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CBSE Board
Class XI Physics
Sample Paper - 3

Q1. A road is banked at an angle of 30° to the horizontal for negotiating a curve of radius $10\sqrt{3}$ m. At what velocity will a car experience no friction while negotiating the curve?

(a) 54 km/hr
(b) 72 km/hr
(c) 36 km/hr
(d) 18 km/hr

Sol. (c)

$tan30° = \frac{v^2}{Rg}$

$v = 36\ km/hr.$

Q2. The P.E. of a certain spring when stretched from natural length through a distance 0.3 m is 10 J. The amount of work in joule that must be done on this spring to stretch it through an additional distance 0.15 m will be

(a) 10 J
(b) 20 J
(c) 7.5 J
(d) 12.5 J

Sol. (d)

$10 = \frac{1}{2}\ K\ (0.3)^2$

$w = \frac{1}{2}\ K\ ((0.45)^2 - (0.3)^2)$

$w = 12.5\ J$

Q3. Assume the aerodynamic drag force on a car is proportional to its speed. If the power output from the engine is doubled, then the maximum speed of the car.

(a) Is unchanged
(b) Increased by a factor of $\sqrt{2}$
(c) Is also doubled
(d) Increases by a factor of four.

Sol. (b)

$F \propto v$

$P = F.V \quad \Rightarrow \quad P = v^2$

Thus $V_{new} = \sqrt{2}\,V$

Q4. A sphere of radius R and made of material of relative density σ has a concentric cavity of radius r. It just floats when placed in a tank full of water. The value of the ration R/r will be

(a) $\left(\frac{\sigma}{\sigma-1}\right)^{1/3}$
(b) $\left(\frac{\sigma-1}{\sigma}\right)^{\frac{1}{3}}$
(c) $\left(\frac{\sigma+1}{\sigma}\right)^{1/3}$
(d) $\left(\frac{\sigma-1}{\sigma+1}\right)^{1/3}$

Sol. (a)

$Mg = F_B$

$\sigma \times 10^3 \times \frac{4}{3}\pi\,[R^3 - r^3]g = 10^3 \times \frac{4}{3}\pi R^3\, g$

Q5. A vertical tank, open at the top, is filled with a liquid and rests on a smooth horizontal surface. A small hole is opened at the centre of side of the tank. The area of cross-section of the tank is N times the area of the hole, where N is a large number. Neglect mass of the tank itself. The initial acceleration of the tank is

(a) $\frac{g}{2N}$
(b) $\frac{g}{\sqrt{2N}}$
(c) $\frac{g}{N}$
(d) $\frac{g}{2\sqrt{N}}$

Sol. (c)

$F_{th} = \rho a v^2 = mA$

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Q6. The dimensional formula for angular momentum is –

(a) ML^2T^{-2}
(b) ML^2T^{-1}
(c) MLT^{-1}
(d) $M^0L^2T^{-2}$

Sol. (b)

$[l] = [mvr] = (MLT^{-1}.L) = ML^2T^{-1}$

Q7. The distance covered by a particle in time t is given by $x = a + bt + ct^2 - dt^3$. The dimensions of a and d are –

(a) L, T^{-3}
(b) L, LT^{-3}
(c) L^0, T^3
(d) None of these

Sol. (a)

$[a] = [x] = L$

$[x] = [dt^3]$

$[d] = LT^{-3}$

Q8. The resultant amplitude due to superposition of two waves $y_1 = 5\sin\ (wt - kx)$ and $y_2 = -5\cos(tw - kx - 150°)$

(a) 5
(b) $5\sqrt{3}$
(c) $5\sqrt{2-\sqrt{3}}$
(d) $5\sqrt{2+\sqrt{3}}$

Sol. (a)

$y_1 = 5\sin(\omega - kx)$

$y_2 = -5\cos(\omega t - kx - 150°) = \sin[(\omega t - kx - 150°) + 270°]$

$\Rightarrow y_2 = 5\sin(\omega t - kx + 120°)$

$\therefore A = \sqrt{5^2 + 5^2 + 2(5)(5)\cos 120°} = 5]$

Q9. A sources S of frequency f_0 and an observer O, moving with speeds v_1 *and* v_2 respectively, are moving away from each other. When they are separated by distance a $(t = 0)$, a pulse is emitted by the source. This pulse is received by O at time t_1 *then* t_1, is equal to

(a) $\frac{a}{v_s+v_2}$
(b) $\frac{a}{v_1+v_s}$
(c) $\frac{a}{v_s-v_2}$
(d) $\frac{a}{v_1+v_2+v_s}$

Sol. (c)

$\Delta v = v_1 - v_2 = 0; t_1 = \frac{a}{(v_s-v_2)}$

Q10. A spherical uniform planet is rotating about its axis. The velocity of a point on its equator is V. Due to the rotation of planet about its axis the acceleration due to gravity g at equator is ½ of g at poles. The escape velocity of a particle on the pole of planet in terms of V.

(a) $V_e = 2V$
(b) $V_e = V$
(c) $V_e = V/2$
(d) $V_e = \sqrt{3}\,V$

Sol. (a)

$g_e = g_p - R\omega^2 \quad \Rightarrow \frac{g}{2} = g - R\omega^2$

$R\omega^2 = \frac{g}{2} \quad \Rightarrow R^2\omega^2 = \frac{gR}{2} \quad \Rightarrow \quad V^2 = \frac{gR}{2}$ ....(i)

$V_e = \sqrt{2gR}$ ......(ii)

From (i) and (ii)

$V_e = \sqrt{2 \times 2V^2} \quad \Rightarrow \quad V_e = 2V$

Q11. A planet revolves about the sun in elliptical orbit. The arial velocity $\left(\frac{dA}{dt}\right)$ of the planet is $4.0 \times 10^{16}\ m^2/s$. The least distance between planet and the sun is $2 \times 10^{12}\ m$. Then the maximum speed of the planet in km/s is:

(a) 10
(b) 20
(c) 40
(d) None of these

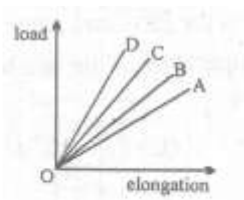
Sol. (c)

$\frac{dA}{dt} = \frac{r^2\omega}{2} =$ is constant

$\therefore \frac{dA}{dt} = \frac{r_{max}^2 \omega_{min}}{2} = \frac{r_{min}^2 \omega_{max}}{2}$

$\Rightarrow \quad \omega_{min} = \frac{2dA/\,dt}{r_{min}} = 40\ k\ m/s$

Q12. The load versus strain graph for four wires of the same material and same length is shown in the figure. The thickest wire is represented by the line



(a) OB
(b) OA
(c) OD
(d) OC

Sol. (c)

$Y = \frac{F\ell}{A\Delta\ell} \Longrightarrow A \propto \frac{F}{\Delta\ell}$ (i.e. slope)

Q13. The specific heat of a metal at low temperature varies according to S= aT^3 where a is constant and T is the absolute temperature. The heat energy needed to raise unit mass of the metal from $T = 1\ \ K\ to\ T = K\ is$

(a) 3 a
(b) $\frac{15a}{4}$
(c) $\frac{2a}{3}$
(d) $\frac{12a}{5}$

Sol. (b)

$H = \int msdT = \int_1^2 1aT^3\, dT = \frac{15a}{4}$

Q14. A steel rod is 4.000 cm in diameter at 30°C. A brass ring has an interior diameter of 3.992 cm at 30°C. In order that the ring just slides onto the steel rod, the common temperature of the two should be nearly $\left(\alpha_{steel} = 11 \times 10^{6/°}C \ and \ \alpha_{brass} = 19 \times 10^{-6/°}C\right)$

(a) 200°C
(b) 250°C
(c) 280°C
(d) 400°C

Sol. (c)

$$4[1 + \alpha_s \, \Delta T] = 3.992 \, [1 + \alpha_b \, \Delta T]$$

$$\Rightarrow \Delta T = 250 \ \Rightarrow T_f = 280$$

Q15. In an elevator, a spring clock of time period T_S (mass attached to a spring) and a pendulum clock of time period T_P are kept. If the elevator accelerates upwards

(a) T_S well as T_P increases
(b) T_S remain same, T_P increases
(c) T_S remains same, T_P decreases
(d) T_S as well as T_P decreases

Sol. (c)

$$T_S = 2\pi\sqrt{\frac{m}{K}}$$

$$T_P = 2\pi\sqrt{\frac{\ell}{g}}$$

Effect of 'g'

Q16. Starting from the mean position a body oscillates simple harmonically with a period of 2s. Its kinetic energy will become 75% of the total energy after

(a) $\frac{1}{6}\ sec.$
(b) $\frac{1}{12}sec.$
(c) $\frac{1}{3}sec.$
(d) $\frac{1}{4}sec.$

Sol. (a)

$$v = A\omega \cos(\omega t)$$

For KE = 75% KE_{max}

$v = \frac{\sqrt{3}}{2}\ of\ V_{max}$

$\frac{\sqrt{3}}{2}\ A\ \omega = A\omega\cos\left(\frac{2\pi}{2} \times t\right) \quad \Rightarrow \quad t = \frac{1}{6}\ sec.$

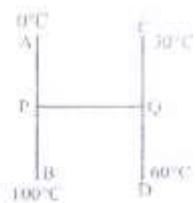
Q17. If at temperature T, the emissive power and absorption power of a body for wave length are $e_\lambda\ and\ a_\lambda$ respectively, then –

(a) $e_\lambda = a_\lambda$
(b) $e_\lambda > a_\lambda$
(c) $e_\lambda < a_\lambda$
(d) There will not be any definite relation between $e_\lambda\ and\ a_\lambda$

Sol. (d)

Kirchoff's Law tells that e = a. But doesn't tell about wavelength dependence of e & a.

Q18. Three identical rods AB, CD and PQ are joined as shown. P and Q are mid points of AB and CD respectively. Ends A, B, C and D are maintained at 0°C, 100°C, 30°C and 60°C respectively. The direction of heat flow in PQ is



(a) From P to Q
(b) From Q to P
(c) Heat does not flow in PQ
(d) Dat. Not sufficient

Sol. (a)

Assume that there is not 'PQ' Rod

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Then $T_P = \frac{100}{2} = 50°C$

$T_P > T_Q \implies$ Heat flow from P to Q

Q19. Two identical vessels, made of different material having conductivities K_1 and K_2 are completely filled with ice at 0°C. Due to temperature of surrounding, the ice in the two vessels melts in 25 min and 20 min respectively. The ration of $K_1 and\ K_2$ is

(a) 5/4
(b) 4/5
(c) 16/25
(d) $\frac{4/5}{\sqrt{(5/4)}}$

Sol. (b)

$$\left(\frac{dH}{dt_1}\right) t_1 = \left(\frac{dH}{dt_2}\right) t_2 = \theta = mL_f$$

$$\Rightarrow \frac{\left(\frac{dH}{dt}\right)_1}{\left(\frac{dH}{dt_2}\right)} = \frac{t_2}{t_1} = \frac{4}{5} \qquad \Rightarrow \qquad \frac{k_1}{k_2} = \frac{4}{5}$$

Q20. A thin circular ring of mass M and radius r is rotating about its axis with a constant angular velocity ω. Two objects, each of mass m are attached gently to the opposite ends of a diameter of the ring. The wheel now rotated with an angular velocity

(a) $\frac{\omega\, M}{(M+m)}$
(b) $\frac{\omega(M-2m)}{(M+2m)}$
(c) $\frac{\omega M}{(M+2m)}$
(d) $\frac{\omega(M+2m)}{M}$

Sol. (c)

Iw = constant

$$Nr^2\omega = (Mr^2 + 2mr^2)\omega'$$

$$\omega' = \frac{\omega M}{M+2m}$$

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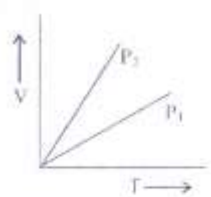
Q21. Two identical solid cylinders run a race starting from rest at the top of an inclined plane. If one cylinder slides and the other rolls

(a) The sliding cylinder will reach the bottom first with greater speed
(b) The rolling cylinder will reach the bottom first with greater speed
(c) Both will reach the bottom simultaneously with the same speed
(d) Both will reach the bottom simultaneously but with different speed

Sol. (a)

Because sliding no rotation is mvolu

Q22. For V versus T curves at constant pressure P_1 and P_2 for an ideal gas shown in figure.



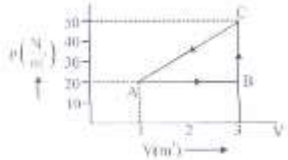
(a) $P_1 > P_2$
(b) $P_1 < P_2$
(c) $P_1 = P_2$
(d) P_1 P_2

Sol. (a)

Slope $= \frac{nR}{P}$

P increases, slop decreases

Q23. In the diagram, the graph between volume and pressure for a thermodynamical process is shown. If $U_A = 0$, $U_B = 20$.J and the energy given from B to C is 30 J, then at the stage of C, the internal energy of the system is:



(a) 50 J
(b) 60 J
(c) 30 J
(d) 10 J

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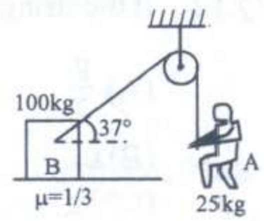
Sol. (a)

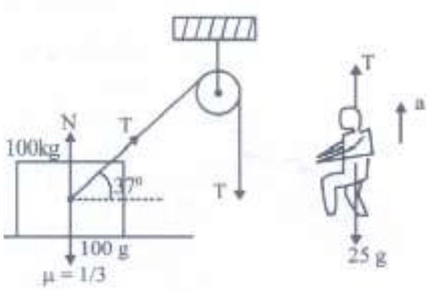
$U_A = 0, U_B = 20\ U_C = ?$
$\Delta Q_{BC} = 30$
$\Delta Q_C = \Delta U_{BC} = U_C - U_B = 30$
$U_C = U_B + 30 = 50$

Q24. Block B of mass 100 kg rests on a rough surface of friction coefficient $\mu = 1/3$. A rope is tied to block B as shown in figure. The maximum acceleration with which boy A of 25 kg can climbs on rope without making block move is:



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

Sol. (b)



$$N + T\sin 37° = 100g$$

$$N = 100g - T\sin 37°$$

$$T - 25\,g = 25a$$

$\therefore$ $$T = 25\,g + 25a$$

For block to start moving

$$T\cos 37° = \mu \times (100\,g - T\sin 37°)$$

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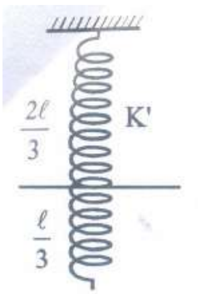
Q25. A spring of force constant k is cut into two pieces such that one piece is double the length of the other. Then the long piece will have a force constant of

(a) $(2/3)\,K$
(b) $(3/2)\,K$
(c) 3k
(d) 6k

Sol. (b)



For a particular material of spring

$$K \propto \frac{1}{\ell} \qquad K\ell = \text{constant}$$

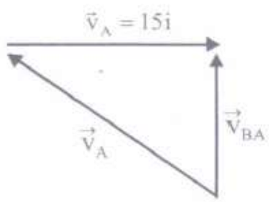
$$\therefore \quad K \times \frac{2\ell}{3} = K \times \ell$$

$$K' = \frac{3K}{2}$$

Q26. Man A sitting in a car moving at 54 km/hr observes a man B in front of the car crossing perpendicularly the road of width 15 m in three seconds. Then the velocity of man B will be

(a) $5\sqrt{10}$ towards the car
(b) $5\sqrt{10}$ away from the car
(c) 5 m/s perpendicular to the road
(d) None

Sol. (b)



$V_{BA} = \frac{15}{3} = m\ /s$

$V_A = 54 \times \frac{5}{18} = 15\ m/s$

$V_{BA} = 5\hat{\imath}$ $\quad\quad\quad\quad$ $\vec{V}_{BA} = \vec{V}_B - \vec{V}_A$

$\vec{V}_B = 5\hat{\jmath} + 15\hat{\imath}$

$|\vec{V}_B| = \sqrt{25 + 225} = 5\sqrt{10}\ m/s$

Q27. A particle is projected from a horizontal plane $(x - z\ plane)$ such that its velocity vector at time t is given by $\vec{V} = a\hat{\imath} + (b - ct)\hat{\jmath}$. Its range on the horizontal plane is given by

(a) $\frac{ba}{c}$
(b) $\frac{2ba}{c}$
(c) $\frac{2ba}{c}$
(d) None

Sol. (b)

Verfical component of velocity

Becomes zero at the highest point $\quad b - ct = 0$

$t = \frac{b}{c}$

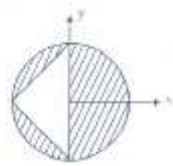
Time of flight $= 2t = \frac{2b}{c}$

Range $= a\left(\frac{2b}{c}\right) = \frac{2ba}{c}$

Q28. From a circle of radius a, an isosceles right angled triangle with the hypotenuse as the diameter of the circle is removed. The distance of the centre of mass of the remaining portion from the centre of the circle is

(a) $3(\pi - 1)a$
(b) $\frac{(\pi-1)a}{6}$
(c) $\frac{a}{3(\pi-1)}$
(d) $\frac{a}{3(\pi+1)}$

Sol. (c)



$$= \frac{(\sigma\pi R^2)(0) - \sigma\left\{\frac{1}{2}(2R)(R)\right\}\left\{-\frac{R}{3}\right\}}{\sigma\pi R^2 - \sigma R^2} = \frac{R}{3(\pi - 1)}$$

Q29. A small bucket of mass M kg is attached to a long inextensible massless cord of length L. The bucket is released from rest when the cord is in a horizontal position. At its lowest position, the bucket scoops up m kg of water and swings up to a height. The height h in meters is

(a) $\left(\frac{M}{M+m}\right)^2 L$
(b) $\left(\frac{M}{M+m}\right) L$
(c) $\left(\frac{M+m}{M}\right)^2 L$
(d) $\left(\frac{M+m}{M}\right) L$

Sol. (a)

Using conservation of energy

$$\frac{1}{2}Mv^2 = MgL \implies V = \sqrt{2gL}$$

Using conservation of linear momentum

$$(M+m)gh = \frac{1}{2}(M+m)\,V^2$$

$$\implies h = \frac{V^2}{2g} = \left(\frac{M}{M+m}\right)^2 L$$

Q30. A smooth sphere is moving on a horizontal surface with a velocity vector $(2\hat{\imath} + 2\hat{\jmath})$ m/s immediately before it hit a vertical wall. The wall is parallel to vector $\hat{\jmath}$ and coefficient of restitution between the sphere and the wall is e $= 1/2$. The velocity of the sphere after it hits the wall is

(a) $\hat{\imath} - \hat{\jmath}$
(b) $-\hat{\imath} + 2\hat{\jmath}$

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(c) $-\hat{\imath}-\hat{\jmath}$
(d) $2\hat{\imath}-\hat{\jmath}$

Sol. (b)