CBSE Board
Class XI Physics
Sample Paper – 6

Q1. A plane flying horizontally at 98 ms^{-1} releases an object which reaches the ground in 10 second. The angle made by the velocity of the object with the horizontal at the time of hitting the ground is

(a) 30°
(b) 45°
(c) 60°
(d) 75°

Sol. (b)

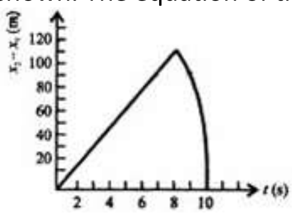
$v_x = 98ms^{-1}$

$v_y = u_y + a_y t$

$= 0 + (9.8ms^{-2})(10s) = 98ms^{-1}$

$\tan\theta = \left(\frac{v_y}{v_x}\right) = \left(\frac{98ms^{-1}}{98ms^{-1}}\right) = 1 \Rightarrow \theta = 45^0$.

Q2. Two stones are thrown up simultaneously from the edge of a cliff 200 m high with initial speeds of 15 ms^{-1} and 30 ms^{-1} Taking g = 10 ms^{-1} the graph of relative position of the second stone with respect to the first has been shown. The equation of the curved part is



(a) $100 + 15t - t^2$
(b) $200 + 30t - 5t^2$
(c) $200 - 15t + 5t^2$
(d) $100 - 30t + 5t^2$

Sol. (b)

For the 2nd stone,

$x_2 = -15t + \frac{1}{2}(10)t^2$

$\Rightarrow x_2 = -15t + 5t^2$

Stone will hit the ground when

$x_2 = 200$ i.e. $200 = -15t + 5t^2$

$5t^2 - 15t - 200 = 0$

or $t^2 - 3t - 40 = 0 \Rightarrow (t-8)(t+5) = 0$

Rejecting the negative value of $t, \Rightarrow t = 8s$.

So, $x_2 = -15t + 5t^2$ for $t \le 8s$

$x_2 = 200$ for $t > 8s$

for the first stone,

$x_1 = -30t + 5t^2$

For $0 \le t \le 8s; x_2 - x_1 = 15t$ (straight part)

For $t > 8s$

$x_2 - x_1 = 200 + 30t - 5t^2$ (curved part)

Q3. From a high tower at time t = 0, one stone is dropped from rest and simultaneously another stone is projected vertically up with an initial velocity. The graph of the distance between the two stones, before either hits the ground, plotted against time 't' will be as

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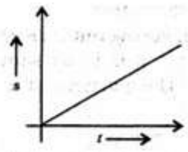

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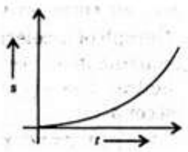

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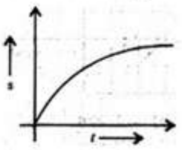

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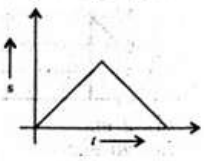


Sol. (A)

$S_{12} = u_{12}.t + \frac{1}{2} a_{12}t^2$

$Now,\ u_{12} = u_1 - u_2 = (+u) - (-v) = 2u$

$a_{12} = a_1 - a_2 = g - g = 0 \Rightarrow s_{12} = (2u)t$

Q4. The maximum height attained by an oblique projectile does not depend upon

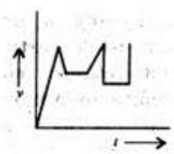
(a) velocity of projection
(b) acceleration due to gravity
(c) angle of projection
(d) mass of projectile

Sol. (d)

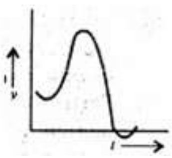
Equations of kinematics do not depend on mass.

Q5. The following figures show velocity V versus time t curves. But only some of these can be realised in practice. These are

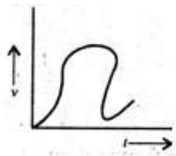
(i)



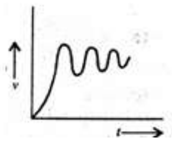
(ii)



(iii)



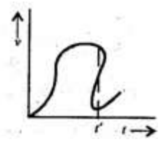
(iv)



(a) (i), (ii) and (iv) only
(b) (i), (ii) and (iii) only
(c) (ii) and (iv) only
(d) All

Sol. (c)

The figure (i) cannot be realized in practice. At the peak points the acceleration or $\frac{dv}{dt}$ is not defined.



In practice some value of acceleration will be there. Further the vertical lines in the figure (i) indicate that the acceleration is infinite, which again is not realized. At the instant t', the particle's velocity is shown to have three different values. It can have only one value. Hence this case is not practical. The cases shown in fig. (ii) and (iv) are practical.

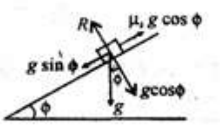
Q6. The upper half of an inclined plane with inclination f is perfectly smooth while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom if the coefficient of friction for the lower half is given by

(a) 2tan f
(b) tan f
(c) 2sin f
(d) 2cos f

Sol. (a)

For upper half smooth incline, component of g down the incline = g sin ϕ

$\therefore \quad v^2 = 2\,(g \sin\phi) = \frac{1}{2}$



For lower half rough incline, frictional retardation = $\mu_k\, g \cos\phi$

$\therefore \quad Resulatnt\ acceleration = g \sin\phi - \mu_k\, g \cos\phi$

$\therefore \quad 0 = v^2\,(g \sin\phi - \mu_k\, g \cos\phi)\frac{1}{2}$

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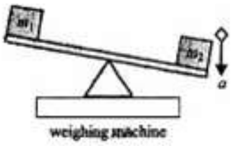
$or\quad 0 = 2\,(g \sin\phi)\,\frac{1}{2} + 2\,g\,(\sin\phi - \mu_k \cos\phi)\,\frac{1}{2}$

$or\quad 0 = \sin\phi + \sin\phi - \mu_k \cos\phi$

$or\quad \mu_k \cos\phi = 2\sin\phi \quad or\ \mu_k = 2\tan\phi$

Q7. In diagram find out the weight registered by the weighing machine.



(a) $(m_1 + m_2)\,a$

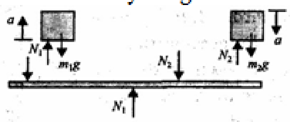
(b) $(m_1 + 2m_2)g + (m_1 + m_2)a$

(c) $(m_1 + m_2)g + (m_1 - m_2)a$

(d) $(m_1 - m_2)a + (m_1 + m_2)g$

Sol. (c)

The free body diagram of the given problem is:



Here the normal force acting on the weighing machine is,

$N = N_1 + N_2$ ...(1)

Constraint in the given problem is, what ever may be the acceleration of m_1 should have it upwards. {This is obvious because the plank holding masses is considered to the rigid}.

Force equations: From individual F.B.D. of mass m_1 and m_2, we have

Mass $m_1 : N_1 - m_1 g = m_1 a$ *which implies*

$N_1 = m_1(g + a)$ ..(2)

Mass $m_2 g - N_2 = m_2 a$ *which implies*

$N_2 = m_2(g - a)$ ...(3)

Equation (2) added to (3) and compared with equation (1) gives,

$N = (m_1 + m_2)g + (m_1 - m_2)a$

This is the weight registered by the weighing machine.

Q8. A smooth block is released at rest on a 45° incline and then slides a distance d. The time taken to slide is n times as much to slide on rough incline than on a smooth incline. The coefficient of friction is

(a) $\mu_s = 1 - \frac{1}{n^2}$

(b) $\mu_s = \sqrt{B.T}$

(c) $\mu_k = 1 - \frac{1}{n^2}$

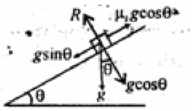
(d) $\mu_k = \sqrt{1 - \frac{1}{n^2}}$

Sol. (c)

$\because$ For smooth plane $d = \frac{1}{2}(g \sin\theta)t^2 \quad (i).$

For rough plane,

Frictional retardation up the plane $= \mu_k (g\cos\theta)$



$\therefore\ d = \frac{1}{2}(g\sin\theta - \mu_k g\cos\theta)(nt)^2$

$\therefore\ \frac{1}{2}(g\sin\theta)t^2 = \frac{1}{2}(g\sin\theta - \mu_k\cos\theta)n^2t^2$

or $\sin\theta = n^2(\sin\theta - \mu_k\cos\theta)$

Putting $\theta = 45^0$

or $\sin 45^0 = n^2(\sin 45^0 - \mu_k \cos 45^0)$

or $\frac{1}{\sqrt{2}} = \frac{n^2}{\sqrt{2}}(1-\mu_k)$ or $\mu_k = 1 - \frac{1}{n^2}.$

Q9. A neutron travelling with velocity u and kinetic energy E collides elastically head-on with a stationary nucleus of mass number A. The fraction of the total energy retained by the neutron is

(a) $\frac{(1-A)^2}{(1+A)^2}$

(b) $\frac{4A}{(1+A)^2}$

(c) $\frac{(A+1)^2}{A}$

(d) $\left(\frac{A}{A-1}\right)^2$

Sol. (a)

Q10. Two masses 10 kg and 20 kg are connected by a mass less spring. A force of 200 N acts on 20 kg mass. At the instant when the 10 kg mass has an acceleration 12 m/s^2 the energy stored in the spring (k = 2400 N/m) will be

(a) 30 J

(b) 3 J

(c) $\sqrt{3}$ J

(d) 80 J

Sol. (b)

$F = 10 \times 12 = 120N$

$F = kx = 2400x$

$\therefore\ x = \frac{1}{20}$ Energy stored in the spring $U = \frac{1}{2}kx^2$

$= \frac{1}{2} \times 2400 \times \frac{1}{400} = 3J$

Q11. Read the passage and answer the question below:

A pan of mass m = 1.5 kg and a block of mass M=3 kg are connected to each other by a light inextensible string, passing over a light pulley as shown in the figure. Initially the block is resting on a horizontal floor. A ball of mass m_0 = 0.5 kg collides with the pan at a speed u_0 = 20 m/s. Consider this instant of collision as t = 0. Assume collision to be perfectly inelastic. Take g = 10m/s^2

Now, answer the following questions based on above information.

Find the velocity of (pan + ball) at t = 2.6 s?

Assume that the block comes to rest instantaneously after striking the floor.

(a) 4 m/s, downward

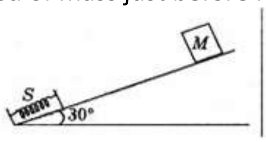
(b) 4 m/s upward

(c) 0.6 m/s upward

(d) 0.4 m/s downward

Sol. (d)

Q12. An ideal massless spring S can be compressed one metre by a force of 100 newton. The small spring is placed at the bottom of a frictionless inclined plane inclined at 30° to horizontal. A block M of mass 10 kg is released from rest at the top of the incline and is brought to rest momentarily after compressing the spring 2 metres. What is the speed of mass just before it reaches the spring? (g = 10 m/s^2).



(a) $\sqrt{20}\ m/s$

(b) $\sqrt{30}\ m/s$

(c) $\sqrt{10}\ m/s$

(d) $\sqrt{40}\ m/s$

Sol. (a)

Applied forces on the spring F = kx, where x is the distance through which it is compressed

$$K = \frac{F}{x} = \frac{100N}{1m} = 100\ \ N/m$$

Let the mass M slide a distance s metres along the incline before hitting the spring. The spring get compressed by 2 metres. Hence the mass M slides a total distance (s + 2) metres along the inciine. Initially M is placed at a height (s+2) sin 30° above the bottom of incline = $\frac{s+2}{2} = h.$

The mass initially P.E. = $Mgh = \frac{Mg(S+2)}{2}$

When the springs compressed, the energy has gone entirely into deformation of spring

$$\frac{1}{2}\ kx^2 = \frac{Mg(s+2)}{2}$$

$$s + 2 = \frac{kx^2}{Mg} = \frac{100\times 2^2}{10\times g} = \frac{40}{g}$$

$$s = \frac{40}{g} - 2 = 2\ m.$$

The mass falls through a height sin 30° = s/2

Gain in K.E. = Loss of P.E.

$$\frac{1}{2}\ Mv^2 = Mgh\ \ \ or\ v = \sqrt{2gh}$$

$$v = \sqrt{2g.\frac{s}{2}}\ = \sqrt{2 \times g} = \sqrt{2g} = \sqrt{20}\,\frac{m}{s}.$$

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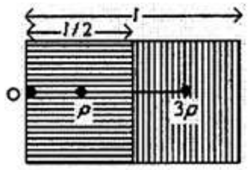
Q13. A trolley filled with sand moves on a smooth horizontal surface with a velocity V_0. A small hole is made at the base of it from which sand is leaving out vertically down at constant rate. As the sand leaves out

(i) the velocity of the trolley remains constant
(ii) the velocity of the trolley increases
(iii) the velocity of the trolley decreases
(iv) the momentum of trolley + leaked out sand is conserved

(a) (i) & (ii) are correct
(b) (iii) & (iv) are correct
(c) (i) & (iii) are correct
(d) (ii) & (iv) are correct

Sol. (d)

Q14. Half of the rectangular plates of length l as shown in the figure is made up on a material of density ρ and the other half of density 3ρ. The distance of centre of mass from O is



(a) 0
(b) ½
(c) 5/8
(d) 1

Sol. (c)

$\frac{\rho_1 x_1 + \rho_2 x_2}{\rho_1 + \rho_2}$

Q15. The centre of mass of the system of particles does not depend on
(a) masses of the particles
(b) forces on the particles
(c) position of the particles
(d) relative distances between the particles

Sol. (b)

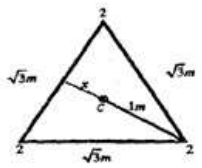
Three particles each of mass 2kg are at the corner of an equilateral 1 triangle of side $\sqrt{3}\, m$.

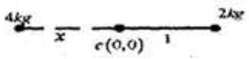
Q16. If one of the particles is removed, the shift in the centre of mass is
(a) 0.2 m
(b) 0.5m
(c) 0.4 m
(d) 0.3 m

Sol. (b)

$$X_{cm} = \frac{\sum m_i x_i}{\sum m_i}$$

$$0 = \frac{4(-x) + 2 \times 1}{6}$$





Q17. The question contains statement-1 (Assertion) and Statement-2 (Reason). It has four choices. You have to select the correct choice.

Assertion: A satellite moves round the earth in a circular orbit under the action of gravity. A person in the satellite experience a zero gravity field in the satellite.

Reason: The contact force by the surface on the person is zero.

(a) if statement-1 is true but statement 2 is false.
(b) if statement-1 is false and statement-2 is true.
(c) if both statement-1 and statement-2 are true and statement-2 is the correct explanation of statement-1.
(d) if both statement-1 and statement-2 are true but statement-2 is not the correct explanation of statement-1.

Sol. (b)

The person experiences zero net force as the force of gravity is balanced by the centrifugal force inside the satellite.

Q18. A body weighs 63 N on the surface of the earth. What is the gravitational force on it due to the earth at a height equal to half the radius of the earth?

(a) 24 N
(b) 28 N
(c) 32 N
(d) 36 N

Sol. (b)

$$F = \frac{GMm}{(R_E+h)^2} = \frac{GMm}{\left(R_E+\frac{R_E}{2}\right)^2} = \left(\frac{2}{3}\right)^2 . \frac{GMm}{R_E^2}$$

$$F = \frac{4}{9} \times 63\ N = 28\ N$$

Q19. The escape velocity of a particle of mass m varies as

(a) m^2
(b) m
(c) m^0
(d) m^{-1}

Sol. (c)

$V_{escape} = \sqrt{\frac{2GM}{R}}$ where M is mass of planet

(it is independent t of mass of particle m)

Q20. An artificial satellite is moving in a circular orbit around the earth with a speed equal to half the magnitude of escape velocity from the earth. Based on above information, answer the following question:

The additional energy required by the satellite to escape the earth is:

(a) $\frac{2GMm}{R}$

(b) $\frac{GMm}{R}$

(c) $\frac{GMm}{2R}$

(d) $\frac{3GMm}{2R}$

Sol. (c)

Energy at h + ΔE = Energy at infinity

$\Rightarrow \frac{-GMm}{R+h} + \Delta E = 0$

$\Delta E = \frac{GMm}{R+h}$

But h = R so $\Delta E = \frac{GMm}{2R}$

Q21. 1 mole of a gast with $\hat{a} = 7/5$ is mixed with 1 mole of a gas with $\hat{a} = 5/3$, then the value of $\hat{a}$ for the resulting mixture is

(a) 7/5

(b) 2/5

(c) 3/2

(d) 12/7

Sol. (c)

For first gas, $\gamma = \frac{7}{5}$, means gas is diatomic

For second gas, $\gamma = \frac{5}{3}$, means gas in monoatomic

Now, $(C_v)_{mono} = \left(\frac{3}{2}R\right)$ and $(C_v/dt = \frac{5}{2}R)$

$(C_v)_{mix} = \frac{\frac{3}{2}R + \frac{5}{2}R}{2}$ (∵ one mole of each gas is taken)

$= 2R$

$(C_v)_{mix} = (C_v)_{mix} + R = 2R + R = 3R$

$(\gamma)_{mix} = \frac{C_p}{C_v} = \frac{3R}{2R} = \frac{3}{2}$

Q22. A fly is flying in a room. The number of degrees of freedom of motion of fly will be

(a) 1

(b) 2

(c) 6

(d) 3

Sol. (d)

Q23. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio $\frac{C_p}{C_v}$ *for the gas is*

(a) 4/3
(b) 3/2
(c) 5/2
(d) 2

Sol. (b)

$T.P^{\frac{1-\gamma}{\gamma}} = \text{constant}$

$P^{\frac{1-\gamma}{\gamma}} \alpha\ T^{-1} \Rightarrow P\alpha\ T^{\frac{-\gamma}{1-\gamma}}$

But $P\alpha\ T^3$ given, $\therefore \frac{-\gamma}{1-\gamma} = 3$

$\therefore -\gamma = 3 - 3\gamma, 2\gamma = 3 \quad \therefore \gamma = \frac{3}{2}$

Q24. Speed of sound in air is 332 m/s at N.T.P. The speed of sound in hydrogen at N.T.P. will be (Air is 16 times heavier than hydrogen)

(a) 5312 m/s
(b) 664 m/s
(c) 2546 m/s
(d) 1328 m/s

Sol. (d)

Q25. The velocity of sound is largest in

(a) Water
(b) Air
(c) Steel
(d) Vacuum

Sol. (c)

Q26. An empty vessel is partially filled with water. The frequency of air column in the vessel

(a) remains the same
(b) depends on purity of water
(c) increases
(d) decreases

Sol. (c)
Assuming vessel to be closed pipe,
For fundamenta 1 mole, f α 1/1 As length decreases, frequency increases

Q27. The difference between the apparent frequency of a source of sound as perceived by the observer during its approach and recession is 2% of the frequency of the source. If the velocity of sound in air is 300 m/s, the velocity of the source is

(a) 6 m/s
(b) 3 m/s
(c) 1.5 m/s
(d) 12 m/s

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Sol. (b)

$$\frac{f'}{f} = \frac{v_s}{v - v_s} \text{ While approaching}, \frac{f''}{f} = \frac{v}{v + v_s} \text{ while recording}$$

$$\frac{f'}{f} - \frac{f''}{f} = \frac{v.2v_s}{(v^2 - v_s^2)} \Rightarrow \frac{f' - f''}{f} = \frac{2v_s}{v}$$

$$[\because \text{neglecting } v_s^2 \; Q \, v_s < v] \text{ But } f' = f = \frac{2f}{100} \Rightarrow \therefore \frac{100}{f} = \frac{2v_s}{v} \Rightarrow \frac{1}{100} = \frac{v_s}{300}$$

$$v_s = 3 \; m/s$$

Q28. When a prongs of a tuning fork are cut, its frequency
(a) Decreases
(b) may increase or decrease depending on the material of fork
(c) increases
(d) remains unchanged

Sol. (c)
When a tuning fork is set into vibration, its prongs are always moving in opposite phase in such a way that the centre of gravity of tuning fork does not change. This requries no external force to maintain vibrations. It will continue vibrating if its handle is simply held in hand. If one of the prongs of tuning fork is cut off and other is allowed to vibrate, its centre of gravity changes during vibrations. Therefore an external force is required for its oscillations. If its handle is simply held in hand, it will not vibrate. However, if it is rigidly fixed or clamped and allowed to vibrate, it will vibrate with greater intensity as compared to fork of two prongs

Q29. The frequency of a tuning fork P is 4% more than that of X. The frequency of another tuning fork Q is 2% less than that of X. When P & Q are sounded together, 9 beats/s are heard. Then frequency of P & Q is
(a) 156 & 165
(b) 156& 147
(c) 165& 174
(d) 147 & 138

Sol. (b)

$$\text{Frequency of P} = x + \frac{4}{100}x = x + 0.04x = 1.04x$$

$$\text{Frequency f Q} = x - \frac{2}{100}x = x - 0.02\,x = 0.98\,x$$

$$\text{No. of beats} = 1.04\,x - 0.98\,x = 9 \Rightarrow x\,[0.06] = 9 \Rightarrow x = 150$$

$$\therefore P = 150 + 0.04 \times 150 = 150 + 6 = 156\text{Hz.}$$

$$\therefore Q = 150 - 0.02 \times 150 = 150 - 3 = 147\text{Hz}$$

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Q30. A point source of sound emits sound uniformly in all directions in a non-absorbing medium. Two points M and N are at a distance of 9m and 25m respectively from the source. The ratio of the amplitudes of the waves at M & N is.

(a) 25/9
(b) 9/25
(c) 3/5
(d) 5/3

Sol. (a)

Let Intensity $= I$

We know $I \alpha \frac{1}{d^2}$ where d is the distance of point from the source.

$\therefore I_1 \alpha \frac{1}{d_1^2}, \quad I_2 \alpha \frac{1}{d_2^2} \quad \frac{I_1}{I_2} = \frac{d_2^2}{d_1^2}$ ....(1)

also $I \alpha a^2$ where 'a' is the wave amplitude

$\therefore \frac{I_1}{I_2} = \frac{a_1^2}{a_2^2}$ .... (2) from eqn (1) & (2) $\left(\frac{a_1}{a_2}\right)^2 = \left(\frac{d_2}{d_1}\right)^2$

$\therefore \frac{a_1}{a_2} = \frac{d_2}{d_1} = \frac{25}{9}$