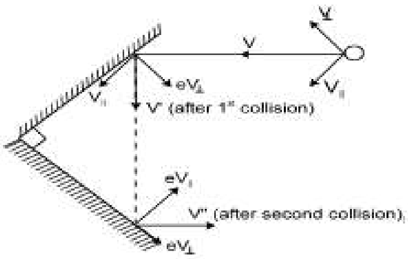
PHYSICS

21.

Ans C

sol.



During 1st collision perpendicular component of V, $V_{\perp}$ becomes e times, while IInd component V_{II} remains unchanged and similarly for second collision. The end result is that both and becomes e times their initial value and hence V" = – eV (the (–) sign indicates the reversal of direction).

22.

SOL:

Formula $F = m\dfrac{dv}{dt} + (V - u)\dfrac{dm}{dt}$

Here u = velocity of sand = O

$m = M_O$ □ μt = mas at time t

and $\dfrac{dm}{dt} = \mu$

$\therefore \quad F = (M_O + \mu t)\dfrac{dm}{dt} + v\mu$

$(F - \mu v)\, dt = (M_O + \mu t)\, dv$

$$\int_o^t \frac{dt}{M_o + \mu t} = \int_o^v \frac{dv}{F - \mu v}$$

$$\frac{1}{\mu}\left[\log(M_o+\mu t)\right]_o^t = \frac{1}{\mu}\ [\log(F-\mu v)]^v{}_o$$

$$\log\frac{(M_o+\mu t)}{M_o} = \log\left(\frac{F}{F-\mu v}\right)$$

$$F-\mu v = \frac{M_oF}{M_o+\mu t} \quad \Rightarrow v = \frac{Ft}{M_o+\mu t}$$

23.

Ans C

Sol. The horizontal component of velocity of sand just before falling on the cart is $v_S = 0$.

The horizontal speed of cart = v_C (constant).

The rate of mass falling on cart = μ (constant).

Horizontal force exerted by falling sand on cart = $\mu\ v_{rel} = \mu\ (v_c - v_S) = \mu\ v_c$

μ and v_C are constant, the horizontal force is constant.

29.

Ans ABC

Sol. The maximum compression in spring for shown situation is $\frac{m_2F}{2(m_1+m_2)K}$.

Since $(m_1 + m_2)K$ is same for all situations ; the compression is maximum for spring 3 and least for spring 2.

30.

Ans AC

Sol. Putting k = 1, $\vec{v}_2 \perp \vec{v}_1$ for oblique collision

and putting k = 1, $\vec{v}_1 = 0,\ \vec{v}_2 = \vec{v}$ for headon collision

33.

Ans 2

Sol. Impulse = $\int F\,dt$

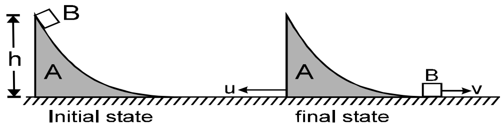
= Area under curve

$= \frac{1}{2}(2)(2) = 2$ kg-m/sec.

34.

Ans. 4

Sol.



(figure - 1)

Let u and v be the speed of wedge A and block B at just after the block B gets off the wedge A. Applying conservation of momentum in horizontal direction, we get.

$mu = mv$ ....(1)

Applying conservation of energy between initial and final state as shown in figure (1), we get

$mgh = \frac{1}{2}mu^2 + \frac{1}{2}mv^2$ ....(2)

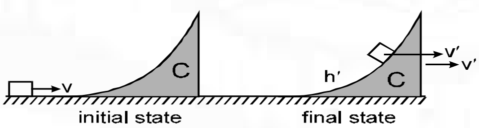
solving (1) and (2) we get

$v = \sqrt{gh}$ ....(3)

At the instant block B reaches maximum height h′ on the wedge C (figure 2), the speed of block B and wedge C are v′.

Applying conservation of momentum in horizontal direction, we get

$mv = (m + m)v'$ ....(4)



Applying conservation of energy between initial and final state

$\frac{1}{2}mv^2 = \frac{1}{2}(m + m)v'^2 + mgh'$ ....(5)

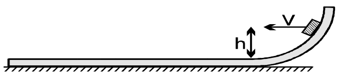
Solving equations (3), (4) and (5) we get

$h' = \frac{h}{4}$ **Ans.**

35.

Ans 3

Sol. Let v be the final speed of block when it is at maximum height h. At that instant the speed of circular track shall also be v.



From conservation of momentum

$$m\sqrt{2gR} = (m + 2m)\ v \qquad ....(1)$$

From conservation of energy

$$\frac{1}{2}m\ (2gR) = \frac{1}{2}\ (m + 2m)\ v^2 + 2mgh \qquad ....(2)$$

solving (1) and (2) we get

$h = \frac{1}{3}R$

Ans. R/3

37.

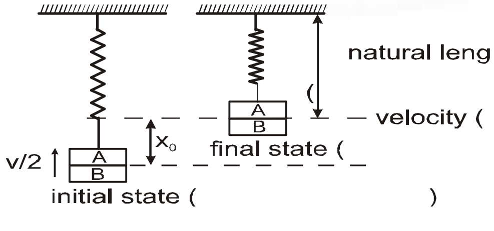
Ans 2

Soln $\sqrt{\frac{6\,m\,g^2}{k}}$

the initial extension in spring is $x_0 = \frac{mg}{k}$

Just after collision of B with A the speed of combined mass is $\frac{v}{2}$.

For the spring to just attain natural length the combined mass must rise up by $x_0 = \frac{mg}{k}$ (sec fig.) and comes to rest.



Applying conservation of energy between initial and final states

$$\frac{1}{2}2m\left(\frac{v}{2}\right)^2+\frac{1}{2}\ k\left(\frac{mg}{k}\right)^2 = 2mg\left(\frac{mg}{k}\right)$$

Solving we get g v = $\sqrt{\frac{6\,m\,g^2}{k}}$

38 Ans 2

Sol. They can avoid the collision when separation between them starts.

Frist A throws ball towards B. Applying conservation of momentum on 'A + ball' system

$$80.1 = 70\ V_A + 10\ (5 + V_A)$$

Where V_A is speed of A towards B after throwing the ball.

$$V_A = \frac{3}{8}\ \text{m/s}$$

B catches the ball and throws towards A. Let V_B is speed of B towards A after the throw. Therefore

$$70.1 - 10\frac{43}{8}. = 70.\ V_B + 10\ (5 + V_B)$$

$$\frac{130}{8} - 50 = 80\ V_B$$

$$-\frac{370}{640} = V_B \qquad Þ\ V_B = -\frac{1}{2}$$

i.e. B is going towards right with speed more than that of A (they are separating).

39.

Ans. (A) p,q (B) p,q (C) q,r (D) q,r

Sol. In all cases speed of balls after collision will be same. In case of elastic collision speed of both balls after collision will be u, otherwise it will be less than u.