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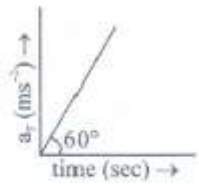
CBSE Board
Class XI Physics
Sample Paper - 2

Q1. Tangential acceleration of a particle moving in a circle of radius 1 m varies with time t as (initial velocity of particle is zero). Time after which total acceleration of particle makes and angle of 30° with radial acceleration is



(a) 4 sec
(b) 4/3 sec
(c) $2^{\frac{1}{3}}\, sec$
(d) $\sqrt{2}\, sec$

Sol. (c)

$\tan 60° = \frac{a_t}{t}$

$a_c = a\, cos30° = \frac{v^2}{1}$

$\frac{dv}{dt} = \frac{2}{\sqrt{3}}\, v^2,$ $t = 2^{2/3}\, sec$

Q2. A particle is moving along the circle $x^2 + y^2 = a^2$ in anticlockwise direction. The x-y plane is a rough horizontal stationary surface. At the point (a cos θ, a sin θ), then unit vector in the direction of friction on the particle is:

(a) $Cos\, \theta\, \hat{\imath} + \sin\theta\, \hat{\jmath}$
(b) $-(\cos\theta\, \hat{\imath} + \sin\theta\, \hat{\jmath})$
(c) $\sin\theta\, \hat{\imath} - \cos\theta \hat{\jmath}$
(d) $\cos\theta\, \hat{\imath} - \sin\theta \hat{\jmath}$

Sol. (c)

$\hat{f} = \sin\theta \hat{\imath} - \cos\theta \hat{\jmath}$

Q3. A particle is released from rest at origin. It moves under influence of potential field U $= x^2 - 3x$, kinetic energy at $x = 2$ is

(a) 2 J
(b) 1 J
(c) 1.5 J
(d) 0 J

Sol. (a)

$E_T = KE + PE$

$E_T = 0\ at\ origin$

$E_T = -2 + KE\ at\ X = 2\ m$

$KE = 2\ J\ AT\ X = 2m$

Q4. Equal mass of three liquids are kept in three identical cylindqecal vessels A, B and C. The densities are $\rho_A, \rho_B\ and\ \rho_C\ with\ \rho_A < \rho_B < \rho_C$. The force on the base will be

(a) Maximum in vessel A
(b) Maximum in vessel B
(c) Maximum in vessel C
(d) Equal in all the vessel

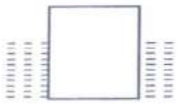
Sol. (d)

Least Density will be minimum in C

Q5. A cuboidal piece of wood has dimensions a, b and c. Its relative density is d. it is floating in a large body of water such that side a is vertical. It is pushed down a bit a and released. The time period of SHM executed by it is:

(a) $2\pi\sqrt{\frac{abc}{g}}$
(b) $2\pi\sqrt{\frac{g}{da}}$
(c) $2\pi\sqrt{\frac{bc}{dg}}$
(d) $2\pi\sqrt{\frac{da}{g}}$

Sol. (d)



Restoring force will be change in Buoyancy force

$F_r = -\Delta F_B = -d_o\ bc \times\ g$

$F_r = -10^3\ bc \times g$

Mass × Acceleration

$Acc \times d \times 10^3 \times abc = -10^3\ bcx\ g$

$Acceleration = -\left(\frac{g}{ad}\right)x$

$T = 2\pi\sqrt{\frac{ad}{g}}$

Q6. If Force = $(x - density) + C$ is dimensionally correct, the dimension of x are–

(a) MLT^{-2}
(b) MLT^{-3}
(c) ML^2T^{-3}
(d) $M^2L^{-2}T^{-2}$

Sol. (d)

$[x] = [force \times density] = MLT^{-2}\frac{M}{L^3}$

Q7. In a new system of units, unit of mass is 10 kg, unit of length is 100 m, unit of time is 1 minutes. Then magnitude of 1 N fore in new system of units will be

(a) 36
(b) 60
(c) 3.6
(d) 0.06

Sol. (c)

$IN = x\ units$

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$x = \left(\frac{1kg}{10kg}\right)\left(\frac{1m}{1oom}\right)\left(\frac{1\,sec}{60\,sec}\right)^{-2} = \frac{1}{10} \times \frac{1}{100} \times 3600$

$x = 3.6$

Q8. A taut string at both ends vibrates inn its nth overtone. The distance between adjacent Node and Antinode is found to be 'd'. If the length of the string is L, then

(a) $L = 2d(n+1)$
(b) $L = d\,(n+1)$
(c) $L = 2dn$
(d) $L = 2d\,(n-1)$

Sol. (a)

$L = (n+1)\frac{\lambda}{2}$ $\qquad \frac{\lambda}{4} = d$

$\Rightarrow L = (n+1)(2d)$]

Q9. In a closed end pipe of length 105 cm, standing waves are set up corresponding to the third overtone. What distance from the closed end, amongst the following, is a pressure Node?

(a) 20 cm
(b) 60 cm
(c) 85 cm
(d) 45 cm

Sol. (d)

105 cm $= \frac{7\lambda}{4}$]

Q10. The mass and diameter of a plane are twice those of earth. What will be the period of oscillation of a pendulum on this planet if it is a seconds pendulum on earth?

(a) $\sqrt{2}\, second$
(b) $2\sqrt{2}$ seconds
(c) $\frac{1}{\sqrt{2}}$ seconds
(d) $\frac{1}{2\sqrt{2}}$ second

Sol. (b)

$g = \frac{GM}{R^2}$ & $g' = \frac{G(2M)}{(2R)^2}$ so $g' = \frac{g}{2}$

$T' = 2\pi\sqrt{\frac{2\ell}{g}}$ $\Rightarrow$ $T' = \sqrt{2}\,T$ $\Rightarrow$ $T' = 2\sqrt{2}\,sec.$

Q11. A planet of mass m is in an elliptical orbit about the sum $(m \ll M_{sun})$ with an orbital period T. If A be the area of orbit, then its angular momentum would be:

(a) $\frac{2mA}{T}$
(b) mAT
(c) $\frac{mA}{2T}$
(d) $2mAT$

Sol. (a)

$\vec{L} = 2m\frac{d\vec{A}}{dt}$ $\Rightarrow$ $L = \frac{2mA}{T}$

Q12. A cylindrical wire of radius 1 mm, length 1 m, Young's modulus $= 2 \times 10^{11}\ N/m^2$, poisson's ration $\mu = \pi/10$ is stretched by a force of 100 N. Its radius will become

(a) 0.99998 mm
(b) 0.99999 mm
(c) 0.99997 mm
(d) 0.99995 mm

Sol. (d)

Stress $= \frac{F}{A} = \frac{100}{\pi(10^{-3})^2} = \frac{10^8}{\pi}$

$\frac{\Delta\ell}{\ell} = \frac{stress}{Y} = \frac{\frac{10^8}{\pi}}{2\times10^{11}} = \frac{5}{\pi} \times 10^{-4}$

$\Delta r = -0.00005\ mm$

$\therefore$ $V_f = 1 - 0.00005\ mm = 0.99995$ mm

Q13. 10 gm of ice at 0°C is kept in a calorimeter of water equivalent 10 gm. How much heat should be supplied to the apparatus to evaporate the water thus formed? (Neglect loss of heat)

(a) 6200 cal

(b) 7200 cal
(c) 13600 cal
(d) 8200 cal

Sol. (d)

$H = m_{colorimeter}\, s_{colorimeter}\, (100-0) + m_{ice}\, [L_f + s_{water}\, (100-0) + L_v]$

$= 10 \times 1 + 10[80 + 1(100) + 540]$

$= 82000\ cal$

Q14. If two rods of length L and 2L having coefficients of linear expansion α and 2α respectively are connected so that total length becomes 3L, the average coefficient of linear expansion of the composition rod equals:

(a) $\frac{3}{2}\alpha$
(b) $\frac{5}{2}\alpha$
(c) $\frac{5}{3}\alpha$
(d) None of these

Sol. (c)

$\alpha_{av} = \frac{L_1 x_1 + L_2 x_2}{L_1 + L_2} = \frac{5\alpha}{3}$

Q15. Two particles P and Q are executing SHM across same straight line whose equations are given as $y_P = A\sin(\omega + \phi_1) and\ y_Q = A\cos(\omega t + \phi_2)$. An observer, at t = 0, observes the particle P at a distance $A/\sqrt{2}$ moving to the right from mean position O while Q at $\frac{\sqrt{3}}{2}$ A moving to the left from mean position O as shown. Then, $(\phi_2 - \phi_1)$ is equal to

(a) π/12
(b) 7π/12
(c) 5π/12
(d) None of these

Sol. (b)

$y_P = A\sin(\omega t + \phi_1)$.

$at\ \ t = 0$

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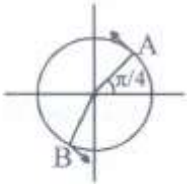

$\frac{A}{\sqrt{2}} = A \sin \phi_1 \quad \Rightarrow \quad \sin \phi_1 = \frac{1}{\sqrt{2}} \quad \Rightarrow \quad \phi_1 = \pi/4, 3\pi/4$

$\& \; V_P = A\,\omega cos\phi_1 \; since \; V_P = (+)iveso, \phi_1 = \pi/4$

$y + Q = A\,cos(\omega t + \phi_2).$

$-\frac{\sqrt{3}\,A}{2} = A \cos \phi_2 \quad \Rightarrow \quad \cos \phi_2 = -\frac{\sqrt{3}}{2} \quad \Rightarrow \quad \phi_2 = \pi/6 = 5\pi/6$

$\& \; V_Q = -A\omega sin\phi_2, since \; V_Q = (-)iveso, \phi_2 = 5\pi/6$

$\therefore \quad \Delta\phi = 5\pi/6 - \pi/4 = \frac{10\pi - 3\pi}{12} = 7\pi/12$

Q16. Equations $y = 2\,A \cos^2 \omega t \; and \; y = A\left(\sin \omega t + \sqrt{3} \cos \omega t\right)$ represent the motion of two particles.

(a) Only one of these is S.H.M.
(b) Ration of maximum speeds is 2 : 1
(c) Ration of maximum speeds 1 : 1
(d) Ration of maximum accelerations is 1 : 4

Sol. (c)

$y - A = A\,cos2\omega t$

$y = 2Asin\left(\omega t + \frac{\pi}{3}\right)$

$\frac{v_1}{v_2} = \frac{A(2\omega)}{(2A)2\omega}$

Q17. A black body calorimeter filled with hot water cools from 60°C in 4 min and 40°C to 30°C in 8 min. The approximate temperature of surrounding is:

(a) 10°C
(b) 15°C
(c) 20°C
(d) 25°C

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Sol. (b)

$\frac{d\theta}{dt} = k\ (\Delta\theta) = k[\theta_w - \theta_S]$

θ_s = Temperature of surrounding

$\theta_w = \frac{\theta_1+\theta_2}{2}$

$\frac{10}{4} = k\ \left[\frac{60+50}{2} - \theta_s\right]$ ....(i)

$\frac{10}{8} = k\ \left[\frac{40+30}{2} - \theta_s\right]$ .....(ii)

Equation (i) divided by (ii) gives

$z = \frac{55-\theta}{35-\theta}$

$70 - 20\ \theta = 55 - \theta$

$\theta = 15°$

Q18. A liquid takes 10 minutes to cool from 80°C to 50°C. The temperature of the surrounding is 20°C. Assuming that the Newton's law of cooling is obeyed, the cooling constant will be –

(a) 0.056/mt
(b) 0.042/mt
(c) 0.081/mt
(d) 0.069/mt

Sol. (d)

$\frac{\Delta T}{\Delta t} = k\ (\theta_w - \theta_s)$

$\frac{80-50}{10\ min} = k\ \left(\frac{80+50}{2} - 20\right)$

$3 = k(65 - 20)$

$k = \frac{1}{15} = 0.63$

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Q19. One end of a copper rod of length 1.0 m and area of cross-sector $10^{-3}\ m^2$ is immersed in boiling water and the other end in ice. If the coefficient of thermal conductivity of copper is 92 cal/ms °C and the latent heat of ice is $8 \times 10^{-3}\ cal/kg,$ then the amount of ice which will melt in one minute is

(a) $9.2 \times 10^{-3}\ kg$
(b) $8 \times 10^{-3}\ kg$
(c) $6.9 \times 10^{-3}\ kg$
(d) $5.4 \times 10^{-3}\ kg$

Sol. (c)

$$\frac{dH}{dt} = -\frac{kA(\Delta T)}{\ell} = \frac{92\times10^{-3}\times100}{1} = 9.2\ cal/sec$$

In one minute

$$H = \left(\frac{dH}{dt}\right) \times 60 = 9.2 \times 60$$

$$9.2 \times 60 = m \times 8 \times 10^4$$

$$m = \frac{9.2\times6}{8\times10^3}$$

Q20. A ring of radius r and mass m rotates about an axis passing through its centre and perpendicular to its plane with angular velocity ω. Its kinetic energy is

(a) mrω
(b) $\frac{1}{2}mr\omega^2$
(c) $mr^2\omega^2$
(d) $\frac{1}{2}mr^2\omega^2$

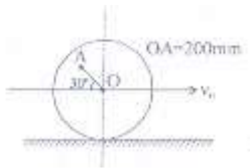
Sol. (b)

By wall energy theorem

$$my\frac{1}{2} = \frac{1}{2}\frac{mL^2}{3}\ \omega^2$$

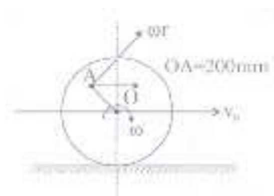
$$\omega = \sqrt{\frac{3g}{L}}$$

Q21. The wheel of radius $r = 300\ mm$ rolls to the right without slipping and has a velocity $v_o = 3\ rn/s$ of its center O. The speed of the point A on the wheel for the instant represented in the figure is



(a) 4.36 m/s
(b) 5 m/s
(c) 3 m/s
(d) 1.5 m/s

Sol. (a)



$$v = \sqrt{v_0^2 + (\omega r^2) + v_0 \omega r \cos 60°}$$

Q22. When unit mass of water boils to become steam at 100°C, it absorbs Q amount of heat. The densities of water and steam at 100°C are ρ_1 and ρ_2 respectively and the atmospheric pressure is p_0. The increases in internal energy of the water is

(a) Q
(b) $Q + p_0 \left(\frac{1}{\rho_1} - \frac{1}{\rho_2}\right)$
(c) $Q + P_0 \left(\frac{1}{\rho_2} - \frac{1}{\rho_1}\right)$
(d) $Q - p_0 \left(\frac{1}{\rho_1} + \frac{1}{\rho_2}\right)$

Sol. (b)

$$Q = \Delta U + W$$

Q23. At a temperature T K, the pressure of 4.0g argon in a bulb is p. The bulb is put in a bath having temperature higher by 50K than the first one. 0.8g of argon gas had to be removed to maintained original pressure. The temperature T is equal to

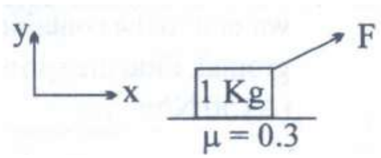
(a) 510 K

(b) 200 K
(c) 100 K
(d) 73 K

Sol. (b)

$n_1 T_1 = n_2 T_2$

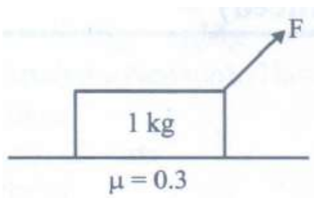
Q24. A force $\vec{F} = \hat{\imath} + 4\hat{\jmath}$ acts on block shown. The force of friction acting on the block is:



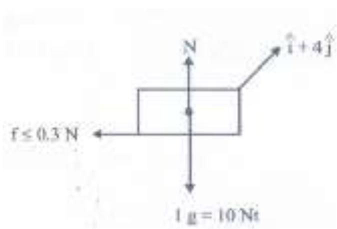
(a) $-\hat{\imath}$
(b) $-1.8\,\hat{\imath}$
(c) $-2.4\,i$
(d) $-3\,\hat{\imath}$

Sol. (a)

$\vec{F} = \hat{\imath} + 4\hat{\jmath}$



Drawing FBD of block,



In vertical direction,

$$N + 4 = 10$$

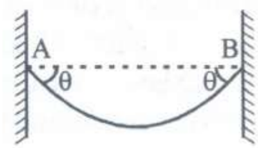
$$N = 6$$

$$F \le 0.3 \times 6$$

As the horizontal component of F is 1 Nt, $(< 1.8\ Nt)$

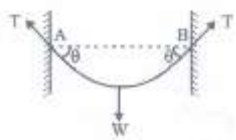
$\therefore$ friction is static which is also equal to 1 Nt in opposite direction.

Q25. A flexible chain of weight W hangs between two fixed points A and B which are at the same horizontal level. The inclination of the chain with the horizontal at both the points of support is θ. What is the tension of the chain at the mid-point?



(a) $\frac{W}{2}\ cosec\ \theta$
(b) $\frac{W}{2}.\tan\theta$
(c) $\frac{W}{2}.\cot\theta$
(d) None

Sol. (c)



Considering the right half part

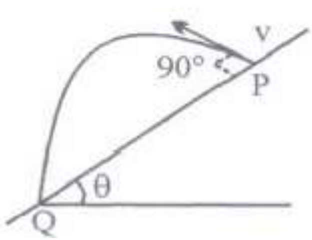
$$T\sin\theta = \frac{w}{2}$$

$$T_0 = T\cos\theta$$

$$= \frac{w}{2\sin\theta}\times\cos\theta$$

$$= \frac{2\cot\theta}{2}$$

Q26. If time taken by the projectile to reach Q is T, then PQ =



(a) $Tv\sin\theta$
(b) $Tv\cos\theta$
(c) $Tv\sec\theta$
(d) $T\ v\tan\theta$

Sol. (d)

$PQ = \frac{1}{2}g\sin\theta\ T^2$

Q27. A particle is projected vertically upwards from a point A on the ground. It takes t_1 time to reach a point B but it still continues to move up. If it takes further t_2 time to reach the ground from point B then height of point B from the grounds is

(a) $\frac{11}{2} g\ (t_1 + t_2)^2$
(b) $g\ t_1\ t_2$
(c) $\frac{1}{8} g\ (t_1 + t_2)^2$
(d) $\frac{1}{2} g\ t_1\ t_2$

Sol. (d)

$h = ut - \frac{1}{2} gt^2$

$gt^2 - 2ut + 2h = 0$

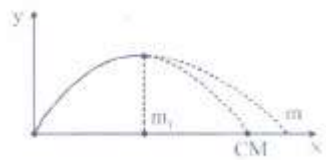
$t_1\ t_2 = \frac{2h}{g}$

$h = \frac{1}{2}\ t_1\ t_2\ g$

Q28. A particle of mass 3 m is projected from the ground at some angle with horizontal. The horizontal range is R. At the highest point of its path it breaks into two pieces m and 2m. The smaller mass comes to rest and larger mass finally falls at a distance x from the point of projection where x is equal to

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

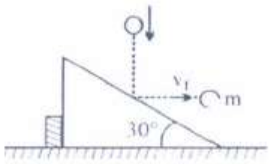
Sol. (c)



$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$

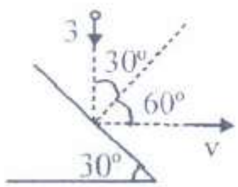
$R = \frac{m\left(\frac{R}{2}\right) + 2m\ (x_2)}{3\ m} \Longrightarrow x_2 = \frac{5R}{4}$

Q29. As shown in the figure a body of mass moving vertically with speed 3 m/s hits a smooth fixed inclined plane and rebounds with a velocity V_f in the horizontal direction. If $\angle$ of inclined is 30°, the velocity V_f will be



(a) 3 m/s
(b) $\sqrt{3}\, m/s$
(c) $1\sqrt{3}\frac{m}{s}$
(d) This is not possible

Sol. (b)



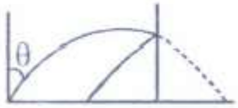
$V = \times \frac{\sqrt{3}}{2} = 3 \times \frac{1}{2}$

$V = \sqrt{3}$

Q30. A ball is projected from ground with a velocity V at angle θ to the vertical. On its path it makes an elastic collision with a vertical wall and returns to ground. The total time of flight of the ball is

(a) $\frac{2v\sin\theta}{g}$
(b) $\frac{2\,v\cos\theta}{g}$
(c) $\frac{v\sin 2\,\theta}{g}$
(d) $\frac{v\cos\theta}{g}$

Sol. (b)



$T = \frac{2\,V\sin(90-\theta)}{g}$