DPP – 6

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Q 1. The coefficient of restitution e for a perfectly elastic collision is
(a) 0 (b) 1
(c) -1 (d) ∞

Q 2. An object A collides head-on elastically with a stationary object B. The object B will recoil with maximum speed if (e=1)
(a) $M_B \gg M_A$ (b) $M_B \ll M_A$
(c) $M_B = M_A$ (d) Insufficient data to predict

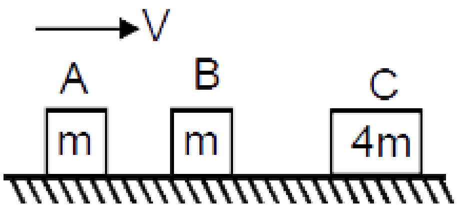
Q 3. An object A of mass m with initial velocity u collides with a stationary object B after elastic collision A moves with $\frac{u}{4}$ calculate mass of B
(a) $\frac{7m}{5}$ (b) $\frac{3m}{5}$
(c) $\frac{9m}{5}$ (d) $\frac{4m}{5}$

Q 4. An object A of mass m moving with speed u collides one dimensionally with another stationary identical object B. Find the velocity of A after collision, if coefficient of restitution of collision is e
(a) $\left[\frac{1-e}{2}\right]u$ (b) $\left[\frac{1+e}{2}\right]u$
(c) eu (d) $-eu$

Q 5. A ball of mass m moving with a speed $2v_0$ collides head-on with an identical ball at rest. If e is the coefficient of restitution, then what will be the ratio of velocity of two balls after collision?
(a) $\frac{1-e}{1+e}$ (b) $\frac{1+e}{1-e}$
(c) $\frac{e-1}{e+1}$ (d) $\frac{e+1}{e-1}$

Q 6. A ball of mass m moving at a speed v makes a head-on collision with an identical ball at rest. The kinetic energy of the balls after the collision is three fourths of the original. Find the coefficient of restitution
(a) 1 (b) $\sqrt{2}$
(c) $\frac{1}{2}$ (d) $\frac{1}{\sqrt{2}}$

Q 7. Three blocks are initially placed as shown in the figure. block A has mass m and initial velocity v to the right. Block B with mass m and block C with mass 4m are both initially at rest. Neglect friction. All collisions are elastic. The final velocity of block A is :



(a) 0.6v to the left
(b) 1.4v to the left
(c) v to the left
(d) 0.4v to the left

Q 8. A block of mass 5 kg moves from left to right with a velocity of 2m/s and collides with another block of mass 3 kg moving along the same line in the opposite direction with velocity 4m/s. If coefficient of restitution is 0.6, determine velocity of the 5 kg block after their collision
(a) 0.6 m/s towards right (b) 1.6 m/s towards left
(c) 1.6 m/s towards right (d) 0.6 towards left

Q 9. Two bodies of masses 5 kg and 3 kg moving in the same direction along the same straight line with velocities 5m/s and 3m/s respectively suffer one-dimensional elastic collision . Find their velocities after the collision
(a) -3.5 m/s, 5.5 m/s (b) 5.5 m/s, 3.5 m/s
(c) 3.5 m/s, 5.5 m/s (d) 2.5 m/s, 4.5 m/s

Q 10. A 10 kg ball and 20 kg ball approach each other with velocities 20m/s and $-10m/s$ respectively . What are their velocities after collision if the collision is perfectly elastic ?
(a) 10 m/s, 20 m/s (b) -10 m/s, 20 m/s
(c) 15 m/s, 25 m/s (d) -20 m/s, 10 m/s

Q 11. In an inelastic collision, which of the following is incorrect
(a) the velocity of both the particles may be same after the collision
(b) kinetic energy is not conserved
(c) linear momentum of the system is conserved
(d) velocity of separation after collision will be more than velocity of approach before collision

Q 12. Two particles of masses 0.5 kg and 0.25kg moving with velocity 4.0 m/s and $-3.0m/s$ collide head on in a perfectly inelastic collision. Find the velocity of the composite particle after collision and KE lost in the collision
(a) 1.67 m/s, 4.1 J (b) 4.1 m/s, 1.67 J
(c) 1.25 m/s, 4.8 J (d) 1.27 m/s, 3.2 J

Q 13. Two equal lumps of putty are suspended side by side from two long strings so that they are just touching. One is drawn aside so that its center of gravity rises a vertical distance

h. It is released and then collides inelastically with the other one. The vertical distance risen by the center of gravity of the combination is -

(a) h (b) 3h/4

(c) h/2 (d) h/4

Q 14. As shown in figure A, B and C are identical balls B and C are at rest and, the ball A moving with velocity v collides elastically with ball B, then after collision:

(a) All the three balls move with velocity v/2

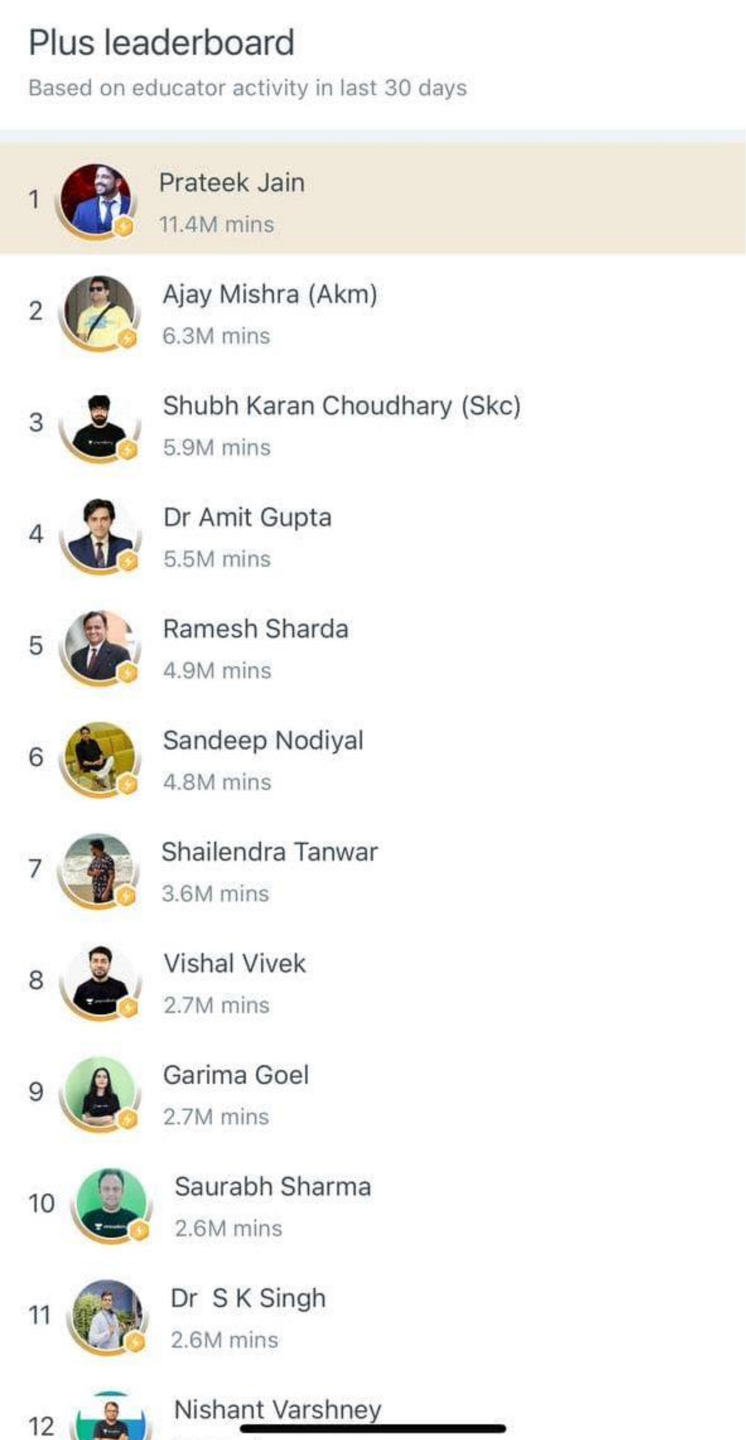
(b) A comes to rest and (B + C) moves with velocity $v/\sqrt{2}$

(c) A moves with velocity v and (B + C) moves with velocity v

(d) A and B come to rest and C moves with velocity v

Answer Key

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



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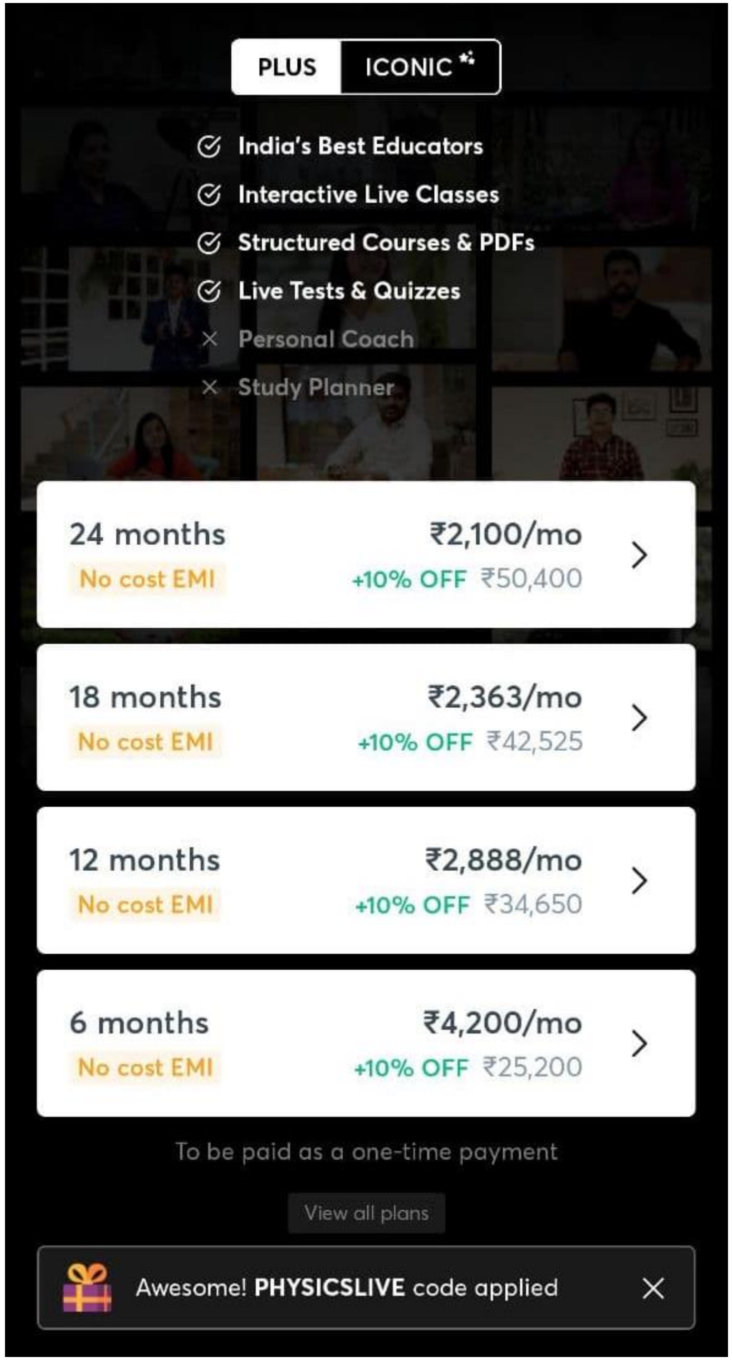

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Written Solution

DPP-6 COM: Elastic & Inelastic Collision, Coefficient of restitution

By Physicsaholics Team

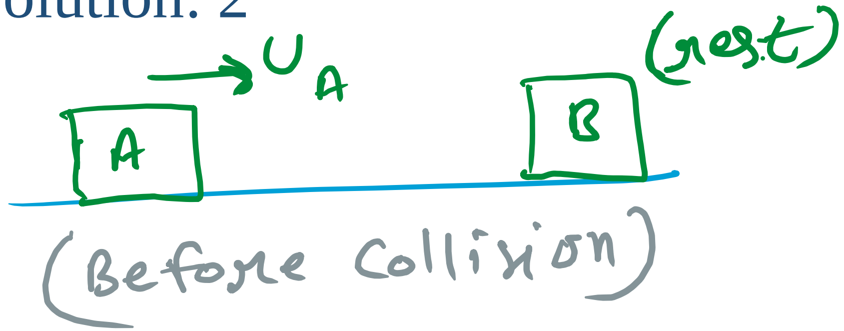
Solution: 1

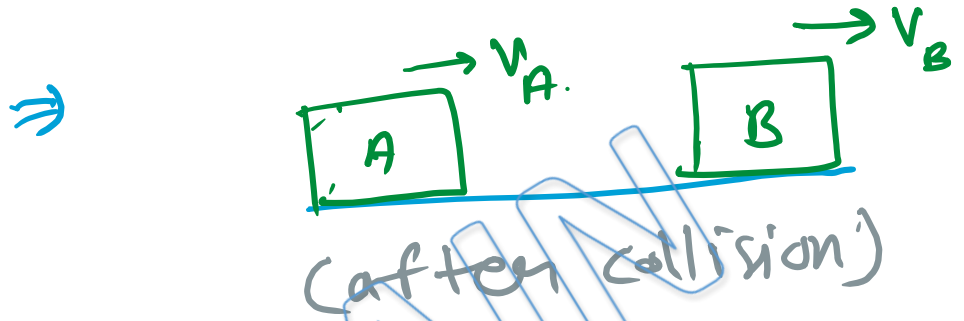
For perfectly elastic collision

$$\boxed{e = 1}$$

Ans. b

Solution: 2





$$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) u_1 + \left(\frac{2m_2}{m_1 + m_2}\right) u_2$$

$$v_2 = \left(\frac{2m_1}{m_1 + m_2}\right) u_1 + \left(\frac{m_2 - m_1}{m_1 + m_2}\right) u_2$$

$\because u_2 = 0$

$$\therefore v_A = \left(\frac{m_A - m_B}{m_A + m_B}\right) u_A$$

$$v_B = \left(\frac{2m_A}{m_A + m_B}\right) u_A$$

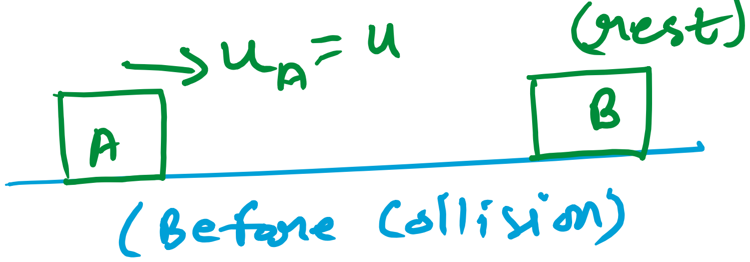
$$v_B = \frac{2}{\left(1 + \frac{m_B}{m_A}\right)} v_A$$

for maximum value of v_B quantity in bracket should be smallest. i.e. $\frac{m_B}{m_A} \to 0$

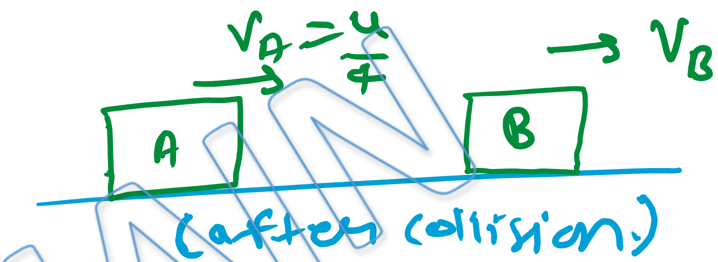
or $m_B << m_A$.

Ans. b

Solution: 3



$\Rightarrow$



for collision

$F_{ext} = 0$

$p_i = p_f$

$m(u) = m\left(\frac{u}{4}\right) + m_B(v_B)$

$\frac{3mu}{4} = m_B v_B \quad \text{— (1)}$

for elastic collision

$e = 1$

$e = \frac{v_B - v_A}{u_A} \Rightarrow \frac{v_B - u/4}{u} = 1$

$v_B = u + u/4 = \frac{5u}{4}$

$\boxed{v_B = \frac{5u}{4}} \quad \text{— (2)}$

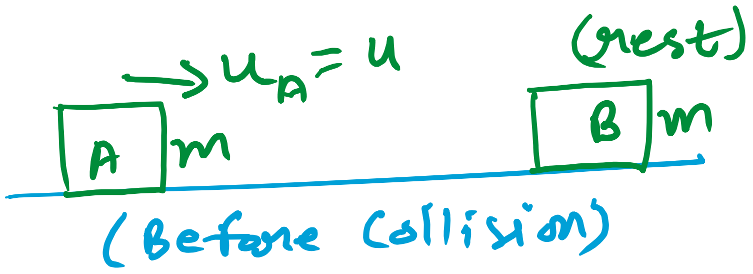
Put v_B in eq^n (1)

$\frac{3mu}{4} = m_B\left(\frac{5u}{4}\right)$

$\boxed{m_B = \frac{3m}{5}}$ Ans.

Ans. b

Solution: 4



$$P_i = P_f$$

$$mu = mV_A + mV_B$$

$$u = V_A + V_B \quad \text{--- (1)}$$

$$e = \frac{V_B - V_A}{u_A} = \frac{V_B - V_A}{u}$$

$$eu = V_B - V_A \quad \text{--- (2)}$$

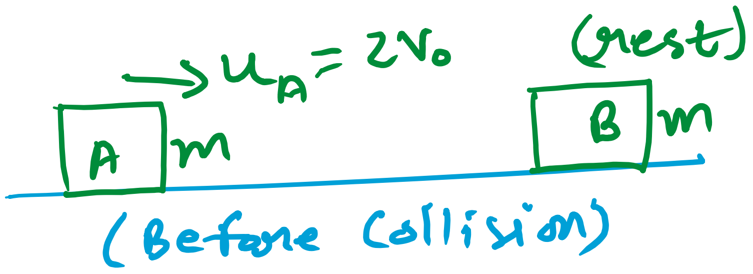
From eq^n (1) & (2)

$$(1) - (2) \Rightarrow u - eu = 2V_A$$

$$V_A = \frac{u(1-e)}{2} \quad \text{Ans.}$$

Ans. a

Solution: 5



$$P_i = P_f$$

$$mu = mV_A + mV_B$$

$$\boxed{u = V_A + V_B} \quad \text{--- (1)}$$

$$e = \frac{V_B - V_A}{u_A} = \frac{V_B - V_A}{u}$$

$$\boxed{eu = V_B - V_A} \quad \text{--- (2)}$$

From eq^n (1) & (2)

$$(1) - (2) \Rightarrow u - eu = 2V_A$$

$$\boxed{V_A = \frac{u(1-e)}{2}}$$

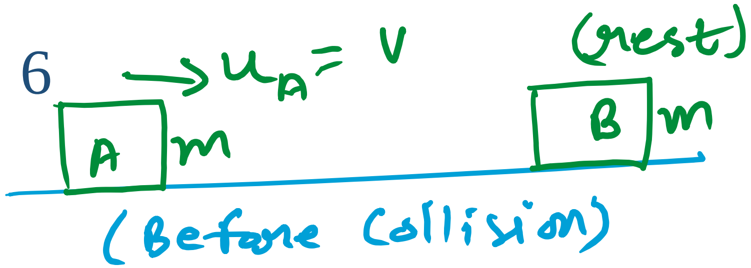
$$(1) + (2) \quad u(1+e) = 2V_B$$

$$\boxed{V_B = \frac{u(1+e)}{2}}$$

$$\Rightarrow \boxed{\frac{V_A}{V_B} = \frac{1-e}{1+e}}$$

Ans. a

Solution: 6



$$\frac{3}{4}(KE_i) = KE_f$$

$$\frac{3}{4}\left(\frac{1}{2} m v^2\right) = \frac{1}{2} m v_A^2 + \frac{1}{2} m v_B^2$$

$$\frac{3}{4} v^2 = v_A^2 + v_B^2 \quad \text{—— (1)}$$

$$e = \frac{v_B - v_A}{v}$$

$$v_B - v_A = e v \quad \text{—— (2)}$$

$$(v_B - v_A)^2 = e^2 v^2 \quad \text{—— (3)}$$

$$m v = m v_A + m v_B$$

$$v = v_A + v_B$$

$$(v_A + v_B)^2 = v^2 \quad \text{—— (4)}$$

from eq (1)

$$\left[v_A^2 + v_B^2\right] = \frac{3}{4} v^2$$

$$\left[\frac{(v_A + v_B)^2 + (v_A - v_B)^2}{2}\right] = \frac{3}{4} v^2$$

$$\frac{v^2 + e^2 v^2}{2} = \frac{3}{4} v^2$$

$$2 + 2e^2 = 3 \Rightarrow 2e^2 = 1$$

$$e^2 = \frac{1}{2} \Rightarrow \boxed{e = \frac{1}{\sqrt{2}}} \text{ Ans.}$$

Ans. d

OR

final Kinetic energy = $\frac{3}{4}$ initial KE.

$\Rightarrow$ loss in KE = $\frac{1}{4} \times$ initial KE.

(formula of loss in KE $= \frac{1}{2}\mu V_{rel}^2 (1-e^2)$ where $\mu = \frac{m_1 m_2}{m_1+m_2}$ and V_{rel} is initial relative velocity of objects)

$$\Rightarrow \frac{1}{2} \times \left(\frac{m \times m}{m+m}\right)(V-0)^2(1-e^2) = \frac{1}{4} \times \frac{1}{2} m V^2$$

$$\Rightarrow \frac{1}{4}(1-e^2) = \frac{1}{8}$$

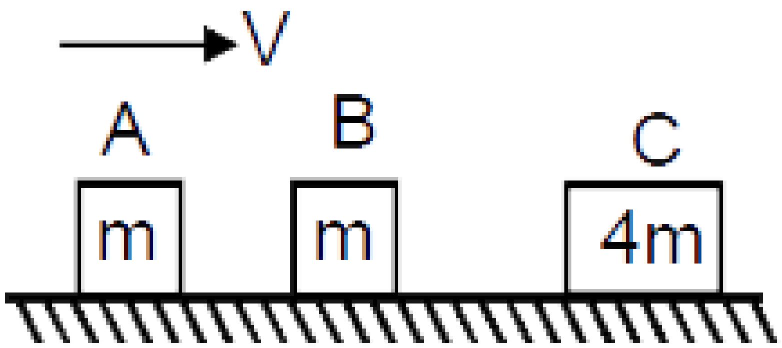
$$\Rightarrow 1-e^2 = \frac{1}{2}$$

$$e^2 = 1/2$$

$$e = 1/\sqrt{2}$$

Ans. d

Solution: 7



→ 1st collision between A & B

after elastic collision between A & B

$\because m_A = m_B = m$

A (rest) B → V

→ 2nd collision between B & C

B (m) → V, C (4m) (rest) ⇒ m → V_1, 4m → V_2

$$V_1 = \frac{m - 4m}{5m} V + 0 = -\frac{3}{5}V$$

-ve sign shows B will move backword

→ 3rd collision between B & A

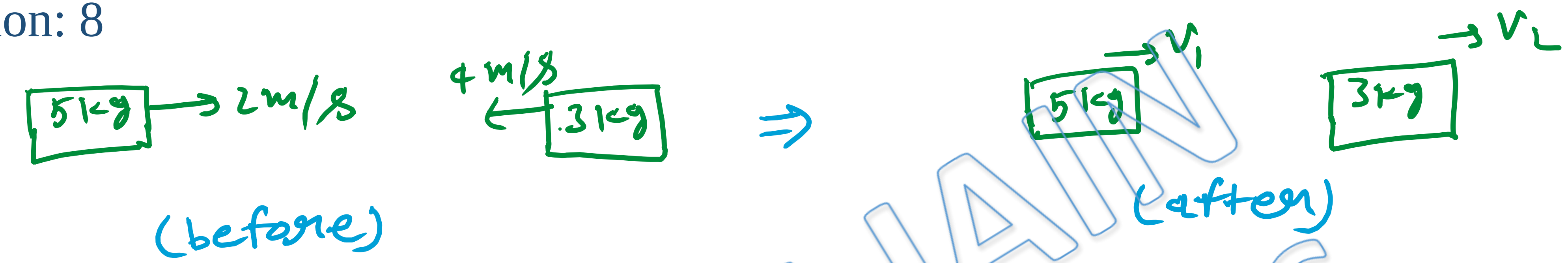
[∵ Elastic collision & equal mass]

A (rest) ← $\frac{3v}{5}$ B ⇒ ← $\frac{3V}{5}$ A, B (rest)

So; Final velocity of A = $\frac{3}{5}V$ = 0.6V (towards left)

Ans. a

Solution: 8



$P_i = P_f$

$(5\times 2) - 3\times 4 = 5v_1 + 3v_2$

$-2 = 5v_1 + 3v_2$ — ①

$e = \dfrac{v_2 - v_1}{2+4} = 0.6$

$\dfrac{v_2 - v_1}{6} = 0.6$

$v_2 - v_1 = 3.6$ — ②

$v_2 = 3.6 + v_1$

put v_2 in eqn ①

$-2 = 5v_1 + 3(3.6 + v_1) = 8v_1 + 10.8$

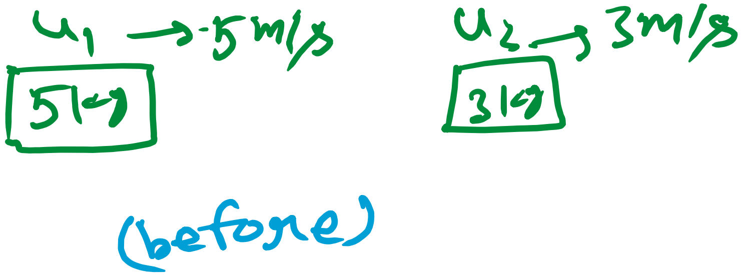
$8v_1 = -12.8 \Rightarrow v_1 = \dfrac{-12.8}{8}$

$\boxed{v_1 = -1.6\ m/s}$ Ans.

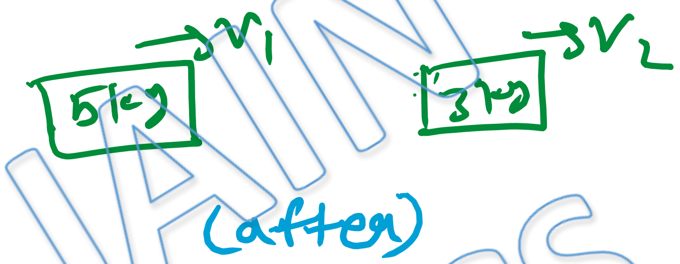
$\boxed{v_1 = 1.6\ m/s \text{ towards left}}$

Ans. b

Solution: 9



$\Rightarrow$



$P_i = P_f$

$5 \times 5 + 3 \times 3 = 5V_1 + 3V_2$

$34 = 5V_1 + 3V_2 \quad \text{—(1)}$

$e = \dfrac{V_2 - V_1}{5 - 3} = 1$

[$\because$ elastic collision]

$V_2 - V_1 = 2$

$V_2 = 2 + V_1 \quad \text{—(2)}$

from (1) & (2)

$34 = 5V_1 + 3(2 + V_1)$

$34 = 8V_1 + 6 \Rightarrow 8V_1 = 28$

$V_1 = \dfrac{28}{8} = \dfrac{7}{2}\,m/s$

$\boxed{V_1 = 3.5\,m/s}$

$\boxed{V_2 = 5.5\,m/s}$

Ans. c

OR

$$V_{1f} = \frac{m_1 - m_2}{m_1 + m_2} V_{1i} + \frac{2m_2}{m_1 + m_2} V_{2i}$$

$$V_{2f} = \frac{2m_1}{m_1 + m_2} V_{1i} + \frac{m_2 - m_1}{m_1 + m_2} V_{2i}$$

$$V_{1f} = \frac{5-3}{5+3} \times 5 + \frac{2 \times 3}{5+3} \times 3 = \frac{5}{4} + \frac{9}{4} = \frac{7}{2} \text{ m/sec}$$

$$V_{2f} = \frac{2 \times 5}{8} \times 5 + \frac{3-5}{8} \times 3 = \frac{25}{4} - \frac{3}{4} = 5.5 \text{ m/sec}$$

Ans. c

Solution: 10

$$v_1 = \left(\frac{10-20}{10+20}\right)(20) + \left(\frac{2(20)}{10+20}\right)(-10)$$

$$= \frac{-10}{30}(20) + \frac{40}{30}(-10) = \frac{-600}{30} \Rightarrow \boxed{v_1 = -20\ \text{m/s}}$$

$$v_2 = \frac{2(10)}{10+20}(20) + \left(\frac{20-10}{10+20}\right)(-10)$$

$$= \left(\frac{20}{30}\right)(20) + \left(\frac{10}{30}\right)(-10) = \frac{300}{30} \Rightarrow \boxed{v_2 = 10\ \text{m/s}}$$

Ans. d

Solution: 11 For Inelastic collision

$$0 \le e < 1$$

(a) for $e = 0$

$$v_1 = v_2$$

(b) KE is not conserved in inelastic collision

(c) momentum is conserved in all type of collisions.

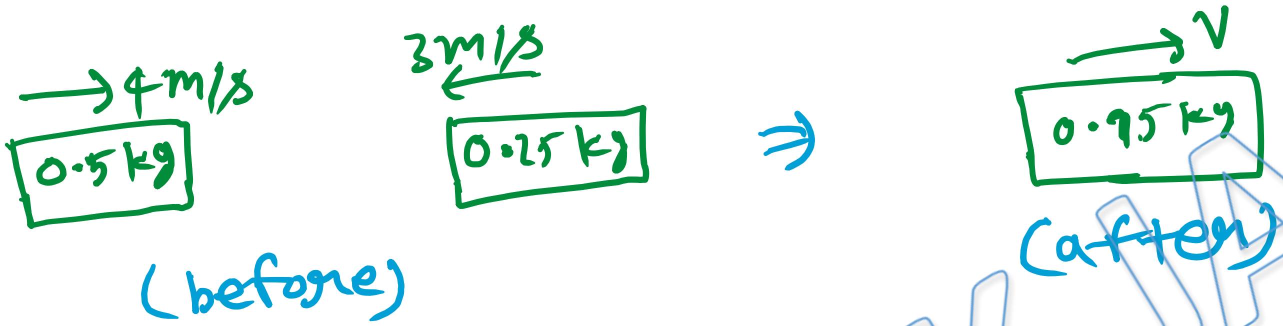
(d) $\because \; e = \frac{\text{Vel. of separation}}{\text{Vel. of approach}} < 1$

so; Vel. of separation < Vel. of approach.

$\Rightarrow$ (d) is incorrect statement

Ans. d

Solution: 12



$P_i = P_f$

$0.5 \times 4 - 0.25 \times 3 = 0.75V$

$2 - 0.75 = 0.75V$

$1.25 = 0.75V$

$V = \frac{1.25}{0.75}$

$$\boxed{V = 1.67 \text{ m/s}}$$ Ans

loss : $\Delta KE = KE_i - KE_f$

$= \frac{1}{2}(0.5)(4)^2 + \frac{1}{2}(0.25)(3)^2 - \frac{1}{2}(0.75)(1.67)^2$

$= 4 + 1.125 - 1.045$

$\Delta KE = 4.08$ J

$$\boxed{\Delta KE \simeq 4.1 \text{ J}}$$ Ans

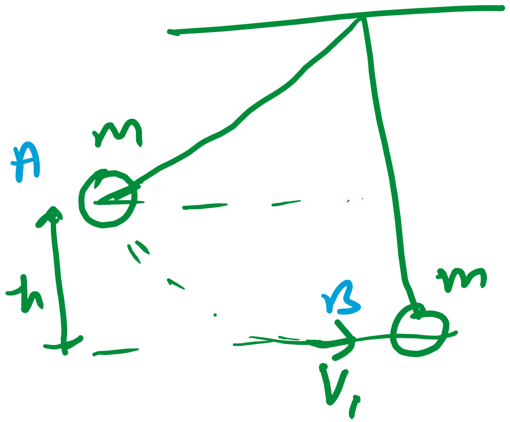
OR

loss in KE in perfectly inelastic Collision $= \frac{1}{2}\mu V_{rel}^2 = \frac{1}{2} \times \frac{.5 \times .25}{.75} \times 7^2$

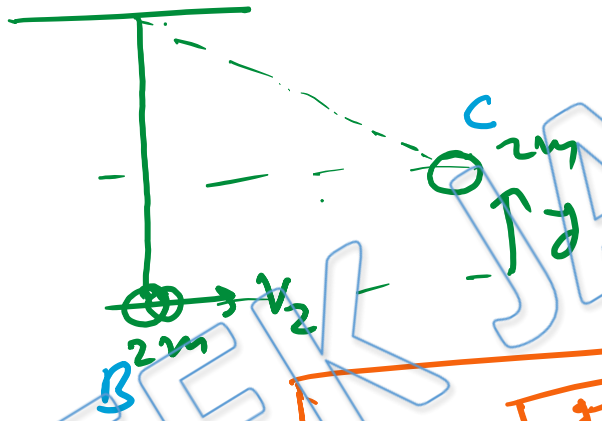
$= \frac{49 \times .5}{6} = 4.1$ J

Ans. a

Solution: 13



⇒



$$\boxed{v_2 = \sqrt{\frac{gh}{2}}}$$

$$mgh = \frac{1}{2} m v_1^2$$

$$\boxed{v_1 = \sqrt{2gh}}$$

Now Both collieds

so; $mv_1 = 2mv_2$

$$v_2 = \frac{v_1}{2} = \sqrt{\frac{gh}{2}}$$

B → C energy conservation

$$\frac{1}{2}(2m) v_2^2 = (2m) g y$$

$$m\left(\frac{gh}{2}\right) = 2m g y \Rightarrow \boxed{y = \frac{h}{4}} \text{ Ans.}$$

Ans. d

Solution: 14 There will be two collisions. first between A & B and then between B and C.

as collision is elastic

& mass of all balls are equal

the → 1st collision (A & B)

(A) → v (B) (rest) ⇒ (A) (rest) ( ) → v

(before) (after)

→ 2nd collision (B & C)

(B) → v (C) (rest) ⇒ (B) (rest) (C) → v

(before) (after)

So; finally A & B are at rest and C will move with velocity v

Ans. d

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Chalo Niklo