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JEE (Main)

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

2023

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 25 January, 2023 (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. Resistance of a cylindrical wire is 5Ω. If length is increased by 5 times by stretching then new resistance is :

(1) 100Ω (2) 125Ω (3) 150Ω (4) 175Ω

Ans. **(2)**

Sol. $R_1 = \frac{\rho\ell}{A} = \frac{\rho\ell}{V}$

$R \propto \ell^2$

$\frac{R_2}{R_1} = \left(\frac{5\ell}{\ell}\right)^2 = 25$

$R_2 = 25 \times 5$

2. A diatomic gas, which has vibrational degree of freedom then molar heat capacity at constant volume is:

(1) $\frac{7R}{2}$ (2) $\frac{3R}{2}$ (3) $\frac{5R}{2}$ (4) $\frac{3R}{2}$

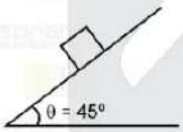
Ans. **(1)**

Sol. $C_v = \frac{fR}{2}$

here $f = 3 + 2 + 2 = 7$

$C_v = \frac{7R}{2}$

3.



Force required to push the box upward is two times of force required to slide down.

(1) $\mu = \frac{1}{2}$ (2) $\mu = \frac{1}{3}$ (3) $\mu = \frac{1}{4}$ (4) $\mu = \frac{1}{\sqrt{2}}$

Ans. **(2)**

Sol. $mg\sin\theta + \mu mg\cos\theta = 2(mg\sin\theta - \mu mg\cos\theta)$

$mg\sin\theta = 3\mu mg\cos\theta$

$\tan\theta = 3\mu$

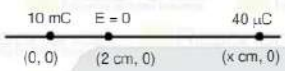
$\mu = \frac{1}{3}$

4. A 10 μC point charge is placed at origin. To get electric field strength zero at 2 cm on +ve x–axis. Where should we place 40 μC charge on the x–axis

(1) 4 (2) 8 (3) 10 (4) 6

Ans. **(4)**

Sol.



At $x = 2$; $E_1 + E_2 = 0$

$\frac{k(10\mu C)}{(2\times10^{-2})^2} = \frac{k\times40}{((x-2)\times10^{-2})^2}$

$x = 6$

5. Two parallel wire with spacing of 7 cm carrying current of 8A and 15A in opposite direction. Calculate the magnetic field at a mid-point between the wire ?

(1) 13.14×10^{-6} T (2) 13.14×10^{-5} T (3) 12.57×10^{-4} T (4) 12.57×10^{-5} T

Ans. **(2)**

Sol. $B_{net} = B_1 + B_2$

$= \frac{\mu_0}{}(i_1 + i_2)$

$2\pi d$

$$= \frac{2\times10^{-7}(8+15)}{3.5\times10^{-2}} = 13.14 \times 10^{-5}\,T$$

6. If $x = 2t^2$ then find the velocity at t = 2sec.

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

Ans. **(3)**

Sol. $V = dx/dt = 4t$

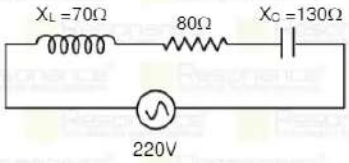
$V(2) = 4 \times 2 = 8$ m/s

7. A LCR circuit in which $X_L = 70$ for inductor, $X_C = 130$ for capacitor and resistance of circuit is 80 Ω. is connected with an AC source of (220 V, 50 Htz). Calculate the power factor of the circuit.

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

Ans. **(1)**

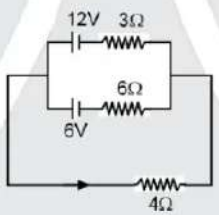
Sol.



Power factor; $\cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$

$$= \frac{80}{\sqrt{80^2 + (130-70)^2}} = \frac{80}{100} = \frac{4}{5}$$

8. In an electrical circuit, there are two batteries of emf 12 V and 6 V having internal resistance of 3Ω and 6 Ω respectively, is connected with a resistance of 4Ω as shown in the figure. Find the current passing through 4Ω resistance :



(1) 0.6 A (2) 1.9 A (3) 1.67 A (4) 1.2 A

Ans. **(3)**

Sol. $E_{eq} = \frac{\frac{12}{3} + \frac{6}{6}}{\frac{1}{3} + \frac{1}{6}} = 10V$ $r_{eq} = 2\Omega$

$$I_{4\Omega} = \frac{10}{2+4} = \frac{5}{3}\,\text{Amp.} = 1.67\,\text{Amp.}$$

9. A particle of mass 1 kg collides elastically with a particle of mass 3 kg at rest. Velocity of 1 kg particle

after collision is 1 m/s opposite to initial velocity then find initial velocity of 1 kg mass particle :

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

Ans. **(3)**

Sol. Before collision

$m_1 = 1kg$ $m_2 = 3kg$

After collision

$m_1v_1 = m_1 \times (-1) + 3 \times v_2$

$v_1 = -1 + 3v_2$ ...(1)

$e = \dfrac{v_2 - (-1)}{+v_1 - 0}$ $(e = 1)$

$+v_1 = v_2 + 1$

$v_2 = v_1 - 1$

$v_1 = -1 + 3(+v_1 - 1)$

$v_1 = -4 + 3v_1$

$2v_1 = +4$

$v_1 = +2$ m/s

10. A particle is doing S.H.M. If covers half of it's amplitude in 2 sec from mean position. How much time it will take to go from half amplitude point to extreme position.

(1) 24 (2) 12 (3) 4 (4) 6

Ans. **(3)**

Sol. Time taken by particle to reach half of amplitude from mean position is equal to $\dfrac{T}{12}$

$\dfrac{T}{12} = 2 \Rightarrow T = 24$ sec

Time taken from half amplitude to extreme position

$\dfrac{T}{6} = \dfrac{24}{6} = 4$ Sec

11. Match the matrix

(1) Adiabatic	(a) no change in internal energy
(2) Isothermal	(b) no heat exchange with surrounding
(3) Isochoric	(c) no change in pressure
(4) Isobaric	(d) work done is zero

(1) (1) – (c), (2) – (b), (3) – (d), (4) – (c) (2) (1) – (b), (2) – (c), (3) – (d), (4) – (a)

(3) (1) – (a), (2) – (b), (3) – (c), (4) – (d) (4) (1) – (b), (2) – (a), (3) – (d), (4) – (c)

Ans. **(4)**

12. A moving coil galvanometer of coil N =200 is connected to torsional spring of K = 100 SI units and placed in B = 0.01 T. If deflection is 0.05 rad at I = 4mA. Find area of coil :

(1) 625 (2) 750 (3) 900 (4) 450

Ans. **(1)**

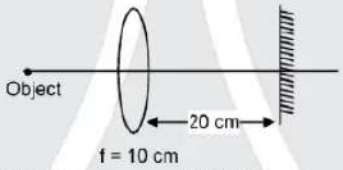
Sol. $\tau_{spring} = \tau_{magnetic\ field}$

$k\theta = M \cdot B \sin 90°$

$k\theta = NiA\,B$

$$A = \frac{k\theta}{NiB} = \frac{100 \times 0.05}{200 \times 4 \times 10^{-3} \times 0.01} = 625\ m^2$$

13. Find the distance of object from lens, so that image formed after the reflection from the plane mirror is 5 cm behind mirror :



(1) 20 cm (2) 15 cm (3) 30 cm (4) 10 cm

Ans. **(3)**

Sol. Final image is 5 cm behind mirror means image formed by lens is 5 cm infront of mirror.

$\therefore$ v = 15 cm for lens

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{15} - \frac{1}{u} = \frac{1}{10} \quad ; \quad \frac{1}{u} = \frac{1}{15} - \frac{1}{10}$$

$u = -30$ cm

14. Match the following physical quantities with their dimensions.

Physical quantity	Dimensions
(A) Y : Young modulus	(P) ML^2T^{-1}
(B) ϕ : Work function	(Q) $ML^{-1}T^{-2}$
(C) η : Viscosity	(R) ML^2T^{-2}
(D) h : plank's constant	(S) $ML^{-1}T^{-1}$

(1) A–Q, B–R, C–P, D–S (2) A–Q, B–R, C–S, D–P

(3) A–P, B–Q, C–R, D–S (4) A–P, B–R, C–Q, D–S

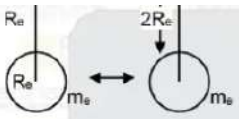
Ans. **(2)**

15. An object of mass m is place at a height R_e from the surface of earth. Find the increase in potential energy of the object. If the height of the object is increased to $2R_e$ from the surface :

(1) $\frac{mgR}{4}$ (2) $\frac{mgR}{6}$ (3) $\frac{mgR}{2}$ (4) $\frac{3mgR}{8}$

Ans. **(2)**

Sol.



$\Delta\mu = \mu_f - \mu_i$

$$= \frac{-Gm_em}{3R_e} - \left(-\frac{Gm_em}{2R_e}\right)$$

$$= \frac{Gm_em}{R_e}\left[\frac{1}{2} - \frac{1}{3}\right]$$

$$= \frac{Gm_em}{6R_e} = \frac{mgR}{6} \qquad \left(g = \frac{Gm_e}{R_e}\right)$$

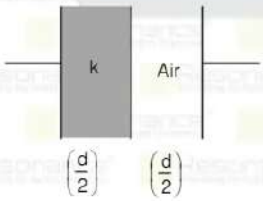
$$= \frac{mgR}{6}$$

16. A parallel plate capacitor has capacitance C. If a dielectric of dielectric constant k and width half of the spacing between the plates is inserted between the plates. Calculate the new capacitance of the capacitor:

(1) $\frac{2C(1+k)}{k}$ (2) $\frac{C(1+k)^2}{k}$ (3) $\frac{2Ck}{1+k}$ (4) $\frac{Ck^2}{1+k}$

Ans. **(3)**

Sol.



$C_1 = \frac{2\varepsilon_0 Ak_1}{d}$ $C_2 = \frac{2\varepsilon_0 Ak_2}{d}$

C_1 and C_2 are in series

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$= \frac{d}{2\varepsilon_0 Ak_1} + \frac{d}{2\varepsilon_0 Ak_2}$$

$$= \frac{d}{2\varepsilon_0 A}\left[\frac{1}{k_1} + \frac{1}{k_2}\right]$$

$$\frac{1}{C} = \frac{d}{2\varepsilon_0 A}\left[\frac{k_1 + k_2}{k_1 k_2}\right]$$

$$C_{eq} = \frac{\varepsilon_0 A}{d}\left(\frac{2kk_1}{k_1 + k_2}\right)$$

$$C_{eq} = C\left(\frac{2k_1k_2}{k_1 + k_2}\right)$$

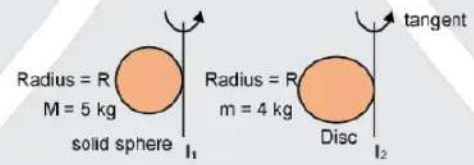
$k_1 = k$

$k_2 = 1$

$$C_{eq} = C\left(\frac{2k}{k+1}\right)$$

$$= \frac{2ck}{k+1}$$

17. Ratio of moment of inertia $\frac{I_1}{I_2}$ of tangential axis shown in figure will be :



(1) 7/5 (2) 2/5 (3) 9/5 (4) 3/2

Ans. **(1)**

Sol. $I_1 = \frac{2}{5}MR^2 + MR^2$ $I_2 = \frac{mR^2}{4} + mR^2$

$= \frac{7}{5}MR^2 = \frac{7}{5} \times 5R^2 = 7R^2$ $= \frac{5}{4}mR^2 = \frac{5}{4} \times 4R^2 = 5R^2$

$\frac{I_1}{I_2} = \frac{7R^2}{5R^2}$

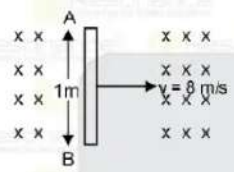
$\frac{I_1}{I_2} = \frac{7}{5}$

18. A metal rod of length 1 m is moving perpendicular to its length with 8 m/s velocity along +ve x axis. If a magnetic field B = 2T exist perpendicular to the plane of motion. Find the emf induced between end of rod.

(1) 8V (2) 12V (3) 16V (4) 20V

Ans. **(3)**

Sol.



$e = Bv\ell$

$= 2 \times 8 \times 1 = 16$ v

19. Image formed by plane mirror for an object placed parallel and in front of mirror.

(I) Real (II) Inverted laterally (III) Erect (IV) virtual

(1) I, III (2) III, IV (3) I, IV (4) II, III

Ans. **(2)**

20. A stationary nucleus breaks into two nuclei having velocities in ratio 3 : 2. Find the ratio of their radii

(1) $\left(\frac{2}{3}\right)^{\frac{1}{3}}$ (2) $\left(\frac{3}{2}\right)^{\frac{1}{3}}$ (3) $\left(\frac{5}{3}\right)^{\frac{1}{3}}$ (4) $\left(\frac{3}{5}\right)^{\frac{1}{3}}$

Ans. **(1)**

Sol. mv = const.

$m \propto \frac{1}{v}$

$\frac{m_1}{m_2} = \frac{v_2}{v_1} = \frac{2}{3}$

$m \propto A$

ρ = const. $m \propto v$ (volume)

$v \propto r^3$

$m \propto r^3$

$$\frac{m_1}{m_2} = \left(\frac{r_1}{r_2}\right)$$

$$\frac{r_1}{r_2} = \left(\frac{m_1}{m_2}\right)^{\frac{1}{3}} = \left(\frac{2}{3}\right)^{\frac{1}{3}}$$

21. Match the matrix :

(A) Faraday's law	(p)	$\oint \vec{B}.d\vec{A} = 0$
(B) Gauss's law of electrostatic	(q)	$\oint \vec{B}.d\vec{\ell} = \mu_0\left(i_c + \varepsilon_0\frac{d\phi_E}{dt}\right)$
(C) Gauss's law of magnetism	(r)	$\oint \vec{E}.d\vec{\ell} = -\frac{d\phi_m}{dt}$
(D) Ampere's Maxwell's law	(s)	$\oint \vec{E}.d\vec{A} = \frac{q_{in}}{\epsilon_0}$

(1) A – s, B – r, C – p, D – q
(2) A – r, B – q, C – p, D – s
(3) A – q, B – s, C – p, D – r
(4) A – r, B – s, C – p, D – q

Ans. **(4)**

Sol. A – r, B – s, C – p, D – q

22. A big drop is divided into 1000 identical droplets. If the big drop had surface energy μ_i and all small droplet together had a surface energy μ_f then μ_i/μ_f is equal to

(1) $\frac{1}{100}$ (2) 10 (3) $\frac{1}{10}$ (4) 1000

Ans. **(3)**

Sol.

$$n \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$$

$$1000 \times r^3 = R^3$$

$$r = R/10$$

$$\mu_i = T \times 4\pi R^2$$

$$\mu_f = n \times T \times 4\pi \times r^2$$

$$\frac{\mu_i}{\mu_f} = \frac{R^2}{r^2 n} = \frac{R^2 \times 100}{R^2 \times 1000} = \frac{1}{10}$$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