

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



## COMPUTER BASED TEST (CBT) Questions & Solutions

Date: 02 September, 2020 (SHIFT-2) | TIME : (03.00 p.m. to 06.00 p.m)

## Duration: 3 Hours | Max. Marks: 300 SUBJECT : PHYSICS



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### PART : PHYSICS

#### Single Choice Type (एकल विकल्पीय प्रकार)

This section contains 20 Single choice questions. Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which Only One is correct.

इस खण्ड में 20 एकल विकल्पी प्रश्न हैं। प्रत्येक प्रश्न के 4 विकल्प (1), (2), (3) तथा (4) हैं, जिनमें से सिर्फ एक सही है।

1. Two uniform circular discs are rotating independently in the same direction around their common axis passing through their centres. The moment of inertia and angular velocity of the first disc are 0.1 kg-m<sup>2</sup> and 10 rad s<sup>-1</sup> respectively while those for the second one are 0.2 kg-m<sup>2</sup> and 5 rad s<sup>-1</sup> respectively. At some instant they get stuck together and start rotating as a single system about their common axis with some angular speed. The kinetic energy of the combined system is

$$= \frac{1}{2}(0.1+0.2) \times \left(\frac{20}{3}\right)^2 \implies k_f = \frac{20}{3}$$

When the temperature of metal wire is increased from 0°C to 10°C, its length increases by 0.02%. The 2. percentage change in its mass density will be closed to :

(1) 0.8	(2) 0.008	(3) 2.3	(4) 0.06
(4)			

Ans. Sol.  $\Delta \ell = \ell \alpha \Delta t$ 

Ans Sol.

$$\begin{aligned} \alpha &= \frac{\Delta \ell}{\ell \Delta T} = \frac{0.02}{100 \times 10}; & \alpha = 2 \times 10^{-5} \\ \gamma &= 3\alpha = 6 \times 10^{-5} \\ \frac{\Delta V}{V} &= \gamma \times \Delta T; & \frac{\Delta V}{V} \times 100 = (6 \times 10^{-5} \times 10 \times 100) = 6 \times 10^{-2} \end{aligned}$$

Volume increase by 0.06% therefore density decrease by 0.06%.

A capillary tube made of glass of radius 0.15 mm is dipped vertically in a beaker filled with methylene 3. iodide (surface tension = 0.05 Nm<sup>-1</sup>, density = 667 kg m<sup>-3</sup>) which rises to height h in the tube. It is observed that the two tangents drawn from observed that the two tangents drawn from liquid-glass interfaces (from opp. sides of the capillary) make an angle of  $60^{\circ}$  with one another. Then h is close to (g = 10 ms<sup>-2</sup>) (4) 0.049 m (1) 0.087 m (2) 0.137 m (3) 0.172 m (1)

Ans.

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**4.** The figure shows a region of length  $\ell'$  with a uniform magnetic field of 0.3 T in it and a proton entering the region with velocity  $4 \times 10^5$  ms<sup>-1</sup> making an angle 60° with the field. If the proton completes 10 revolution by the time it cross the region shown,  $\ell'$  is close to (mass of proton =  $1.67 \times 10^{-27}$  kg , charge of the proton =  $1.6 \times 10^{-19}$  C)





II<sup>nd</sup> case when  $Q_4$  is Positive W  $Q_4 + Q_2 + Q_2 + Q_4$ 

$$\frac{W}{EQ_{+}} = \frac{\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4}{Q_1 + Q_3 + Q_4} = 0.5$$

#### Q<sub>4</sub> = -1960

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**6.** In a hydrogen atom the electron makes a transition from  $(n + 1)^{th}$  level to the n<sup>th</sup> level. If n >> 1, the frequency of radiation emitted is proportional to :

(1) 
$$\frac{1}{n^4}$$
 (2)  $\frac{1}{n}$  (3)  $\frac{1}{n^3}$  (4)  $\frac{1}{n^2}$   
Ans. (3)  
Sol.  $E_n = -\frac{Rhc}{n^2}$   
 $E_{n+1} = -\frac{Rhc}{(n+1)^2}$   
 $\Delta E = E_{n+1} - E_n$   
 $h_v = Rhc \left[ \frac{1}{n^2} - \frac{1}{(n+1)^2} \right]$   
 $v = Rc \left[ \frac{(n+1)^2 - n^2}{n^2(n+1)^2} \right]$   
 $v = Rc \left[ \frac{1+2n}{n^2(n+1)^2} \right]$   
 $n >> 1 \Rightarrow v = R.c \left[ \frac{2n}{n^2 \times n^2} \right] = \frac{2RC}{n^3}$   
 $v \propto \frac{1}{n^3}$ 

7. In a Young's double slit experiment, 16 fringes are observed in a certain segment of the screen when light of wavelength 700 nm is used. If the wavelength of light is changed to 400 nm, the number of fringes observed in the same segment of the screen would be :

(1) 24  
(2) 18  
(3) 28  
(4) 30  
Sol. 
$$y = \frac{m_1 D \lambda_1}{d} = \frac{m D \lambda_2}{d}$$

$$\frac{m_2}{m_1} = \frac{\lambda_1}{\lambda_2} \Longrightarrow m_2 = \frac{700}{400} \times 16 = 28$$

8. A potentiometer wire PQ of 1m length is connected to a standard cell E<sub>1</sub>. Another cell E<sub>2</sub> of emf 1.02 V is connected with a resistance 'r' and switch S (as shown in figure). With switch S open, the null position is obtained at a distance of 49 cm from Q. The potential gradient in the potentiometer wire is :



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Sol.  $X = V/\ell$ 

 $x = \frac{1.02}{49}$ 

= 0.02 volt/cm

**9.** The displacement time graph of a particle executing SHM is given in figure : (sketch is schematic and not to scale)



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**13.** In plane electromagnetic wave, the directions of electric field and magnetic field are represented by  $\hat{k}$  and  $2\hat{i}-2\hat{j}$ , respectively. What is the unit vector along direction of propagation of the wave.

(1) 
$$\frac{1}{\sqrt{2}}(\hat{j}+\hat{k})$$
 (2  $\frac{1}{\sqrt{5}}(\hat{i}+2\hat{j})$  (3)  $\frac{1}{\sqrt{5}}(2\hat{i}+\hat{j})$  (4)  $\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$ 

Ans. (4)

$$\hat{E} \times \hat{B} = \frac{1}{\sqrt{2}} \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 1 \\ 1 & -1 & 0 \end{vmatrix} = \frac{\hat{i} + \hat{j}}{\sqrt{2}} \implies \hat{C} = \frac{\hat{i} + \hat{j}}{\sqrt{2}}$$

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Net acceleration of particle is constant, initial velocity is zero therefore path is straight line.



**15.** An ideal gas in a closed container is slowly heated. As its temperature increases, which of the following statements are true ?

(3) (B) and (C)

(4) (C) and (D)

- (A) the mean free path of the molecules decreases
- (B) the mean collision time between the molecules decreases.
- (C) the mean free path remains unchanged.
- (D) the mean collision time relations unchanged.
- (1) (A) and (D) (2) (A) and (B)
- Ans.

(3)

Sol. As we know mean free path

$$\lambda = \frac{1}{\sqrt{2} \left(\frac{N}{V}\right) \pi d^2}$$

N = no. of molecule

V = volume of container

d = diameter of molecule

Velocity constant and no. of molecules are same.

So mean free path remains same.

As temperature increases no. of collision increases so relaxation time decrease.

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**16.** A carrying current I is bent in the shape ABCDEFA as shown, where rectangle ABCEA and ADEFA are perpendicular to each other. If the sides of the rectangles are of lengths a and b, then the magnitude and direction of magnetic moment of the loop ABCDEFA is :



**17.** A particle is moving 5 times as fast as an electron. The ratio of the de-Broglie wavelength of the particle to that of the electron is  $1.878 \times 10^{-4}$ . The mass of the particle is close to : (1)  $1.2 \times 10^{-28}$  kg (2)  $9.7 \times 10^{-28}$  kg (3)  $9.1 \times 10^{-31}$  kg (4)  $4.8 \times 10^{-27}$  kg

Sol.  $\lambda = \frac{h}{mv}$   $\Rightarrow \qquad \frac{m'}{m} = \frac{v\lambda}{v'\lambda'} = \frac{1}{5} \times \frac{1}{1.878} \times 10^{-4} \times 9.1 \times 10^{-31}$  $m' = 9.7 \times 10^{-28} \text{ kg}$ 

**18.** The height 'h' at which the weight of a body will be the same as that at the same depth 'h' from the surface of the earth is (Radius of the earth is R and effect of the rotation of the earth is neglected)

(1) R/2 (2) 
$$\frac{\sqrt{5}R - R}{2}$$
 (3)  $\frac{\sqrt{5}}{2}R - R$  (4)  $\frac{\sqrt{3}R - R}{2}$ 

Ans. (2)

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Sol. \_

 $\frac{GM}{(R+h)^2} = \frac{GM}{R^3}(R-h)$   $R^3 = (R+h)^2 (R-h)$   $= (R^2 + h^2 + 2hR) (R-h)$   $R^3 = R^3 + h^2R + 2hR^2 - R^2h - h^3 - 2h^2R$   $h^3 + h^2 (2R - R) - R^2h = 0$   $h^3 + h^2R - R^2h = 0$   $h^2 + hR - R^2 = 0$   $h = \frac{-R \pm \sqrt{R^2 + 4(1)R^2}}{2}$   $= \frac{-R \pm \sqrt{5R}}{2}$   $= \frac{(\sqrt{5} - 1)}{2}R$ 

**19.** A 10μF capacitor is fully to a potential difference of 50VAfter removing the source voltage it is connected to an uncharged capacitor in parallel. Now the potential difference across them becomes 20 V. The capacitance of the second capacitor is :

	(1) 10μF	(2) 20µF	(3) 30µF	(4) 15μF
Ans.	(4)			
Sol.	$V = \frac{C_1 V_1 + C_2 V_2}{C_1 + C_2}$			
	$20 = \frac{10 \times 50 + 0}{20 + C}$			
	C = 15μF			
20				- ( (

An inductance coil has a reactance of 100Ω. When an AC signal of frequency 1000 Hz is applied to the coil, the applied voltage leads the current by 45°. The self-inductance of the coil is :
 (1) 5.5 × 10<sup>-5</sup> H
 (2) 1.1 × 10<sup>-2</sup> H
 (3) 6.7 × 10<sup>-7</sup> H
 (4) 1.1 × 10<sup>-1</sup> H

Ans. (2)  
Sol. 
$$\tan \theta = \frac{x_L}{R} = \tan 45^\circ$$
  
 $x_L = R$   
 $= 100 = \sqrt{x_L^2 + R^2}$   
 $100 = \sqrt{R^2 + R^2}$   
 $\sqrt{2}R = 100$   
 $R = 50\sqrt{2}$   
 $\therefore X_L = 50\sqrt{2}$   
 $L_{\omega} = 50\sqrt{2}$   
 $L = \frac{50\sqrt{2}}{2\pi \times 1000} = \frac{25\sqrt{2}}{\pi}$  mH.  
 $= 1.1 \times 10^{-2}$  H

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#### Numerical Value Type (संख्यात्मक प्रकार) This section contains 5 Numerical value type questions. इस खण्ड में 5 सख्यात्मक प्रकार के प्रश्न हैं।

21. A particle of mass m is moving along the x-axis with initial velocity  $u\hat{i}$ . It collides elastically with a particle of mass 10m at rest and then moves with half its initial kinetic energy (see figure). If  $\sin \theta_1 = \sqrt{n} \sin \theta_2$  then value of n is \_\_\_\_\_.



#### Ans. 10.00

Sol. From momentum conservation in perpendicular direction of initial motion.

.....(1)

Given that 
$$\left(\frac{1}{2}mu^2\right)\frac{1}{2} = \frac{1}{2}mv_1^2$$
 .....(2)  
From equation (1) & (2)

 $\sin \theta_1 = \sqrt{10} \sin \theta_2$ 

 $mv_1 \sin \theta_1 = 10 mv_2 \sin \theta_2$ 

**22.** A wire of density  $9 \times 10^{-3}$  kg cm<sup>-3</sup> is stretched between two clamps 1 m apart. The resulting strain in the wire is  $4.9 \times 10^{-4}$ . The lowest frequency of the transverse vibrations in the wire (Young's modulus of wire  $Y = 9 \times 10^{10}$  Nm<sup>-2</sup>), (to the nearest integer),\_\_\_\_\_

#### Ans. 35.00

Sol. Fundamental frequency in the string

$$f = \frac{1}{2\ell} \sqrt{\frac{T}{\mu}} = \frac{1}{2\ell} \sqrt{\frac{T}{\rho A}} = \frac{1}{2\ell} \frac{\sqrt{Y \Delta \ell}}{\rho \ell}$$
$$f = \frac{1}{2\ell} \sqrt{\frac{Y \Delta \ell}{\rho \ell}} \qquad (\frac{\Delta \ell}{\ell} = 4.9 \times 10^{-4})$$
$$= \frac{1}{2\ell} \sqrt{\frac{9 \times 10^{10} \times 4.9 \times 10^{-4}}{\rho \ell}} = 35.$$

$$=\frac{1}{2}\sqrt{\frac{9\times10^{-3}\times10^{-6}}{9\times10^{-3}\times10^{-6}}}$$

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A light ray enters a solid glass sphere of refractive index m =  $\mu = \sqrt{3}$  at an angle of incidence 60°. The 24. ray is both reflected and refracted at the farther surface of the sphere. The angle (in degrees) between the reflected and refracted rays at this surface is \_\_\_\_\_

Ans. 90.00

x = 23

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**25.** An ideal cell of emf 10V is connected in circuit shown in figure. Each resistance is 2Ω. The potential difference (in V) across the capacitor when it is fully charged is \_\_\_\_\_\_



Ans. 08.00

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