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JEE (Main)

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

2022

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 28 July, 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. Half-life of radioactive nucleus is 60 days. Find time taken to decay 7/8th of original nuclei

(1) 200 days (2) 100 days (3) 150 days (4) 180 days

Ans. **(4)**

Sol. $N = N_0\left(\frac{1}{2}\right)^n$

$\frac{1}{8} = \left(\frac{1}{2}\right)^n$

n = 3

$t = n.\ T_{1/2} = 3 \times 60$

t = 180 days

2. If radius of the earth shrinks by 2% then find percentage change in acceleration due to gravity :

(1) 1% (2) 2% (3) 3% (4) 4%

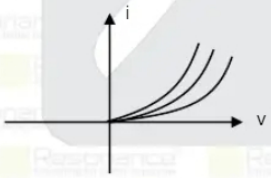
Ans. **(4)**

Sol. $g = \frac{Gm}{R^2}$

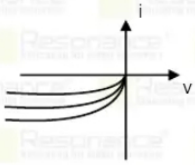
$G = Gm.\ R^{-2} = \frac{\Delta g}{g} \times 100 = -2 \times \frac{\Delta R}{R} \times 100$

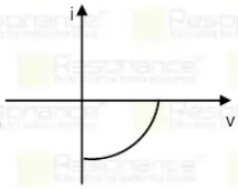
$= -2 \times (-2) = \frac{\Delta g}{g} \times 100 = 4\%$

3. The characteristic curve of solar cell will be :

(1) 

(2) 

(3) 

(4) 

Ans. **(4)**

Sol. $\Delta V = \varepsilon - ir$

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4. In amplitude modulation, the modulation index (μ) should be :

(1) $\mu = 1$ (2) $\mu < 1$ (3) $\mu > 1$ (4) $\mu \in (0, 2)$

Ans. **(2)**

Sol. To prevent distortion, $\mu < 1$

5. A wire having length ℓ and resistance R is stretched then its new length is 2ℓ and new resistance is R'. Then R/R' is

(1) 1 : 9 (2) 9 : 1 (3) 1 : 4 (4) 4 : 1

Ans. **(3)**

Sol. In case of stretching

$T \propto \ell^2$

$\frac{R}{R'} = \frac{\ell^2}{(2\ell)^2} = \frac{1}{4}$

6. Find dimensions of $\frac{B^2}{\mu_0}$ here B is magnetic field, μ_0 is permeability of free shape

(1) $ML^{-1}T^{-2}$ (2) $M^2L^{-1}T^{-2}$ (3) $ML^{-2}T^{-1}$ (4) MLT^{-1}

Ans. **(1)**

Sol. We know that energy density i.e. energy per unit volume is B^2

$2\mu_0$

So dimensions of $\frac{B^2}{\mu_0}$ is same as that of energy density

[Energy density] = $\frac{\text{Energy}}{\text{Volume}} = \frac{ML^2T^{-2}}{L^3} = [ML^{-1}T^{-2}]$

7. An astronomical telescope is in normal configuration for relaxed eyes. Its magnification power is 2 and the length of telescope tube is 30 cm, then the focal length of the eyepiece will be :

(1) 30 cm (2) 15 cm (3) 20 cm (4) 60 cm

Ans. **(1)**

Sol. M.P. = $f_0/f_e = 2$

$L = f_0 - f_e = 30$, solving $f_e = 30$, $f_0 = 60$ cm

8. A train is moving towards a mountain with a constant velocity of 36 km/hr and it is emitting a sound of original frequency of 660 Hz. If speed of sound is 330 m/sec, then find the frequency of the reflected sound :

(1) 600 Hz (2) 700 Hz (3) 800 Hz (4) 900 Hz

Ans. **(2)**

Sol. $\Delta f_b \approx f_0\left(\frac{2u}{v}\right) = (660)\left(\frac{2\times10}{330}\right) = 40\text{Hz}$

$F_r = 660 + 40 = 700$ Hz

9. An apple falls from a tree at a height 19.6 m above the ground. At the same instant a man starts running towards tree to catch the apple with speed 2.5 m/s. If the man successfully catches the apple just before it hits the ground, find initial distance of the man from tree. (neglect height of the man)

(1) 10 m (2) 15 m (3) 5 m (4) 20 m

Ans. **(3)**

Sol. Time taken by both will be same

So, $\sqrt{\frac{2\times19.6}{9.8}} = \frac{d}{5/2}$

$\Rightarrow \quad 2 = \frac{2d}{5} \quad \Rightarrow \quad d = 5\text{m}$

10. Choose the correct statements for the current sensitivity of a galvanometer

(A) If number of windings in the coil is increased, the current sensitivity will decrease

(B) If the magnetic field is increased, then the current sensitivity will increase

(C) If the area enclosed by the loop is increased, the current sensitivity will increase

(D) If the torsional stiffness is increased, the current sensitivity will also increase

(1) A and B (2) B and C (3) A and D (4) A, C and D

Ans. **(3)**

Sol. (NBA) i = Cθ

current sensitivity = $\frac{i}{\theta} = \frac{C}{NBA}$

11. A metallic rod of mass per unit length λ is lying horizontally on a smooth inclined plane which makes an angle of 45º with the horizontal. The rod is not allowed to slide down by flowing a current through it when a magnetic field of induction B is acting on it in the vertical direction. The minimum current flowing in the rod to keep it stationary is :

(1) $\frac{\lambda g}{B}$ (2) $\frac{\sqrt{2}\,\lambda g}{B}$ (3) $\frac{\lambda g}{\sqrt{2}\,B}$ (4) $\frac{2\lambda g}{B}$

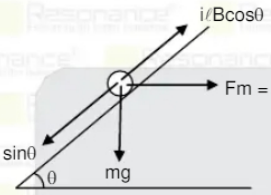
Ans. **(1)**

Sol. For equal

$i\ell B\cos\theta = mg\sin\theta$

$i\ell B\cos\theta = (\lambda\ell)g\sin\theta$

$i = \frac{\lambda g}{B}\tan\theta = \frac{\lambda g}{B}\tan 45^{\circ}$



12. There are two electric dipoles P_1 & P_2 kept in two different uniform electric fields E_1 & E_2 respectively find ratio of maximum torques acting on both dipoles it is given that $\frac{P_1}{P_2} = \frac{1}{2}$ & $\frac{E_1}{E_2} = \frac{1}{3}$

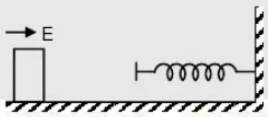
(1) $\frac{1}{3}$ (2) $\frac{1}{6}$ (3) $\frac{1}{8}$ (4) 4

Ans. **(2)**

Sol. $\tau_{max} = PE$

So $\frac{\tau_{m_1}}{\tau_{m_2}} = \frac{P_1}{P_2}\frac{E_1}{E_2} = \frac{1}{2}\times\frac{1}{3} = \frac{1}{6}$

13. Initial kinetic energy of the block is E. When compression in the spring is 25 cm & then its speed becomes half of initial speed. If spring constant of the spring is k = nE. Find value of n.



(1) 12 (2) 24 (3) 36 (4) 48

Ans. **(2)**

Sol. Final kinetic energy of the block is $\frac{E}{4}$ so according to conservation of mechanical energy loss in kinetic energy of block = gain in potential energy of spring.

$\Rightarrow \quad E - \frac{E}{4} = \frac{1}{2}K(.25)^2 \quad \Rightarrow \quad k = 24E$

14. If component of a vector $2\hat{i}+\hat{j}-\hat{k}$ along an another vector $\hat{i}+2\hat{j}+\alpha\hat{k}$ is zero, then the value of α will be

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

Ans. **(4)**

Sol. $\vec{A}\cdot\vec{B}$ = (2) (1) + (1) (2) + (α) (–1) = 0

α = 4

15. Be-Broglie wavelength of electrons is $\lambda = \frac{12.27}{x}$ Å. If

A = momentum of the electron in N. sec

B = kinetic energy of the electron in J

C = The potential difference by which the electron is acceleration

(1) A (2) B (3) $\sqrt{B}$ (4) $\sqrt{C}$

Ans. **(4)**

Sol. $\lambda_e = \frac{12.27}{\sqrt{v}}$ Å

16. Cross section area of solid cylindrical steel wire is A = 300 cm^2 and its Young's modulus is 2×10^{11} N/m^2. How much tension force is required so that the stretching in the wire becomes 2% ?

(1) 1.2×10^6 N (2) 1.2×10^7 N (3) 1.2×10^9 N (4) 1.2×10^8 N

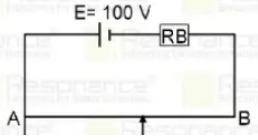
Ans. **(4)**

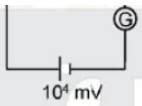
Sol. $\frac{F}{A} = (Y)\left(\frac{X}{\ell_0}\right)$

$F = yA\left(\frac{X}{\ell_0}\right) = (2 \times 10^{11})(300 \times 10^{-4})\left(\frac{2}{100}\right)$

$F = 1.2 \times 10^8$ N

17. In a potentiometer experiment length of potentiometer AB wire is 300 cm and its resistance is 30Ω. Find value of resistance in resistance box for which voltage 10^4 mV of secondary circuit will be balanced at 100 cm length of potentiometer wire :





(1) 70 Ω (2) 80 Ω (3) 90 Ω (4) 30 Ω

Ans. **(1)**

Sol. $V = x\ell$

$\Rightarrow$ 10^4 mV = x 100

$\Rightarrow$ $10^4 \times 10^{-3} = x\ 100$

$\Rightarrow$ $x = \frac{1}{10}$ v/cm

Now $x = \frac{V_{AB}}{L} \Rightarrow \frac{1}{10} = \frac{\frac{100}{A+30}.30}{300}$

$\Rightarrow$ $\frac{1}{10} = \frac{100\times30}{300(R+30)}$

$\Rightarrow$ R + 30 = 100

$\Rightarrow$ R = 70Ω

18. Efficiency of a Carnot engine is 50%. If the temperature of the sink is decreased by 40°C, keeping the temperature of the source constant, then its efficiency becomes 80%. Find the temperature of the source:

(1) $\frac{200}{3}$ K (2) $\frac{400}{3}$ K (3) 200 K (4) 400 K

Ans. **(2)**

Sol. $\eta = 1 - \frac{T_L}{T_H} = 0.5$

$\Rightarrow$ $1 - \frac{T_L - 40}{T_H} = 0.8$

Solving we will get $T_H = \frac{400}{3}$, $T_L = \frac{200}{3}$ K

19. In a pure inductive alternating circuit inductance of inductor is 30 mH. If current in inductor is i = 2 sin (100 πt – 30°) then voltage across inductor will be

(1) 20 sin (100 πt + 30°) (2) 18.84 sin (100 πt + 60°)

(3) 19.8 sin (100 πt – 60°) (4) 20.1 sin (100 πt – 30°)

Ans. **(2)**

Sol. $X_L = \omega L = 100\pi \times 30 \times 10^{-3}$

$= 3\pi\Omega$

So $v = iX_L = 2 \times 3\pi$

$= 6\pi = 18.84$ v

So, V = 18.84 sin (100πt – 30 + 90)

$\Rightarrow$ V = 18.84 sin(100πt + 60°)

20. Four rings, each of mass M and radius R are rigidly connected (welded) as shown in the figure. The total moment of inertia of the system about the axis OO', which is lying in the plane will be :

(1) $3mR^2$ (2) $4mR^2$ (3) $2mR^2$ (4) $8mR^2$

Ans. **(2)**

Sol. $I_{net} = \frac{mR^2}{2} + \frac{mR^2}{2} + \frac{3}{2}mR^2 + \frac{3}{2}mR^2$

$I_{net} = 4mR^2$

21. A balloon is ejecting the gases of density ρ with a relative velocity of $v_{rel.}$ from an orifice of cross-section area A. The thrust force acting on the balloon will be :

(1) $2\rho Av^2$ (2) $\rho Av^2/r$ (3) ρAv^2 (4) zero

Ans. **(3)**

Sol. $F_{th} = v_{rel}\, dm/dt$

$= (v_{rel})\ (\rho A v_{rel})$

$F_{th} = \rho A v_{rel}^2$

22. Two identical parallel plate capacitor, each of capacitance 40 μF are connected in series. A di–electric slab of di–electric constant k is filled completely between the plates of one of the capacitor, and now the equivalent capacitance becomes 24 μF. The value of k will be :

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

Ans. **(3)**

Sol. $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$

$\frac{1}{24} = \frac{1}{40k} + \frac{1}{40} \quad \Rightarrow \quad k = \frac{3}{2}$

23. The wave equation is given by $y(x, t) = 0.5 \sin \frac{2\pi}{\lambda} (400\, t - x)$, the wave speed will be

(1) 200 m/sec (2) 400 m/sec (3) $200\sqrt{2}$ m/sec (4) $400\sqrt{2}$ m/sec

Ans. **(2)**

Sol. $y(x, t) = 0.5 \sin \frac{2\pi}{\lambda} (vt - x) \Rightarrow v = 400$

24. An accident in a nuclear laboratory resulted in deposition of a certain amount of radioactive material of half-life 18 days inside the laboratory. Tests revealed that the radiation was 64 times more than the permissible level required for safe operation of the laboratory. What is the minimum number of days after which the laboratory can be considered safe for use ?

(1) 64 (2) 90 (3) 108 (4) 120

Ans. **(3)**

Sol. $A = A_0 2^{-t/T_H}$

$\Rightarrow \quad \frac{A_0}{64} = A_0 2^{-t/T_H}$

$\Rightarrow \quad 6 = \frac{t}{T_H}$

$\Rightarrow \quad t = 6T_H = 108$ days