\omega t)$

21. If the given circuit is in resonance (i.e. $X_L = X_C$), then the rms current in the circuit will be



(1) 2 Amp (2) 4 Amp (3) 0.5 Amp (4) zero

Ans. (4)

Sol. $X_L = i(L\omega)$, $X_C = -\frac{i}{C\omega}$

Their resultant will be $\frac{X_C X_L}{X_C + X_L} = \frac{(i(L\omega))\left(-\frac{i}{C\omega}\right)}{iL\omega + \left(-\frac{i}{C\omega}\right)}$

$= \frac{\frac{L}{C}}{\left(L\omega - \frac{i}{C\omega}\right)} = -\frac{L}{C\left(L\omega - \frac{1}{C\omega}\right)}$

In case of resonance $\omega = \frac{1}{\sqrt{LC}}$

$\Rightarrow L\omega = \frac{1}{\quad} \Rightarrow |Z| \to \infty \Rightarrow i \to 0$

$C\omega$

22. Wave length of a photon and de-Broglie wavelength of an electron is same. The speed of an electron is V & speed of a photon is C. The ratio of Kinetic energies (KE) & momentums (P) of these are

(1) $\frac{KE_e}{KE_{Ph}} = \frac{2C}{V}$ (2) $\frac{KE_e}{KE_{Ph}} = \frac{V}{2C}$ (3) $\frac{P_e}{P_{Pn}} = \frac{1}{2}$ (4) $\frac{P_e}{P_{Pn}} = 2$

Ans. **(2)**

Sol. For both

$L = \frac{h}{P} \Rightarrow P = \frac{h}{\lambda}$

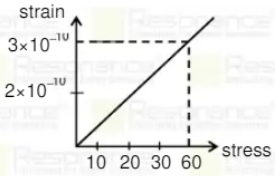
So P will be same for e & photon

$KE_e = \frac{1}{2}mv^2 = \frac{PV}{2}$

$KE_{Ph} = mC^2 = PC$

$\frac{KE_e}{KE_{ph}} = \frac{V}{2C}$

23. On a rod stress – strain graph is as shown strain



When stain in wire is 5×10^{-2} then find energy stored per unit volume in the wire

(1) 5×10^7 J/m^3 (2) 7×10^7 J/m^3 (3) 9×10^7 J/m^3 (4) 10^7 J/m^3

Ans. (3)

Sol. From given graph

$Y = \frac{\text{stress}}{\text{strain}}$

$Y = \frac{60}{3\times10^{-10}} = 2 \times 10^{11}$ N/m^2

Energy density = $\frac{1}{2}Y(\text{strain})^2$

$= \frac{1}{2}(2 \times 10^{11})(3 \times 10^{-2})^2 = 9 \times 10^7$ J/m^3

24. A uniform elastic wire is hanging near the earth's surface then stretching due to its self weight is $x = 10^{-6}$m . If it is hanged near the surface of an another planet, then its stretching is 6×10^{-5} m. If gravity field near the earths surface is 10 m/sec^2, then the gravity field near the other planet will be in m/sec^2 :

(1) 4 (2) 6 (3) 8 (4) 12

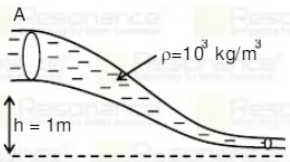
Ans. (2)

Sol. $x = \frac{<T>}{K} = \frac{\frac{mg+0}{2}}{\frac{YA}{\ell_0}} = \frac{mg\ell_0}{2YA}$

$x \propto g \Rightarrow \frac{g_2}{g_1} = \frac{x_2}{x_1} \Rightarrow \frac{g_2}{10} = \frac{6\times10^{-5}}{10\times10^{-5}}$

$g_2 = 6$

25. A liquid is flowing in a non-uniform pipe as shown. Cross-sectional area at A is double then cross-sectional area at B. A is at 1 m height form B. Pressure at B is 4000 Pascal higher then A. Velocity at point A is



(1) 2 m/s (2) 4 m/s (3) 6 m/s (4) 8 m/s

Ans. (1)

Sol. From eqⁿ

$$\frac{1}{2}\rho V_A^2 + \rho gh + \rho_A = \frac{1}{2}\rho V_B^2 + \rho gh + \rho_B$$

$$10^3 V_B^2 + 2\times10^3 \times 10 \times 1 + 2\rho_A$$

$$= 10^3(2V_A)^2 + 0 + 2\rho_B)$$

$$= 2 \times 10^4 + 2(P_A - P_B) = 3 \times 10^3 V_A^2$$

$$V_A = 2 \text{ m/s}$$

26. **Statement-1 :** The electric dipole moment of a non-polar molecule is zero.
Statement-2 : In non polar molecule, the centre of charge of both the atoms lie on the same point.

(1) Statement-1 is True, Statement-2 is True (2) Statement-1 is False, Statement-2 is True

(3) Statement-1 is True, Statement-2 is False (4) Statement-1 is False, Statement-2 is False.

Ans. **(3)**