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CBSE Board
Class XI Physics
Sample Paper - 4

Q1. A man is standing on a rough $(\mu = 0.5)$ horizontal disc rotating with constant angular velocity of 5 rad/sec. At what distance from centre should he stand so that he does not slip on the disc?

(a) R ≤ 0.2 m
(b) R > 0.2 m
(c) R > 0.5 m
(d) R > 0.3 m

Sol. (a)

$\mu mg = m\, R_{max}\, w^2$

$5 = R_{max}\, 25$

$R \leq 0.2\, m$

Q2. A body of mass m accelerates uniformly from rest to a speed V_0 in time t_0. The work done on the body till any time t is

(a) $\frac{1}{2}\, mv_0^2\, \left(\frac{t^2}{t_0^2}\right)$
(b) $\frac{1}{2} mv_0^2\, \left(\frac{t_0}{t}\right)$
(c) $mv_0^2 \left(\frac{t}{t_0}\right)$
(d) $mv_0^2 \left(\frac{t}{t_0}\right)^3$

Sol. (a)

$v_0 = 0 + at_0$

$a = \frac{v_0}{t_0}$

$v = 0\, \left(\frac{v_0}{t_0}\right) t$

$w = DKE = \frac{1}{2}\, mv^2$

$w = \frac{1}{2} mv_0^2\, \left(\frac{t^2}{t_0^2}\right)$

Q3. $F = 2x^2 - 3x - 2$. Choose correct option

(a) $x = -1/2$ is position of stable equilibrium
(b) $x = 2$ is position of stable equilibrium
(c) $x = -1/2$ is position of unstable equilibrium
(d) $x = 2$ is position of neutral equilibrium

Sol. (a)

$F = 2x^2 - 3x - 2 = 0$ for equilibrium

$at = x - \frac{1}{2}$, stable equilibrium

Q4. The weight of an empty balloon on a spring balance is w_1. The weight becomes w_2 when the balloon is filled with air. Let the weight of the air itself be w. Neglect the thickness of the balloon when it is filled with air. Also neglect the difference in the densities of air inside and outside the balloon

(a) $w_2 = w_1$
(b) $w_2 = w_1 + w$
(c) $w_2 > w_1 + w$
(d) $w_2 > w_1$

Sol. (a)

Weight of air = force of buoyance

Q5. Two rain drops of radii r_1 and r_2 reaching the ground with terminal velocities have their linear moment p and 32p. The ratio r_2/r_1 will be

(a) 2 : 1
(b) 1 : 2
(c) 2 : 3
(d) 3 : 2

Sol. (a)

Weight of sphere = weight of mercury displaced + weight of oil displaced

Or $V_{\rho g} = \frac{V}{2} \times 13.6g + \frac{V}{2} \times 0.8 \times g$

Or $\rho = \frac{13.6+0.8}{2} = 7.2\ gcm^{-3}$

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Q6. If E, M, J and G denote energy, mass, angular momentum and gravitational constant then $\frac{EJ^2}{M^5G^2}$ has the dimensions of –

(a) Length
(b) Angle
(c) Mass
(d) Time

Sol. (b)

$$\frac{ML^2T^{-2}\left(M\,LT^{-1}L\right)^2}{M^5(M^{-1}L^3T^{-2})^2} = M^0L^0T^0$$

Q7. The velocity of a moving particle depends upon time t as $v = at + \frac{b}{t+c}$. The dimensional formula for b is –

(a) $[M^0L^0T^0]$
(b) $[M^0L^1T^0]$
(c) $[M^0L^1T^{-1}]$
(d) $[M^0L^1T^{-1}]$

Sol. (b)

$$\left[\frac{b}{t}\right] = [v]$$

$$[v] = LT^{-1}.T = L$$

Q8. The ratio of maximum to minimum intensity due to superposition of two waves is $\frac{49}{9}$. Then the ratio of the intensity of component waves is

(a) $\frac{25}{4}$
(b) $\frac{16}{25}$
(c) $\frac{4}{49}$
(d) $\frac{9}{49}$

Sol. (a)

$$\left[\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right]^2 = \frac{49}{9}; \frac{I_1}{I_2} = \frac{25}{4}]$$

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Q9. The frequency changes by 10% as a sound source approaches a stationary observed with constant speed v_s. What would be the percentage change in frequency as the source recedes the observer with the same speed. Given that $v_s < v$. (v = speed of sound in air)

(a) 14.3%
(b) 20%
(c) 10.0%
(d) 8.5%

Sol. (d)

$$1.1\, f_0 = f_0 \left[\frac{v}{v-v_s}\right] \; and \; f = f_0 \left[\frac{v}{v+v_s}\right] \;]$$

Q10. Two point masses of mass 4m and m respectively separated by d distance are revolving under mutual force of attraction. Ration of their kinetic energies will be:

(a) 1 : 4
(b) 1 : 5
(c) 1 : 1
(d) 1 : 2

Sol. (a)

They will revalue about this centre of mass

Position of centre of mass

$$0 = 4\, m\, (-x) + m\, (d - x)$$

$$x = \frac{d}{5}$$

They will same ω

$$\frac{K_{4m}}{K_m} = \frac{\frac{1}{2} I_{4m}\omega^2}{\frac{1}{2} I_m \omega^2} \quad \Rightarrow \quad \frac{K_{4m}}{K_m} = \frac{I_{4m}}{I_m}$$

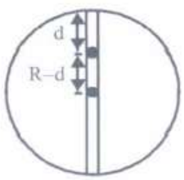
$$\frac{K_{4m}}{K_m} = \frac{\frac{1}{2}(4m)\left(\frac{d}{5}\right)^2}{\frac{1}{2}(m)\left(\frac{4d}{5}\right)^2} \quad \Rightarrow \quad \frac{K_{4m}}{K_m} = \frac{1}{4}$$

Q11. If a tunnel is cut at any orientation through earth, then a ball released from one end will reach the other end in time (neglect earth rotation)

(a) 84.6 minutes
(b) 42.3 minutes
(c) 8 minutes
(d) Depends on orientation.

Sol. (b)

$g_d = g\left(1 - \frac{d}{R}\right) \quad \Rightarrow \quad g_d = \frac{g}{R}(R-d) \quad \Rightarrow g_d = \frac{g}{R} \times$



$F_R = -mg_d \quad \Rightarrow \quad F_R = -\frac{mg}{R} \times$

$T = 2\pi\sqrt{\frac{mR}{mg}} \quad \Rightarrow \quad T = 2\pi\sqrt{\frac{R}{g}} \quad T = 84.6\ min$

$t = \frac{T}{2} \quad \Rightarrow \quad t = 42.3\ min$

Q12. The density of material A is 1500 kg/m^3 and that of another material B is 2000 kg/m^3. It is found that the heat capacity of 8 volumes of A is equal to heat capacity of 12 volumes of B. The ratio of specific heats of A and B will be

(a) 1 : 2
(b) 3 : 1
(c) 3 : 2
(d) 2 : 1

Sol. (d)

$1500 \times 8 \times S_A = 2000 \times 12 \times S_B$

$\Rightarrow \frac{S_A}{S_B} = \frac{2}{1}$

Q13. In a wire of young's modulus Y, the longitudinal strain produced is α then the strain energy per unit volume stored in the wire will be

(a) $Y\,\alpha^2$
(b) $2\,Y\,\alpha^2$

(c) $Y\alpha^2/2$
(d) $Y^2\alpha/2$

Sol. (c)

Energy density

$= \frac{1}{2}(Y\alpha)(\alpha) = \frac{Y\alpha^2}{2}$

Q14. A block of ice of mass 50 kg in pushed out on a horizontal plane with a velocity of 5 m/s. Due to friction it comes to rest after covering a distance of 25 metre. How much ice will milt? (assume complete heat is given to ice)

(a) 0.86 gm
(b) 1.86 gm
(c) 35 gm
(d) 10 gm

Sol. (b)

$m \times 80 = \frac{\frac{1}{2}\times 50\times(5)^2}{4.2}$

$\Rightarrow m = 1.86\ gm$

Q15. If for a particle moving is a SHM, there is a sudden increases of 1% in restoring force just as particle passing through mean position, percentage change in amplitude will be

(a) 1%
(b) 2%
(c) 0.5%
(d) Zero

Sol. (c)

Restoring force is independent of amplitude

Q16. A small bob attached to a light inextensible thread of length l has a periodic time T when allowed to vibrate as a simple pendulum. The thread is now suspended from a fixed end O of a vertical rigid rod of length $\frac{3l}{4}$ (as in figure). If now the pendulum performs periodic oscillations in this arrangement, the periodic time

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(a) $\frac{3T}{4}$
(b) $\frac{T}{2}$
(c) T
(d) 2T

Sol. (a)

$T' = 2\left(\frac{T}{8} + \frac{T}{4}\right)$

Q17. If a body at 27°C emits 0.3 watt of heat then at 627°C, it will emit heat equal to –

(a) 24.3 watt
(b) 0.42 watt
(c) 2.42 watt
(d) 0.9 watt

Sol. (a)

27°C = 300 k

627°c = 900 k

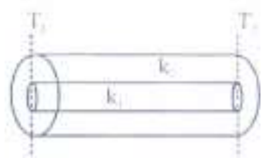
$P_2 = P_1 (3)^4 = 81 \times p_1$

$P_1 = 0.3$

Q18. A cylinder of radius R made of a material of thermal conductivity k_1 is surrounded by a cylindrical shell of inner radius R and outer radius 2R made of a material of thermal conductivity k_2. The two ends of the combined system are maintained at differet temperatures. There is no loss of heat from the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is

(a) $k_1 + k_2$
(b) $\frac{k_1 k_2}{k_1+k_2}$
(c) $\frac{1}{4}(k_1 + 3k_2)$
(d) $\frac{1}{4}(3k + k_2)$

Sol. (c)



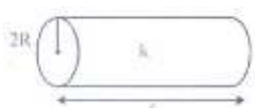
Parallel combination

$$R_{eq} = \frac{R_1\,R_2}{R_1+R_2}$$

$$R_1 = \frac{\ell}{k_1(\pi R^2),}\ R_2 = \frac{\ell}{k_2 3\pi R^2}$$

$$R_{eq} = \left(\frac{\ell}{\pi R^2}\right)\left(\frac{\ell}{\pi R^2}\right)\left(\frac{\ell}{k_1 k_2}\right)\left(\frac{1}{3}\right)$$

$$\frac{\ell}{\pi R^2}\frac{1}{k_1} + \frac{1}{3k_2}$$



$$R_{New} = \frac{\ell}{k(4\pi R^2)} = R_{eq}$$

$$R_{eq} = \frac{\ell}{\pi R^2}\left(\frac{1}{3k_2+k_1}\right)$$

$$\frac{\ell}{\pi R^2\,(4k)} = \frac{\ell}{\pi R^2}\left(\frac{\ell}{3k_2+k_1}\right)$$

$$\Rightarrow k = \frac{3k_2+k_1}{4}$$

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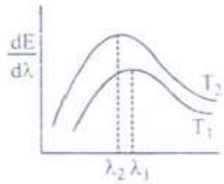
Q19. The spectral emissive power E_λ for a body at temperature T_1 is plotted against the wavelength and area under the curve is found to be A. At a different



(a) 3
(b) 1/3
(c) $1/\sqrt{3}$
(d) $\sqrt{3}$

Sol. (d)

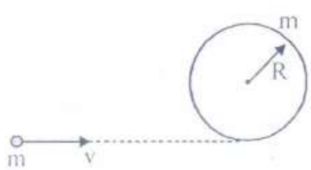
$$\frac{E_1}{E_2} = \frac{1}{9} = \left(\frac{T_1}{T_2}\right)^4$$

$$\lambda_1 T_1 = \lambda_2 T_2 \Longrightarrow \frac{T_1}{T_2} = \frac{\lambda_2}{\lambda_1}$$

$$\frac{1}{9} = \left(\frac{\lambda_2}{\lambda_1}\right)^4 \quad \Longrightarrow \frac{\lambda_2}{\lambda_1} = \frac{1}{\sqrt{3}}$$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{3}$$

Q20. A circular hoop of mass m, and radius R rests flat on a horizontal frictionless surface. A bullet, also of mass m, and moving with a velocity v, strikes the hoop and gets embedded in it. The thickness of the hoop is much smaller than R. The angular velocity with which the system rotates after the bullet strikes the hoop is



(a) $\frac{V}{4R}$
(b) $\frac{V}{3R}$
(c) $\frac{2V}{3R}$
(d) $\frac{3V}{4R}$

Sol. (b)

$$mv\frac{R}{2} = 1\omega$$

$$I = \left[mR^2 + \frac{mR^2}{4}\right] + \frac{mR^2}{4} = \frac{3mR^2}{4}$$

$$mv\frac{R}{2} = \frac{3mR^2}{2}\ \omega \qquad \omega = \frac{v}{3R}$$

Q21. A stone of mass m, tied to end of a string, is whirled around in a horizontal circle. (Neglect the force due to gravity). The length of the string is reduced gradually, keeping the angular momentum of the same about the centre of the circle constant. Then, the tension in the string is given by $T = Ar^n$, where A is a constant, r is the instantaneous radius of the circle, and n is

(a) 1
(b) –1
(c) –2
(d) –3

Sol. (d)

$$T = Ar^n = \frac{mv^2}{r}$$

$$L = mvr$$

$$L = k\, r^{\frac{mv^2}{2}}$$

$$L = mvr$$

$$L = kr^{\frac{n+3}{2}}$$

Since $\frac{dL}{dt} = 0, n = -3$

Q22. 2 moles of a monoatomic gas are expanded to double volume, through a process P/V = constant. If its initial temperature is 300 K, then which of the following is not true.

(a) $\Delta T = 900\ K$
(b) $\Delta Q = 3200\ R$
(c) $\Delta Q = 3600\ R$
(d) $W = 900\ R$

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Sol. (b)

$\frac{P}{V} cons\tan t = K$

$\Longrightarrow K\ V^2 = nRT$

$\Longrightarrow KV^2 = nRT$

$\Longrightarrow \frac{V_1^2}{V_2^2} = \frac{T_1}{T_2}$

$V_1 = V; V_2 = 2v\ ; T_1 = 300\ k$

$\Delta W = \int pdv$

$= \int_v^{2v} kvdv = \frac{3kv^2}{2}$

$\Delta Q = \Delta u + \Delta w$

Q23. Which of following statement is not according to the postulates of kinetic theory of gases: –

(a) Gas molecules are of small size
(b) Gas molecules always in moving with all possible velocities
(c) There is no force between the molecules
(d) None of these

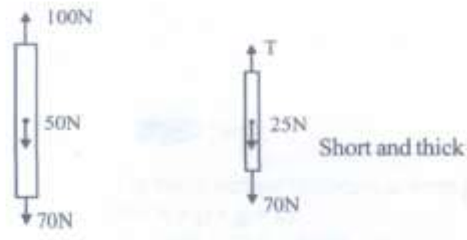
Sol. (d)

Refer to postulates

Q24. A rope of mass 5 kg is moving vertically in vertical position with an upwards force of 100 N acting at the upper end a downwards force of 70 N acting at the lower end. The tension at midpoint of the rope is

(a) 100 N
(b) 85 N
(c) 75 N
(d) 105 N

Sol. (b)



$a = \frac{120-100}{5}$

$= 4\ m/s^2 \downarrow$

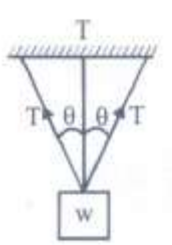
Q25. A weight can be hung in any of the following four ways by string of same type. In which case is the string most likely to break?

(a) A
(b) B
(c) C
(d) D

Sol. (d)

String will break easily if the tension in the string is more.

$2\cos\theta\, W$



$T = \frac{w}{2\cos\theta}$

∴ as θ increases, $\cos\theta$ decreases, T increases

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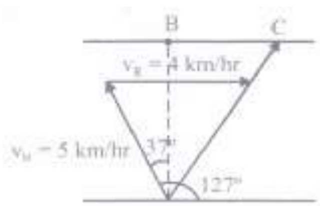
Q26. A swimmer swims in still water at a speed = 6 km/hr. He enters a 200 m wide river, having river flow speed = 4 km/hr at point A and proceeds to swim at an angle of 127° with the river flow direction. Another point B is located directly across A on the other side. The swimmer lands on the other bank at a point C, from which he walks the distance CB with a speed = 3 km/hr. The total time in which he reaches from A to B is

(a) 5 minutes
(b) 4 minutes
(c) 3 minutes
(d) None

Sol. (b)



$t_1 = \frac{200\ m}{V_m \cos 37°}$

$= \frac{0.2}{5 \times 4\ km/hr}$

$t_1 = \frac{1}{20}\ hr = 3\ min$

$BC = (V_R - V_m \sin 37°)\frac{1}{20}$

$= \frac{1}{20} km$

$t_2 = \frac{BC}{3\ km/hr} = \frac{1}{60} hr = 1\ min$

Total time $= t_1 + t_2 = 3\text{ min} + 1\text{ min} = 4\ min$

Q27. A ball is projected from top of a tower with a velocity of 5 m/s at an angle of 53° to horizontal. Its speed when it is at a height of 0.45 m from the point of projection is:

(a) 2 m/s
(b) 3 m/s
(c) 4 m/s
(d) Data insufficient.

Sol. (c)

$$V = \sqrt{(5\sin 53°)^2 - 2g(0.45) + (5\cos 53°)}$$

$$v = 4\,m/s$$

Q28. A body of mass 'm' is dropped from a height of 'h'. Simultaneously another body of mass 2m is thrown up vertically with such a velocity V that they collide at the height h/2. If the collision is perfectly inelastic, the velocity at the time of collision with the ground will be:

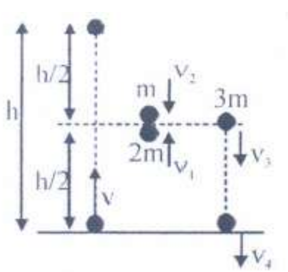
(a) $\sqrt{\frac{5\,g\,h}{4}}$
(b) $\sqrt{g\,h}$
(c) $\sqrt{\frac{g\,h}{4}}$
(d) $\frac{\sqrt{10\,gh}}{3}$

Sol. (d)

$$V_2 = \sqrt{2\,g\,\left(\frac{h}{2}\right)} = \sqrt{gh}$$

$$t = \sqrt{\frac{2\left(\frac{h}{2}\right)}{g}} = \sqrt{\frac{g}{h}}$$

Now using relative motion



$$t = \frac{h}{v-0} \Rightarrow \sqrt{\frac{g}{h}} = \frac{h}{v} \Rightarrow v = \sqrt{gh}$$

$$v_1^2 = v^2 - 2g\left(\frac{h}{2}\right) \Rightarrow v_1^2 = gh - gh = 0 \Rightarrow v_1 = 0]$$

Using conservation of linear momentum

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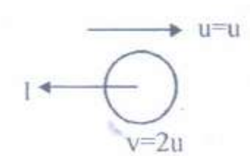
$3\,m\,v_3 = m\,v_2 - 2m\,v_1 \implies 3m\,v_3 = m\sqrt{gh} - 2m\,(0) \implies v_3 = \frac{1}{3}\sqrt{gh}$

$v_4^2 = v_3^2 + 2g\left(\frac{h}{2}\right) \qquad \implies v_4^2 = \frac{gh}{9} + gh = \frac{10\,gh}{9} \qquad \therefore v_4 = \frac{\sqrt{10\,gh}}{3}$

Q29. A force exert an impulse I on particle changing its speed from u to 2u. The applied force and the initial velocity are oppositely directed along the same line. The work done by the force is

(a) $\frac{3}{2} I\,u$
(b) $\frac{1}{2} I\,u$
(c) $I\,u$
(d) 2 I u

Sol. (b)



$I = 3\,mu$

$W = \Delta K = \frac{1}{2}(2u)^2 - \frac{1}{2}\,mu^2 = \frac{3\,mu.u}{2} = \frac{Iu}{2}$

Q30. A boy hits a baseball with a bat and imparts an impulse J to the ball. The boy hits the ball again with the same force, except that the ball and the bat are in contact for twice the amount of time as in the first hit. The new impulse equals:

(a) Half the original impulse
(b) The original impulse
(c) Twice the original impulse
(d) Four times the original impulse

Sol. (c)

$I = \int F dt$