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JEE (Main)

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

2023

COMPUTER BASED TEST (CBT)

Questions & Solutions

Date: 31 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. Match **List-I** with **List-II**

	List-I		List-II
A.	Angular momentum	I.	$[ML^2T^{-2}]$
B.	Torque	II.	$[ML^{-2}T^{-2}]$
C.	Stress	III.	$[ML^2T^{-1}]$
D.	Pressure gradient	IV.	$[ML^{-1}T^{-2}]$

Choose the correct answer from the options given below :

(1) A – IV, B – II, C- I, D- III (2) A – II, B – III, C- IV, D- I

(3) A – III, B – I, C- IV, D- II (4) A – I, B – IV, C- III, D- II

Ans. **(3)**

2. Under the same load, wire A having length 5.0 m and cross section 2.5×10^{-5} m^2 stretches uniformly by the same amount as another wire B of length 6.0 m and a cross section of 3.0×10^{-5} m^2 stretches. The ratio of the Young's modulus of wire A to that of wire B will be:

(1) 1 : 4 (2) 1 : 1 (3) 1 : 10 (4) 1 : 2

Ans. **(2)**

Sol. $Y_A = \dfrac{F \times L_A}{A_A \times \Delta L}$

$Y_B = \dfrac{F \times L_B}{A_B \times \Delta L}$ $\Delta L \rightarrow$ constant

$\dfrac{Y_A}{Y_B} = \dfrac{L_A \times A_B}{L_B \times A_A} = \dfrac{5 \times 3 \times 10^{-5}}{6 \times 2.5 \times 10^{-5}}$

$\dfrac{Y_A}{Y_B} = \dfrac{1}{1}$

3. An alternating voltage source V = 260 sin (628t) is connected across a pure inductor of 5 mH. Inductive reactance in the circuit is :

(1) 3.14 Ω (2) 6.28 Ω (3) 0.318 Ω (4) 0.5 Ω

Ans. **(1)**

Sol. $X_L = \omega L = 628 \times 5 \times 10^{-3} = 3140 \times 10–3$

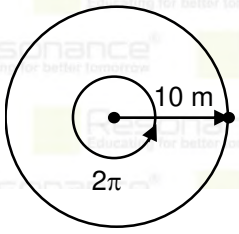
$X_L = 3.14\ \Omega$

4. A body is moving with constant speed, in a circle of radius 10 m. The body completes one revolution in 4 s. At the end of 3rd second, the displacement of body (in m) from its starting point is:

(1) 15π (2) $10\sqrt{2}$ (3) 30 (4) 5π

Ans. **(2)**

Sol.



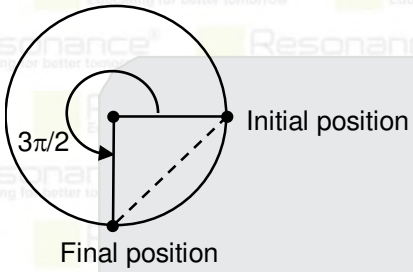
Completing 2π angle in 4 second

ω (Angular velocity) = $\frac{2\pi}{4} = \frac{\pi}{2}$

$\omega = \frac{\pi}{2}$ rad/sec.

Angular displacement = $\omega(t)$

Angular displacement in 3 sec. = $\left(\frac{\pi}{2}\right)(3) = \frac{3\pi}{2}$ rad.



Displacement = $R\sqrt{2}$ = 14m

5. Considering a group of positive charges, which of the following statements is correct?
(1) Net potential of the system cannot be zero at a point but net electric field can be zero at that point.
(2) Net potential of the system at a point can be zero but net electric field can't be zero at that point.
(3) Both the net potential and the net electric field cannot be zero at a point.
(4) Both the net potential and the net field can be zero at a point.

Ans. **(1)**

6. The H amount of thermal energy is developed by a resistor in 10 s when a current of 4A is passed through it. If the current is increased to 16A, the thermal energy developed by the resistor in 10 s will be:

(1) $\frac{H}{4}$ (2) H (3) 4H (4) 16 H

Ans. **(4)**

Sol. $H = i^2Rt = 16 \times R \times t$

$H^1 = 256 \times R \times t$

$\frac{H^1}{H} = 16 \Rightarrow H^1 = 16H$

7. For a solid rod, the Young's modulus of elasticity is 3.2×10^{11} Nm^{-2} and density is 8×10^3 kg m^{-3} The velocity of longitudinal wave in the rod will be.

(1) 3.65×10^3 ms^{-1} (2) 18.96×10^3 ms^{-1} (3) 145.75×10^3 ms^{-1} (4) 6.32×10^3 ms^{-1}

Ans. **(4)**

Sol. $V = \sqrt{\frac{Y}{\rho}}$ $Y \rightarrow$ young's modulus

$\rho \rightarrow$ Density

$V \rightarrow$ Velocity of wave

$V = \sqrt{\frac{3.2 \times 10^{11}}{8 \times 10^3}}$

$V = 6.32 \times 10^3$ m/s

8. A long conducting wire having a current I flowing through it, is bent into a circular coil of N turns. Then it is bent into a circular coil of n turns. The magnetic field is calculated at the centre of coils in both the cases. The ratio of the magnetic field in first case to that of second case is :

(1) n : N (2) N : n (3) $N^2 : n^2$ (4) $n^2 : N^2$

Ans. **(3)**

Sol. $B_1 = \frac{\mu_0 i \times N}{2R}$

$B_2 = \frac{\mu_0 i \times n}{2R'}$

But $(2\pi R)N = (2\pi R')n$

So, $R'/R = N/n$

$\frac{B_1}{B_2} = \left(\frac{N}{n}\right)^2$

9. The radius of electron's second stationary orbit in Bohr's atom is R. The radius of 3rd orbit will be :

(1) $\frac{R}{3}$ (2) 9R (3) 2.25R (4) 3R

Ans. **(3)**

Sol. $r_n = \frac{n^2 r_0}{Z}$ Z = 1 for hydrogen

for n = 2

$R = 2^2 r_0$

$r_0 = \frac{R}{4}$

for n = 3

$r_3 = 3^2 \times \frac{R}{4}$

$r_3 = \frac{9}{4}R$

$r_3 = 2.25\ R$

10. If the two metals A and B are exposed to radiation of wavelength 350 nm. The work functions of metals A and B are 4.8 eV and 2.2 eV. Then choose the correct option.

(1) Both metals A and B will emit photo-electrons

(2) Metal B will not emit photo-electrons

(3) Both metals A and B will not emit photo-electrons

(4) Metal A will not emit photo-electrons

Ans. **(4)**

Sol. For photo-emission

$h\nu > \phi$

E of photon $= \frac{12400}{350 \times 10^{-9}} = \frac{12400}{3500\ \text{Å}} = \frac{124}{35} = 3.54$ eV

for ϕ_1, $h\nu < \phi_1$ 3.54 eV < 4.8 eV

for ϕ_2, $h\nu > \phi_2$ 3.54 eV > 2.2 eV

So, second plate will be able to emit electron.

11. The number of turns of the coil of a moving coil galvanometer is increased in order to increase current sensitivity by 50%. The percentage change in voltage sensitivity of the galvanometer will be:

(1) 50% (2) 75% (3) 0% (4) 100%

Ans. **(3)**

Sol. As current sensitivity increased, deflection in current increased but there will not be any change in voltage.

12. Given below are two statements :

Statement I : For transmitting a signal, size of antenna (ℓ) should be comparable to wavelength of signal (at least $\ell = \frac{\lambda}{4}$ in dimension)

Statement II : In amplitude modulation, amplitude of carrier wave remains constant (unchanged).

In the light of the above statements, choose the most appropriate answer from the options given below.

(1) **Statement I** is correct but **Statement II** is incorrect

(2) Both **Statement I** and **Statement II** are incorrect

(3) Both **Statement I** and **Statement II** are correct

(4) **Statement I** is incorrect but **Statement II** is correct

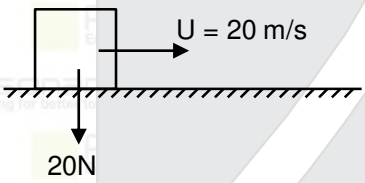
Ans. **(1)**

13. A body of mass 10 kg is moving with an initial speed of 20 m/s. The body stops after 5 s due to friction between body and the floor. The value of the coefficient of friction is: (Take acceleration due to gravity $g = 10\ ms^{-2}$)

(1) 0.2 (2) 0.4 (3) 0.5 (4) 0.3

Ans. **(2)**

Sol.



Friction force = $\mu N = \mu(20)$

(a) retardation = $\frac{20\mu}{2} = 10\mu$

$a = -10\mu$

$V_{final} = 0$

$U_{inifial} = 20$ m/s

time taken to stop = 5 sec.

$v = u + at$

$0 = 20 + (-10\mu)(5)$

$\Rightarrow \quad 50\mu = 20$

$\mu = \frac{20}{50} = \frac{2}{5} = 0.4$

14. Match **List-I** with **List-II**

	List-I		**List-II**
A.	Microwaves	I.	Physiotherapy
B.	UV rays	II.	Treatment of cancer
C.	Infra-red light	III.	Lasik eye surgery
D.	X-ray	IV.	Aircraft navigation

Choose the correct answer from the options given below :

(1) A – IV, B – I, C- II, D- III (2) A – II, B – IV, C- III, D- I

(3) A – IV, B – III, C- I, D- II (4) A – III, B – II, C- I, D- IV

Ans. **(3)**

15. Given below are two statements:

Statement I : In a typical transistor, all three regions emitter, base and collector have same doping level.

Statement II : In a transistor, collector is the thickest and base is the thinnest segment.

In the light of the above statements, choose the **most appropriate** answer from the options given below.

(1) Both **Statement I** and **Statement II** are incorrect

(2) **Statement I** is correct but **Statement II** is incorrect

(3) Both **Statement I** and **Statement II** are correct

(4) **Statement I** is incorrect but **Statement II** is correct

Ans. **(4)**

16. Heat energy of 735 J is given to a diatomic gas allowing the gas to expand at constant pressure. Each gas molecule rotates around an internal axis but do not oscillate. The increase in the internal energy of the gas will be:

(1) 572 J (2) 735 J (3) 441 J (4) 525 J

Ans. **(4)**

Sol. For isobaric process

$\Delta\theta = nC_P\Delta T$

$$\Delta\theta = n\frac{7}{2}R\Delta T \quad \Rightarrow nR\Delta T = \frac{2}{7}\Delta\theta$$

now change in internal energy

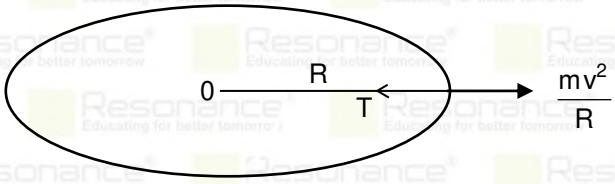
$$\Delta U = \frac{5}{2}nR\Delta T \quad \Rightarrow \Delta U = \frac{5}{2}\times\frac{2}{7}\Delta\theta \Rightarrow \quad \frac{5}{7}\Delta\theta = \frac{5}{7}\times 735 \ = 525 \text{ J}$$

17. A stone of mass 1 kg is tied to end of a massless string of length 1 m. If the breaking tension of the string is 400 N, then maximum linear velocity, the stone can have without breaking the string, while rotating in horizontal plane, is:

(1) 40 ms^{-1} (2) 20 ms^{-1} (3) 400 ms^{-1} (4) 10 ms^{-1}

Ans. **(2)**

Sol.



$$T = \frac{MV^2}{R}$$

$$400 = \frac{1\times V^2}{1}$$

$V = 20$ m/s

18. A body weight W, is projected vertically upwards from earth's surface to reach a height above the earth which is equal to nine times the radius of earth. The weight of the body at that height will be:

(1) $\frac{W}{100}$ (2) $\frac{W}{3}$ (3) $\frac{W}{91}$ (4) $\frac{W}{9}$

Ans. **(1)**

Sol.

$$W = \frac{Gm_e}{R_e^2} \times m$$

$$W' = \frac{Gm_e}{(9R_e + R_e)^2} \times m = \frac{Gm_e}{(10R_e)^2} \times m$$

$$W' = \frac{Gm_e}{100R_e} \times m \Rightarrow \quad W' = \frac{1}{100} \times W$$

19. A microscope is focused on an object at the bottom of a bucket. If liquid with refractive index $\frac{5}{3}$ is poured inside the bucket, then microscope have to be raised by 30 cm to focus the object again. The height of the liquid in the bucket is :

(1) 12 cm (2) 18 cm (3) 50 cm (4) 75 cm

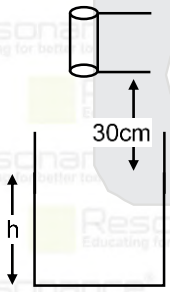
Ans. **(4)**

Sol. $d = h\left(1 - \frac{1}{\mu}\right)$

$$30 = h\left(1 - \frac{3}{5}\right)$$

$$30 = h \times \frac{2}{5}$$

$\therefore$ h = 75 cm



20. A hypothetical gas expands adiabatically such that its volume changes from 08 litres to 27 litres. If the ratio of final pressure of the gas to initial pressure of the gas is $\frac{16}{81}$. Then the ratio of $\frac{Cp}{Cv}$ will be.

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

Ans. **(4)**

Sol. We know $\frac{C_P}{C_V} = \gamma$

and for an adiabatic process $P_1V_1^{\gamma} = P_2V_2^{\gamma}$

$$\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^{\gamma}$$

$$\frac{81}{16} = \left(\frac{27}{8}\right)^{\gamma}$$

$$\left(\frac{3}{2}\right)^4 = \left(\frac{3}{2}\right)^{3\gamma}$$

comparing power index

$4 = 3\gamma$

$\gamma = 4/3$

21. Two light waves of wavelengths 800 and 600 nm are used in Young's double slit experiment to obtain interference fringes on a screen placed 7 m away from plane of slits. If the two slits are separated by 0.35 mm, then shortest distance from the central bright maximum to the point where the bright fringes of the two wavelength coincide will be_____mm.

Ans. **48.00**

Sol. D = 7m

$d = 0.35 \times 10^{-3}$ m

$\lambda_1 = 800 \times 10^{-9}$ m

$\lambda_1 = 600 \times 10^{-9}$ m

Let Y be the common distance of the bright fringes by the both wavelength

$$Y = \frac{n_1\lambda_1 D}{d} = \frac{n_2\lambda_2 D}{d}$$

$n_1\lambda_1 = n_2\lambda_2$

$n_1 = 800 \times 10^{-9}$ m $= n_2\ 600 \times 10^{-9}$

$4n_1 = 3n_2$

for 4 to be minimum and n are integer

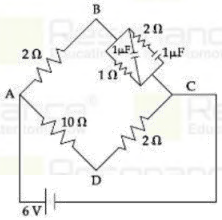
$n_1 = 3, n_2 = 4$

$$Y = \frac{n_1\lambda_1 D}{d}$$

$$Y = \frac{3\times800\times10^{-9}\times7}{0.35\times10^{-3}}$$

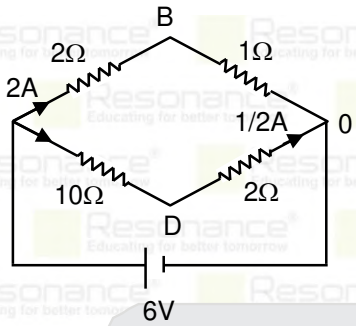
Y = 48 mm

22. For the given circuit, in the steady state, $|V_B - V_D|$=_____ V.



Ans. **1**

Sol. After a long time



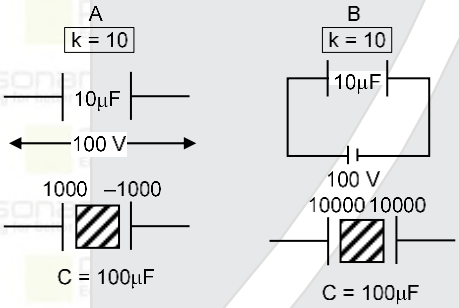
KVL :

$V_B - 2 \times 1 + 2 \times 1/2 = V_D \qquad \Rightarrow V_B - V_D = 1V$

23. Two parallel plate capacitors C_1 and C_2 each having capacitance of 10 μF are individually charged by a 100 V D.C. source. Capacitor C_1 is kept connected to the source and a dielectric slab is inserted between it plates. Capacitor C_2 is disconnected from the source and then a dielectric slab is inserted in it. Afterwards the capacitor C_1 is also disconnected from the source and the two capacitors are finally connected in parallel combination. The common potential of the combination will be_____V. (Assuming Dielectric constant=10)

Ans. **55**

Sol.

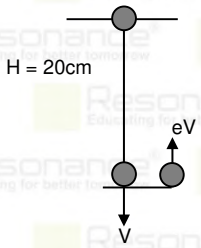


$$V = \frac{1000 + 10000}{100 + 100} = \frac{11000}{200} = 55\ V$$

24. A ball is dropped from a height of 20 m. If the coefficient of restitution for the collision between ball and floor is 0.5, after hitting the floor, the ball rebounds to a height of_____m.

Ans. **5**

Sol.



$V = \sqrt{2gH} \qquad ...(1)$

$$H_{max} = \frac{e^2v^2}{2g} \quad ...(2)$$

from equation (1) and (2)

$$H_{mass} = \frac{e^2(2gH)}{2g}$$

$$H_{max} = \frac{1}{4} \times 20 = 5m$$

25. A series LCR circuit consists of R=80Ω, X_L=100 Ω, and X_C=40 Ω. The input voltage is 2500 cos(100 πt)V. The amplitude of current, in the circuit, is_____ A.

Ans. **25**

Sol. $V_0 = I_0Z$

$$I_0 = \frac{V_0}{Z} \qquad \left[Z = \sqrt{R^2 + (X_L - X_C)^2}\right]$$

$$I_0 = \frac{2500}{\sqrt{(80)^2 + (100-40)^2}} = \frac{2500}{\sqrt{80^2 + 60^2}} = \frac{2500}{100} = 25\ A$$

26. Two discs of same mass and different radii are made of different materials such that their thicknesses are 1 cm and 0.5 cm respectively. The densities of materials are in the ratio 3:5. The moment of inertia of these discs respectively about their diameters will be in the ratio of $\frac{x}{6}$. The value of x is_____.

Ans. **5**

Sol. $m_1 = m_2$

$$\pi R_1^2 \times t_1 \times \rho_1 = \pi R_2^2 \times t_2 \times \rho_2$$

$$\frac{R_1^2}{R_2^2} = \frac{25}{30}$$

$$\frac{I_1}{I_2} = \frac{\frac{mR_1^2}{4}}{\frac{mR_2^2}{4}} = \frac{R_1^2}{R_2^2} = \frac{25}{30} = \frac{5}{6}$$

27. The displacement equations of two interfering waves are given by

$y_1 = 10\sin\left(\omega t + \frac{\pi}{3}\right)$cm, $_{1/2} = 5\ [\sin\omega t + \sqrt{3}\cos\omega t]$ cm respectively.

The amplitude of the resultant wave is_____cm.

Ans. **20**

Sol. $y_1 = 10\sin\left(\omega t + \frac{\pi}{3}\right)$

$$y_2 = 5 \times 2\left(\frac{\sqrt{3}}{2}\cos\omega t + \frac{1}{2}\sin\omega t\right) = 10\sin\left(\omega t + \frac{\pi}{3}\right)$$

$$y_{net} = y_1 + y_2 = 20\sin\left(\omega t + \frac{\pi}{3}\right)$$

28. If the binding energy of ground state electron in a hydrogen atom is 13.6 eV, then, the energy required to remove the electron from the second excited state of Li^{2+} will be : $x \times 10^{-1}$ eV. The value of x is_____.

Ans. **136**

Sol. $E = 13.6 \times z^2/n^2$ eV [n = 3 ; z = 3]

$E_{Li} = 13.6 \times (3)^2/(3)^2$

$E_{Li} = 13.6$ eV $= 136 \times 10^{-1}$ eV

29. A water heater of power 2000 W is used to heat water. The specific heat capacity of water is 4200 J kg^{-1} K^{-1}. The efficiency of heater is 70%. Time required to heat 2 kg of water from 10°C to 60°C is_____S. (Assume that the specific heat capacity of water remains constant over the temperature range of the water).

Ans. **300**

Sol. Power of heater = 2000W

heat required = $ms\Delta T$

$= 2 \times 4200 \times (60 - 10) = 420000$ J

efficiency of power is 70%

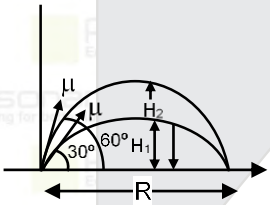
$$70\% \text{ of power} = \frac{70}{100} \times 2000 = 1400\text{W}$$

$$\text{Time taken} = \frac{\text{heat}}{\text{power}} = \frac{420000}{1400} = 300 \text{ S}$$

30. Two bodies are projected from ground with same speeds 40 ms^{-1} at two different angles with respect to horizontal. The bodies were found to have same range. If one of the body was projected at an angle of 60°, with horizontal then sum of the maximum heights, attained by the two projectiles, is m. (Given g = 10 ms^{-2})

Ans. **80**

Sol.



$$H_1 = \frac{u^2 \sin^2(30)}{2g}, \qquad H_2 = \frac{u^2 \sin^2 60^\circ}{2g}$$

$$H_1 = \frac{u^2}{8g}, \qquad H_1 = \frac{3u^2}{8g} \qquad \therefore H_1 + H_2 = \frac{4u^2}{8g} = 80 \text{ m}$$

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