DPP – 7

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/37

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Q 1. A 3 kg bomb explodes into 3 equal pieces A, B and C. A flies with a speed of 40 m/s and B with a speed off 30 m/s making an angle off 90^0 with the direction of A. The angle made by the direction of C with that of A is

(a) $\cos^{-1}\left(\frac{4}{5}\right)$ (b) $\pi - \cos^{-1}\left(\frac{4}{5}\right)$

(c) $\cos^{-1}\left(\frac{3}{5}\right)$ (d) $\pi - \cos^{-1}\left(\frac{3}{5}\right)$

Q 2. A bomb of mass m initially at rest, on the ground suddenly explodes in to two fragments. The fragment of mass $\frac{2m}{3}$ moves out with a velocity v. With the total energy released during the explosion, the unexploded bomb can be raised to what height above the ground?

(a) $\frac{v^2}{2g}$ (b) $\frac{2v^2}{g}$

(c) $\frac{v^2}{g}$ (d) $\frac{v^2}{4g}$

Q 3. A neutron decays to a proton and an electron. Find the fraction of energy gone to proton if total energy released is k. $(m_p = 1836m_e)$

(a) $\frac{1}{1836}$ (b) $\frac{1836}{1837}$

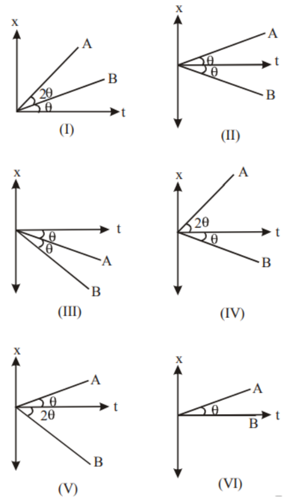
(c) $\frac{1835}{1837}$ (d) $\frac{1}{1837}$

Q 4. The object at rest suddenly explodes into three parts with the mass ratio 2:1:1. The parts of equal masses move at right angles to each other with equal speed v. The speed of the third part after the explosion will be:

(a) 2v (b) $v/\sqrt{2}$

(c) v/2 (d) $\sqrt{2}$v

Q 5. An initially stationary box on a frictionless floor explodes into two pieces, piece A with mass m_A and piece B with mass m_B . Two pieces then move across the floor along x-axis. Graph of position versus time for the two pieces may be



(a) II, IV and V (b) I, III, VI
(c) I, III, V (d) II, III, VI

Q 6. A stationary object explodes into masses m_1 and m_2. They move in opposite directions with velocities V_1 and V_2. The ratio of kinetic energy E_1 to kinetic energy E_2 is

(a) $\frac{m_2}{m_1}$ (b) $\frac{m_1}{m_2}$
(c) $\frac{2m_2}{m_1}$ (d) $\frac{2m_1}{m_2}$

Q 7. A bomb of mass 12kg at rest explodes into two fragments of masses in the ratio 1:3. The K.E of the smaller fragment is 216J. The momentum of heavier is (in kg-m/s):

(a) 36 (b) 72
(c) 108 (d) Insufficient data

Q 8. A shell of mass m moving with velocity v suddenly breaks into 2 pieces. The part having mass m/3 remains stationary. The velocity of other part will be

(a) $\frac{2v}{3}$ (b) $\frac{7v}{5}$
(c) $\frac{3v}{2}$ (d) none of these

Q 9. A Shell following a parabolic path explodes somewhere in its flight. The center of mass of fragments will continue to move in

(a) Vertical direction (b) any direction
(c) Horizontal direction (d) same parabolic path

Q 10. A projectile of mass 3m explodes at highest point of its path. It breaks into three equal parts. One part retraces its path, the second one comes to rest. The range of the projectile was 100 m if no explosion would have taken place. The distance of the third part from the point of projection when it finally lands on the ground is -

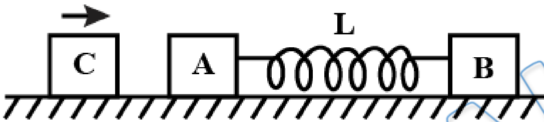
(a) 100 m (b) 150 m
(c) 250 m (d) 300 m

Q 11. A bomb of mass M is projected from the ground with speed v at angle theta with the horizontal at the maximum height from the ground it explodes into two fragments of equal mass if one fragment comes to rest immediately after explosion then the horizontal range of center of mass is

(a) $\frac{v^2 \sin^2 \theta}{g}$ (b) $\frac{v^2 \sin \theta}{g}$

(c) $\frac{v^2 \sin^2 \theta}{2g}$ (d) $\frac{v^2 \sin 2\theta}{g}$

Q 12. Two blocks A and B, each of mass m, are connected by a massless spring of natural length L and spring constant k. The blocks are initially resting on a smooth horizontal floor with the spring at its natural length as shown in Fig. A third identical block C, also of mass m moves on the floor with a speed v along the line joining A and B and collides elastically with A, then



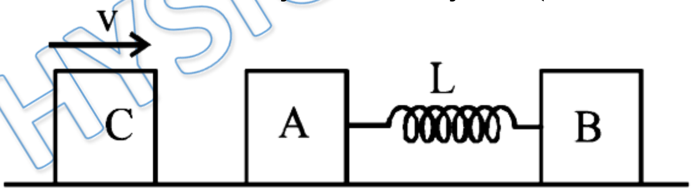
(a) the kinetic energy of the A-B system, at maximum compression of the spring, is zero

(b) the kinetic energy of the A-B system, at maximum compression of the spring, is $\frac{3mv^2}{4}$

(c) the maximum compression of the spring is $v\sqrt{m/k}$

(d) the maximum compression of the spring is $v\sqrt{m/2k}$

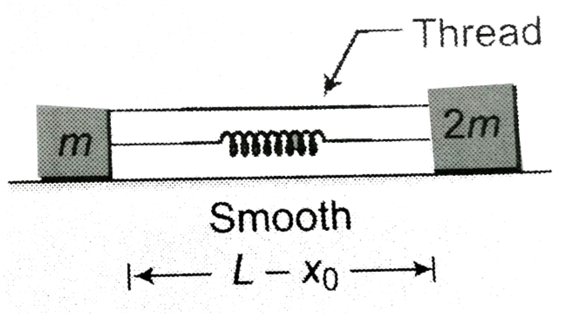
Q 13. Two blocks A and B of masses m and 2m are connected by a massless spring of natural length L and spring constant k. The blocks are initially resting on a smooth horizontal floor with the spring at its natural length , as shown . A third identical block C of mass m moves on the floor with a speed v along the line joining A and B and collides elastically with A. Find the velocity of com of system (block A + B + spring)



(a) $\frac{2v}{3}$ (b) $\frac{v}{3}$

(c) v (d) $\frac{3v}{2}$

Q 14. Two blocks of masses m and 2m compress a spring of spring constant k by x_o and blocks are a connected by a thread and placed on a smooth surface as shown. Now , thread is burned. Find the speed of each block when the spring attains its normal length L



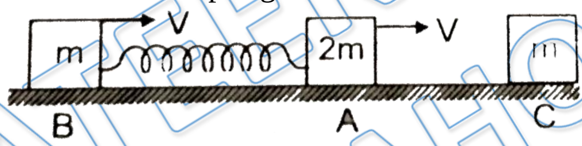
(a) Speed of mass m is $2\left(\sqrt{\frac{k}{6m}}\right)x_o$ and for 2m is $\left(\sqrt{\frac{k}{6m}}\right)x_o$

(b) Speed of mass m is $\left(\sqrt{\frac{k}{6m}}\right)x_o$ and for 2m is $2\left(\sqrt{\frac{k}{6m}}\right)x_o$

(c) Speed of mass m is $2\left(\sqrt{\frac{k}{3m}}\right)x_o$ and for 2m is $\left(\sqrt{\frac{k}{3m}}\right)x_o$

(d) Speed of mass m is $\left(\sqrt{\frac{k}{3m}}\right)x_o$ and for 2m is $2\left(\sqrt{\frac{k}{3m}}\right)x_o$

Q 15. Two blocks A and B of mass 2 m and m respectively are connected to a massless spring of spring constant K. if A and B moving on the horizontal frictionless surface with velocity v to right. If A collides with C of mass m elastically and head on, then the maximum compressions of the spring will be

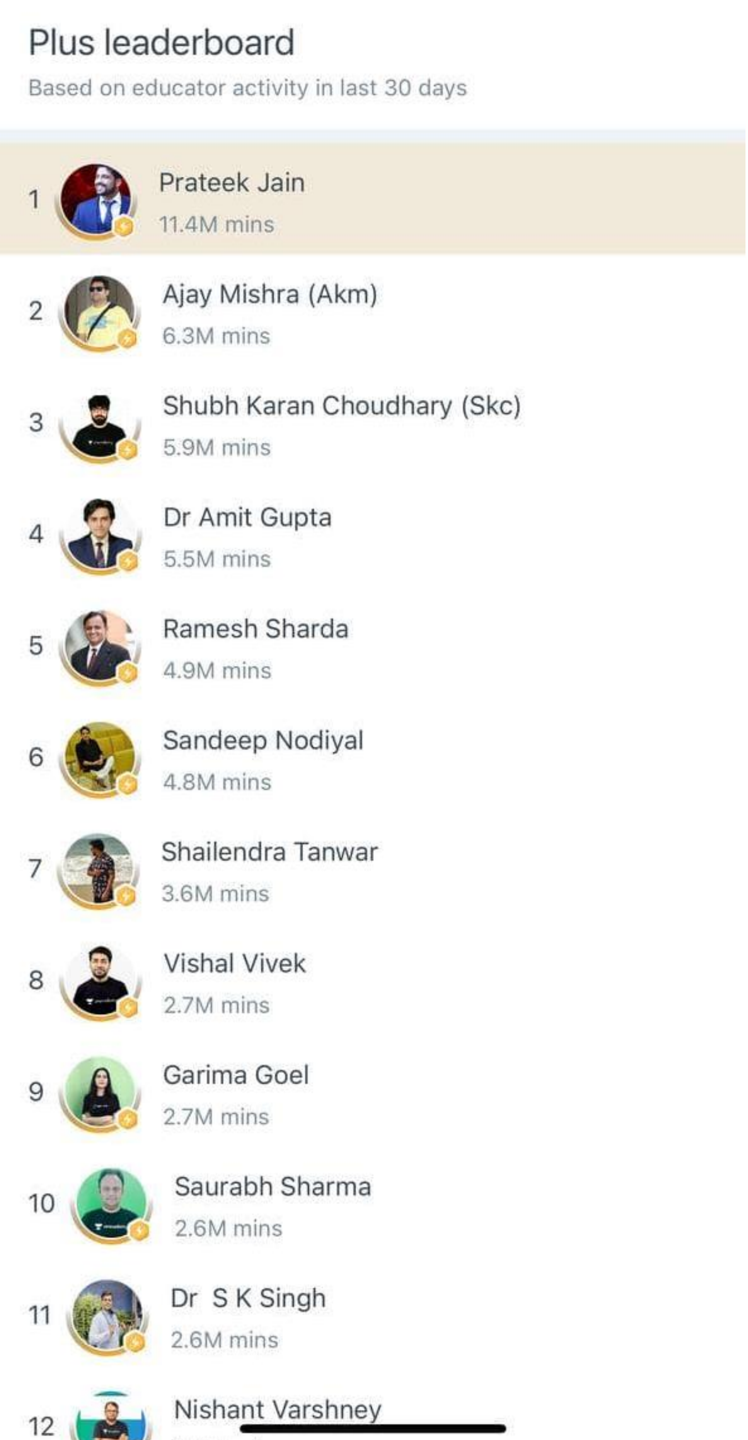


(a) $\sqrt{\frac{3m}{2k}}V$ (b) $\sqrt{\frac{27m}{8k}}V$

(c) $\sqrt{\frac{9m}{8k}}V$ (d) $\sqrt{\frac{8m}{27k}}V$

Answer Key

Q.1 b	**Q.2 c**	**Q.3 d**	**Q.4 b**	**Q.5 a**
Q.6 a	**Q.7 a**	**Q.8 c**	**Q.9 d**	**Q.10 c**
Q.11 d	**Q.12 d**	**Q.13 b**	**Q.14 a**	**Q.15 d**



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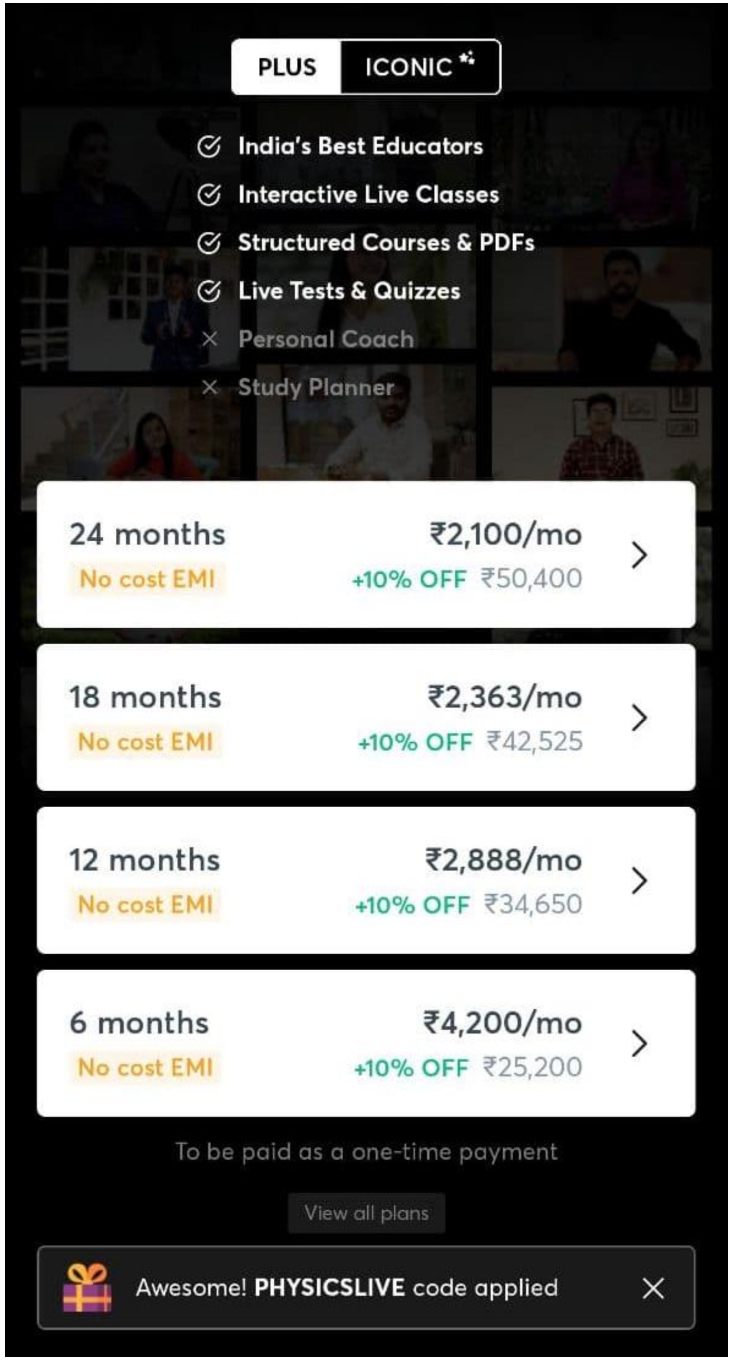

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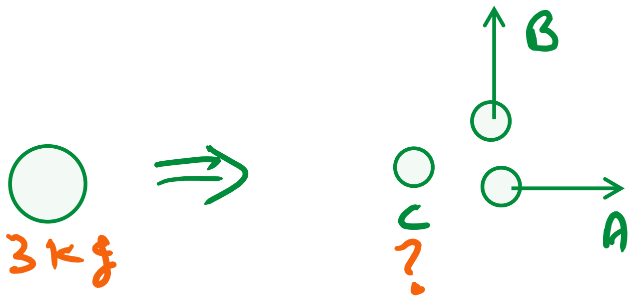
Written Solution

DPP-7 COM: Super Elastic Collision, Spring block questions

By Physicsaholics Team

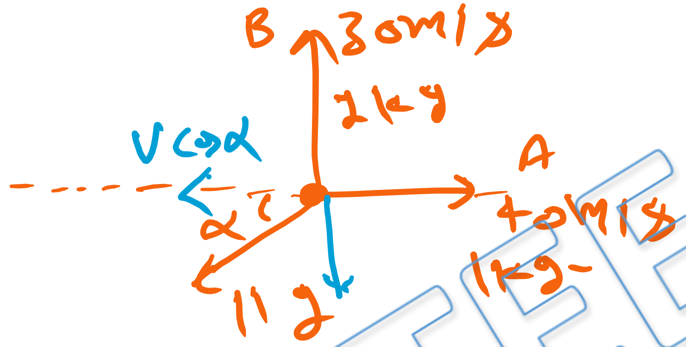
Solution: 1

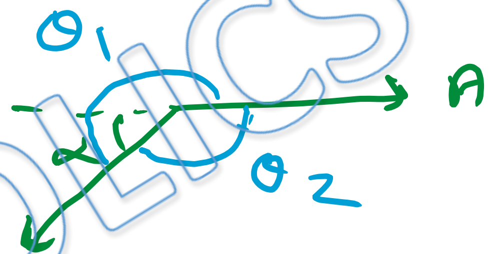


$p_A = 40$ kg m/s

$p_B = 30$ kg m/s

$p_C = v$ kg m/s



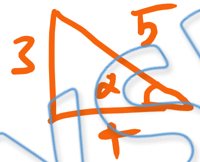


$\because F_{ext} = 0$

so, P = conserved

$v \sin\alpha = 30$ —(1)

$v \cos\alpha = 40$ —(2)



$\frac{(1)}{(2)}$ $\tan\alpha = \frac{3}{4}$

so, $\alpha = \tan^{-1}\frac{3}{4} = \cos^{-1}\frac{4}{5}$

$\alpha = \tan^{-1}\left(\frac{3}{4}\right)$

so, $\theta_1 = \pi + \alpha$

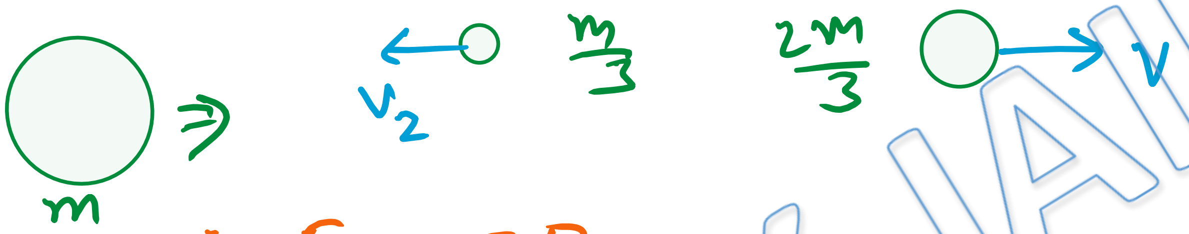
$\theta_1 = \pi + \cos^{-1}\frac{4}{5}$ Ans

and $\theta_2 = \pi - \alpha$

$\theta_2 = \pi - \cos^{-1}\frac{4}{5}$ Ans

Ans. b

Solution: 2



$\because F_{ext} = 0$

$\therefore p_i = p_f$

$0 = \frac{2m}{3}v - \frac{m}{3}v_2 \Rightarrow \boxed{v_2 = 2v}$

So, Total energy released $= E = \frac{1}{2}\frac{m}{3}(2v)^2 + \frac{1}{2}\frac{2m}{3}(v)^2$

$= mv^2$

For complete mass m

PE, KE = 0

h

KE, PE = 0

$KE_1 + PE_1 = KE_2 + PE_2$

$\therefore mv^2 + 0 = 0 + mgh$

$\boxed{h = \frac{v^2}{g}}$ Ans.

Ans. c

Solution: 3

$\because$ $F_{ext} = 0$

$\therefore$ Momentum is conserved

$$p_i = p_f$$

$$0 = p_p - p_e$$

$$\boxed{p_p = p_e}$$

$$\frac{KE_p}{KE_e} = \frac{p_p^2/2m_p}{p_e^2/2m_e} = \frac{m_e}{m_p}$$

$$\frac{KE_p}{KE_e} = \frac{m_e}{1836 m_e} = \frac{1}{1836}$$

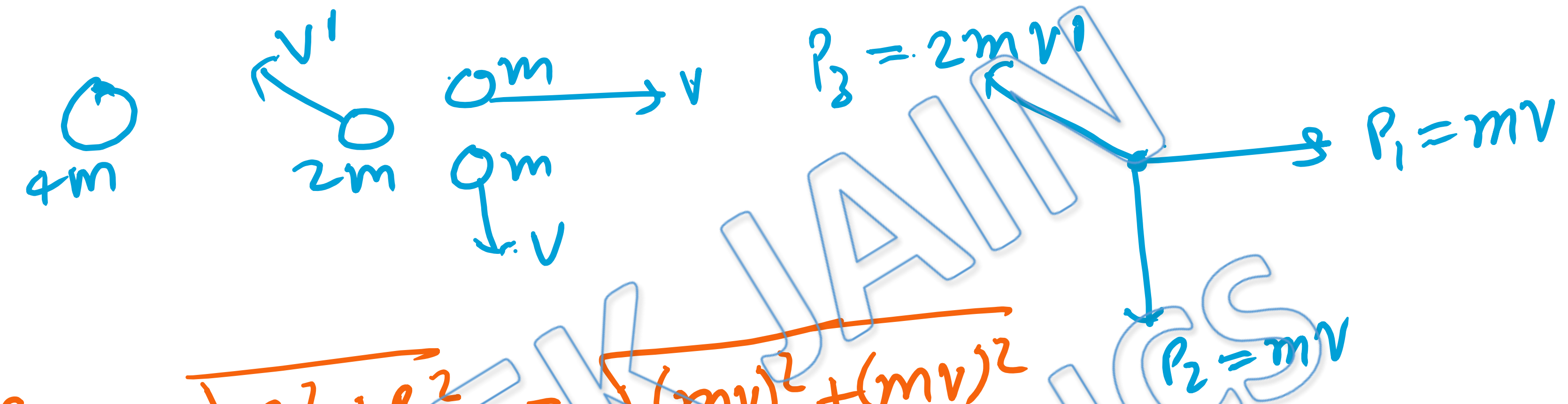
$\because$ $KE_p + KE_e = K$

So, $KE_p = \frac{1}{1+1836} \times K$

$$\boxed{KE_p = \frac{K}{1837}}$$ Ans.

Ans. d

Solution: 4



$$P_3 = \sqrt{P_1^2 + P_2^2} = \sqrt{(mv)^2 + (mv)^2}$$

$$P_3 = \sqrt{2}\, mv$$

$$2mv' = \sqrt{2}\, mv$$

$$\boxed{v' = \frac{v}{\sqrt{2}}} \text{ Ans.}$$

Ans. b

Solution: 5

Physically possible explosions are those in which both particles move in opposite directions. i.e. signs of velocities are $\Rightarrow$ II, IV & V

Ans. a

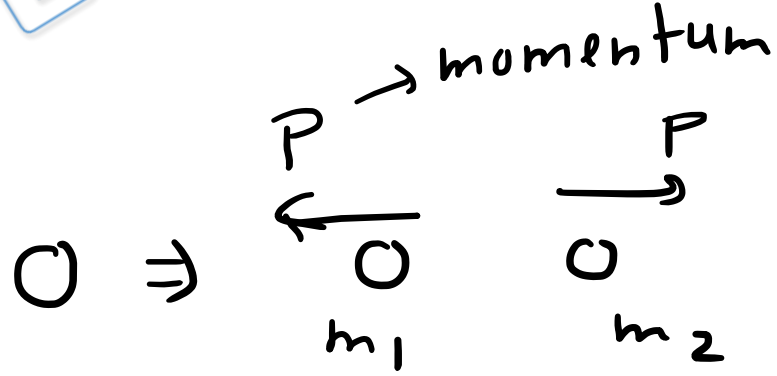
Solution: 6

$$m_1 v_1 = m_2 v_2 \Rightarrow \boxed{\frac{v_1}{v_2} = \frac{m_2}{m_1}}$$

$$\frac{E_1}{E_2} = \frac{\frac{1}{2} m_1 v_1^2}{\frac{1}{2} m_2 v_2^2} = \frac{m_1}{m_2}\left(\frac{v_1}{v_2}\right)^2 = \frac{m_1}{m_2}\left(\frac{m_2}{m_1}\right)^2 = \frac{m_2}{m_1}$$

$$\boxed{\frac{E_1}{E_2} = \frac{m_2}{m_1}} \text{ Ans.}$$

OR



$$K_1 = P^2/2m_1$$

$$K_2 = P^2/2m_2 \Rightarrow \frac{K_1}{K_2} = \frac{m_2}{m_1}$$

Ans. a

Solution: 7

12 kg ⇒ m, $3m$

$m = 3\,kg$

$3m = 9\,kg$

$(KE)_m = 216\,J$

$$\frac{p^2}{2m} = 216$$

$$\frac{p^2}{2 \times 3} = 216 \Rightarrow p^2 = 216 \times 2 \times 3 = 6^3 \times 6 = 6^4$$

$$p = 6^2$$

$$\boxed{p = 36\ kg\text{-}m/s}\ \text{Ans}$$

Ans. a

Solution: 8

$m \rightarrow v \Rightarrow \frac{m}{3},\ v = 0 \qquad \frac{2m}{3} \rightarrow v' = ?$

$$mv = \frac{m}{3}(0) + \frac{2m}{3}(v')$$

$$v = 0 + \frac{2v'}{3}$$

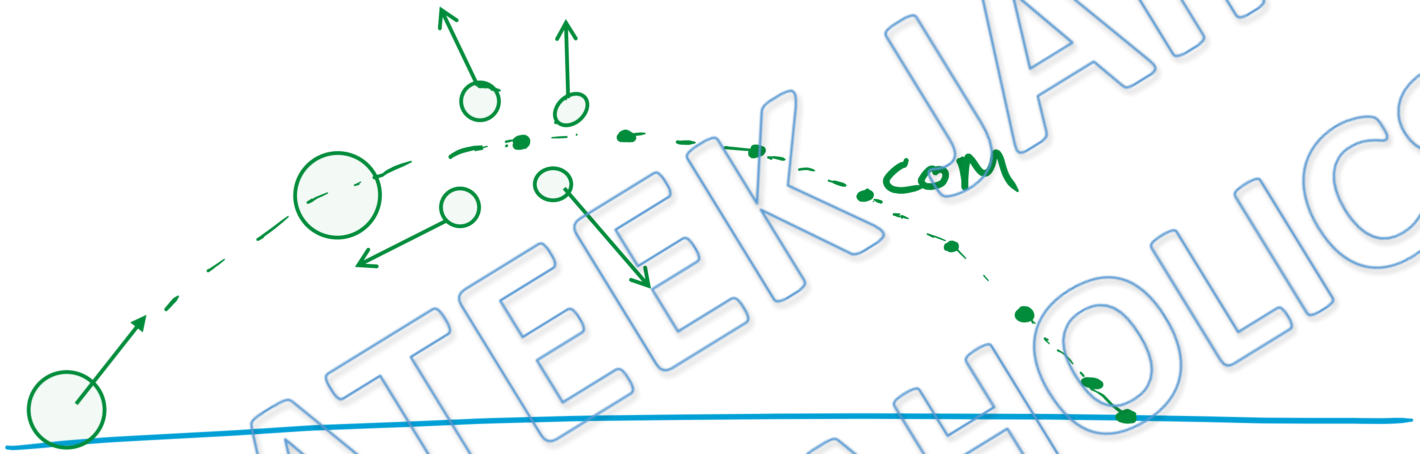
$$\Rightarrow \boxed{v' = \frac{3v}{2}} \text{ Ans.}$$

Ans. c

Solution: 9

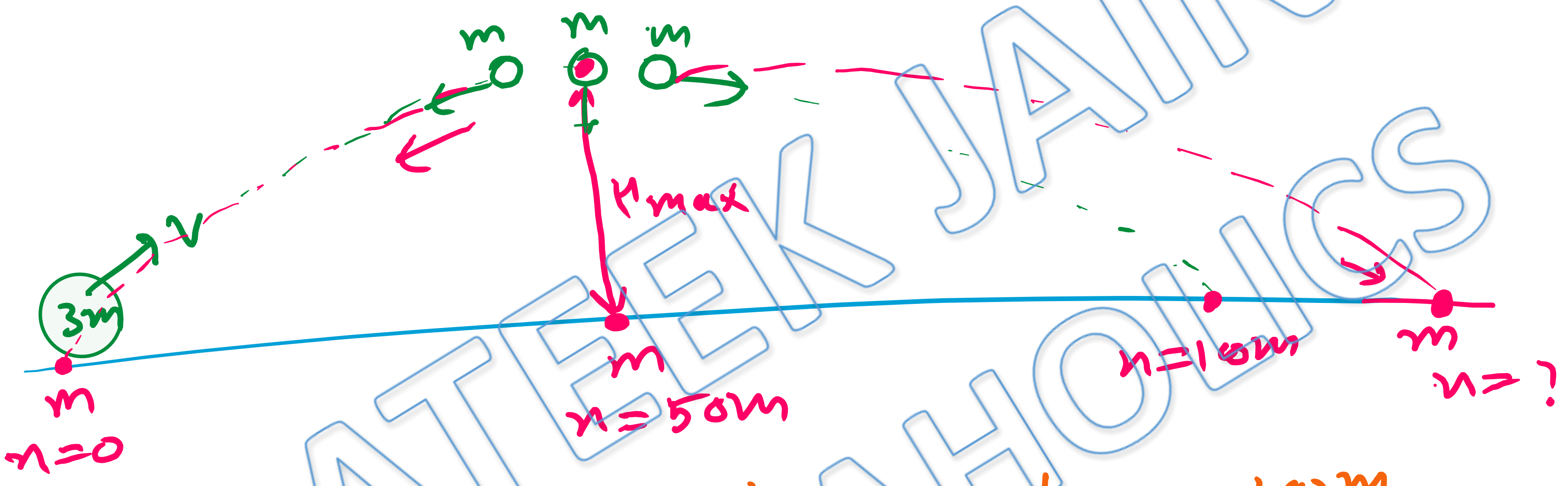
∵ there is no external force other than 'mg'

so; com will not change it's path.



Ans. d

Solution: 10



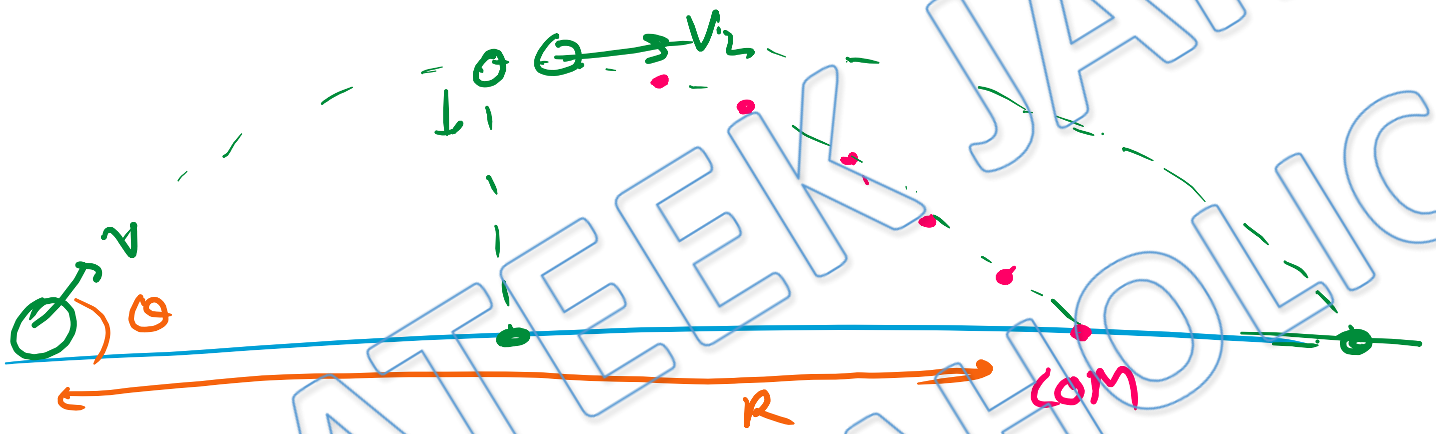
$\because (F_{net})_{ext} = 0$, com will be at $x = 100\,m$

so; $x_{cm} = 100 = \dfrac{m(0) + m(50) + m(x)}{m + m + m} \Rightarrow 100 = \dfrac{m(50 + x)}{3m}$

$300 = 50 + x \Rightarrow \boxed{x = 250\,m}$ Ans

Ans. c

Solution: 11



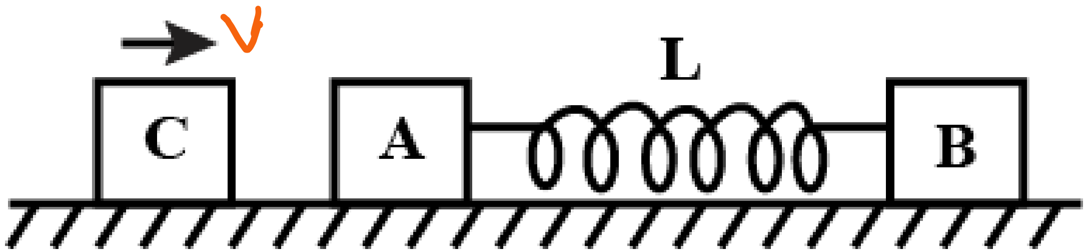
∵ com will follow same parabolic path

so, com will be at $x = R$

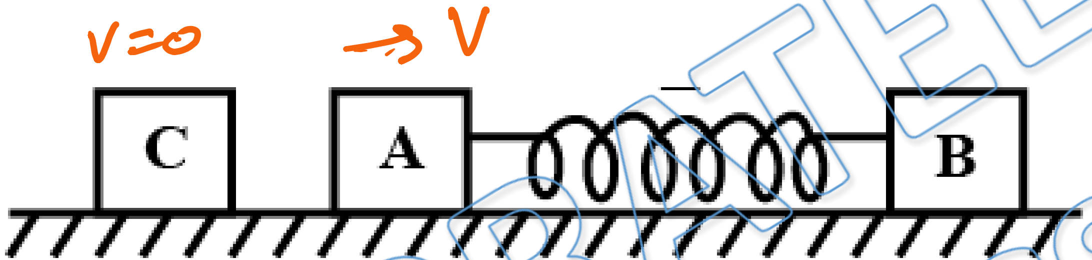
$$R = \frac{v^2 \sin 2\theta}{g}$$ Ans

Ans. d

Solution: 12



after collision between A & C



$\because m_A = m_c$ & collision is elastic

Now for AB & spring system.

at max compression, $V_A = V_B = V_0$

$\Rightarrow mV = (m+m)V_0 \Rightarrow \boxed{V_0 = \frac{V}{2}}$

at max. compression

from energy conservation

$\frac{1}{2}mV^2 = \frac{1}{2}m_T V_0^2 + \frac{1}{2}kx^2$

$\frac{1}{2}mV^2 = \frac{1}{2}(2m)\left(\frac{V}{2}\right)^2 + \frac{1}{2}kx^2$

$mV^2 = \frac{mV^2}{2} + kx^2$

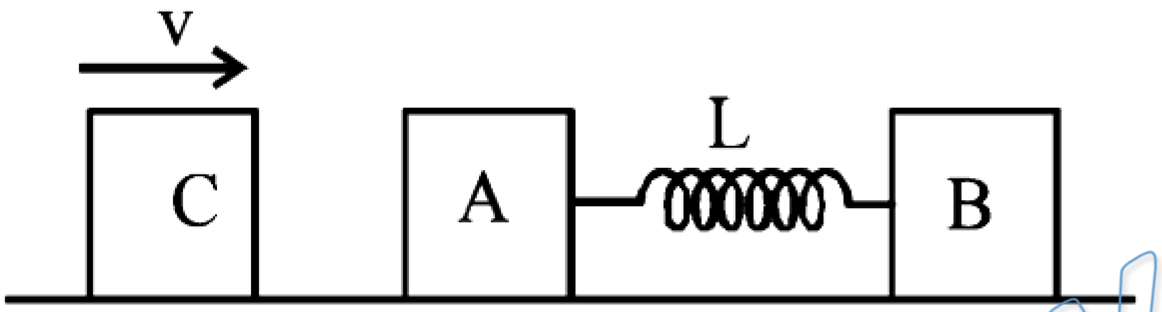
$kx^2 = \frac{mV^2}{2} \Rightarrow \boxed{x = \sqrt{\frac{m}{2k}}\,V}$ Ans.

& $KE_f = \frac{1}{2}(2m)V_0^2 = \frac{1}{2}(2m)\left(\frac{V}{2}\right)^2 = \frac{mV^2}{4}$

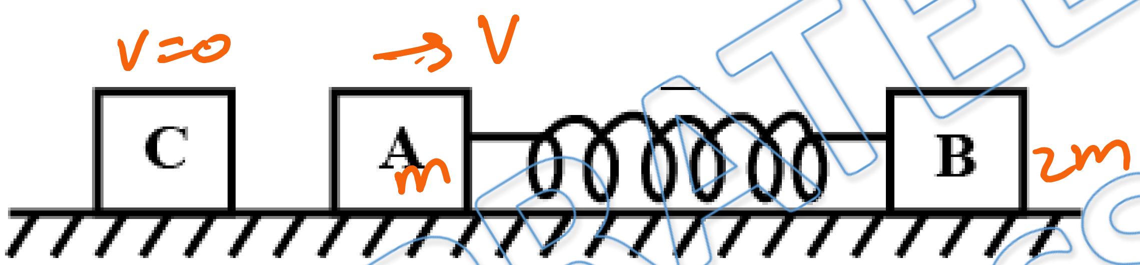
$\boxed{KE_f = \frac{mV^2}{4}}$

Ans. d

Solution: 13



after collision between A & C



∵ $m_A = m_C$ & collision is elastic.

Now for AB & spring system

at max compression $v_A = v_B = v_0$

$$mv = (m + 2m)v_0 \Rightarrow \boxed{v_0 = \frac{v}{3}}$$

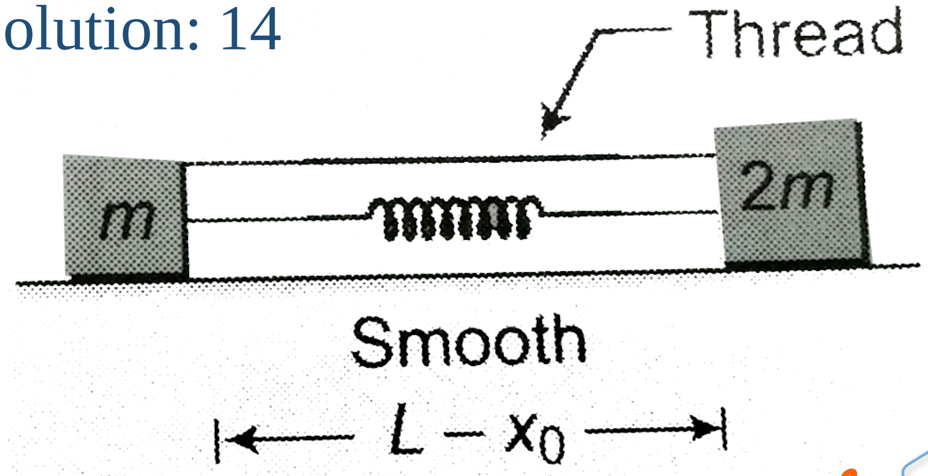
$$v_{cm} = \frac{m\left(\frac{v}{3}\right) + 2m\left(\frac{v}{3}\right)}{m + 2m}$$

$$v_{cm} = \frac{3m\left(\frac{v}{3}\right)}{3m}$$

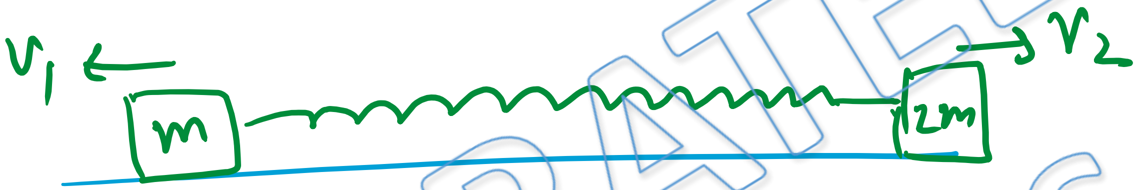
$$\boxed{v_{cm} = \frac{v}{3}}$$

Ans. b

Solution: 14



Let at Natural length of spring



∵ for m, 2m & spring system

$F_{ext} = 0$

∴ momentum is conserved

so; $0 = 2mV_2 - mV_1$

$\Rightarrow mV_1 = 2mV_2$

$$V_1 = 2V_2 \quad \text{—(1)}$$

& from Energy Conservation

$$\frac{1}{2}k(x_0)^2 = \frac{1}{2}mV_1^2 + \frac{1}{2}2mV_2^2$$

$$kx_0^2 = mV_1^2 + 2mV_2^2 \quad \text{—(2)}$$

$$kx_0^2 = m(2V_2)^2 + 2mV_2^2$$

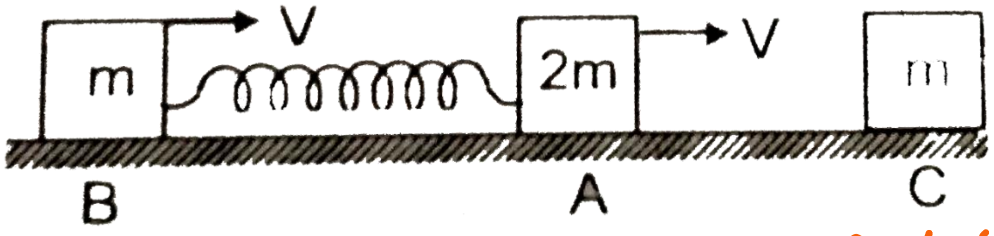
$$kx_0^2 = 6mV_2^2$$

$$V_2 = \sqrt{\frac{k}{6m}}\, x_0$$

& $$V_1 = 2\sqrt{\frac{k}{6m}}\, x_0$$ Ans.

Ans. a

Solution: 15



after collision between A & C

∵ elastic collision.

∴

$$v_1 = \left(\frac{2m-m}{2m+m}\right)v + 0 = \frac{v}{3}$$

$$v_2 = \left(\frac{2(2m)}{2m+m}\right)v + 0 = \frac{4v}{3}$$

∴

now B + A + spring system.

at max compression

$$v_B = v_A = v_0$$

$$mv + 2m\left(\frac{v}{3}\right) = (m+2m)v_0$$

$$\frac{5}{3}mv = 3mv_0$$

$$\boxed{v_0 = \frac{5}{9}v}$$

from energy conservation

$$\frac{1}{2}mv^2 + \frac{1}{2}(2m)\left(\frac{v}{3}\right)^2 = \frac{1}{2}(3m)\left(\frac{5}{9}v\right)^2 + \frac{1}{2}kx^2$$

$$mv^2 + \frac{2mv^2}{9} = \frac{75\,mv^2}{81} + kx^2$$

$$kx^2 = \frac{99\,mv^2}{81} - \frac{75\,mv^2}{81} = \frac{24\,mv^2}{81}$$

$$kx^2 = \frac{8}{27}mv^2 \Rightarrow x = \frac{8m}{27k}v^2$$

$$\boxed{x = \sqrt{\frac{8m}{27k}}\,v}$$ Ans.

Ans. d

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Chalo Niklo