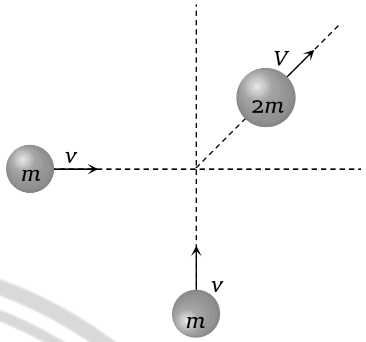
Perfectly Inelastic Collision

1. (c)



Initial momentum of the system

$\vec{P}_i = mv\hat{\imath} + mv\hat{\jmath}$

$|\vec{P}_i| = \sqrt{2}mv$

Final momentum of the system = $2mV$

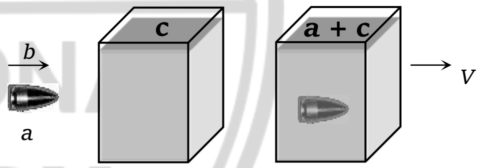
By the law of conservation of momentum

$\sqrt{2}mv = 2mV \Rightarrow V = \frac{v}{\sqrt{2}}$

2. (b)

3. (c)

4. (b)



Initially bullet moves with velocity *b* and after collision bullet get embedded in block and both move together with common velocity.

By the conservation of momentum

$\Rightarrow a \times b + 0 = (a + c)\, V \Rightarrow V = \frac{ab}{a+c}$

5. (d) Initially mass 10 *gm* moves with velocity 100 *cm/s*

$\therefore$ Initial momentum = 10 × 100 = $1000\frac{gm \times m}{sec}$

After collision system moves with velocity $v_{sys.}$ then

Final momentum = $(10 + 10) \times v_{sys.}$

By applying the conservation of momentum

$10000 = 20 \times v_{sys.} \Rightarrow v_{sys.} == 50\ cm \rightleftarrows / \rightleftarrows\ s$

If system rises upto height *h* then

$$h = \frac{v_{sys.}^2}{2g} = \frac{50 \times 50}{2 \times 1000} = \frac{2.5}{2} = 1.25\ cm$$

6. (b)

7. (c)

8. (c) $m_1 v_1 - m_2 v_2 = (m_1 + m_2) v$

$\Rightarrow 2 \times 3 - 1 \times 4 = (2+1)\ v \Rightarrow v = \frac{2}{3}\ m/s$

9. (c) Initial momentum of the system = $mv - mv = 0$

As body sticks together $\therefore$ final momentum = $2mV$

By conservation of momentum $2mV = 0 \therefore V = 0$

10. (a) If initially second body is at rest then

Initial momentum = mv

Final momentum = $2mV$

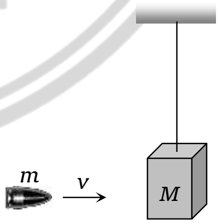
By conservation of momentum $2mV = mv \Rightarrow V = \frac{v}{2}$

11. (d)

Initial momentum = mv

Final momentum = $(m + M)V$

By conservation of momentum $mv = (m + M)V$



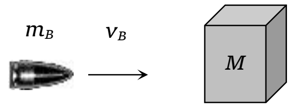
$\therefore$ Velocity of (bag + bullet) system $V = \frac{mv}{M+m}$

$\therefore$ Kinetic energy = $\frac{1}{2}(m + M)\ V^2$

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

12. (b)

Initial K.E. of system = K.E. of the bullet $=\frac{1}{2} m_B v_B^2$



By the law of conservation of linear momentum

$$m_B v_B + 0 = m_{\text{sys.}} \times v_{\text{sys.}}$$

$\Rightarrow v_{\text{sys.}} = \frac{m_B v_B}{m_{\text{sys.}}} = \frac{50\times10}{50+950} = 0.5\ m \rightleftarrows/\rightleftarrows s$

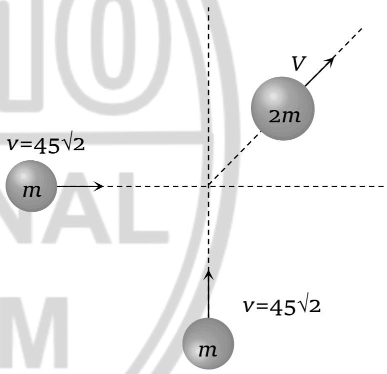
Fractional loss in K.E. $= \frac{\frac{1}{2}m_B v_B^2 - \frac{1}{2}m_{\text{sys.}} v_{\text{sys.}}^2}{\frac{1}{2}m_B v_B^2}$

By substituting $m_B = 50 \times 10^{-3} kg,\ v_B = 10\ m \rightleftarrows/\rightleftarrows s$

$m_{\text{sys.}} = 1kg,\ v_s = 0.5\ m \rightleftarrows/\rightleftarrows s$ we get

Fractional loss $= \frac{95}{100}$ $\therefore$ Percentage loss = 95%

13. (b)



Initial momentum

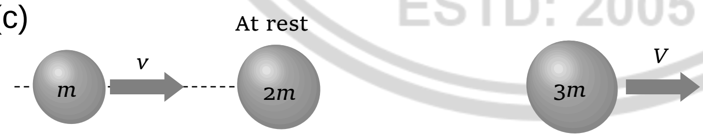
$\vec{P} = m45\sqrt{2}\ \hat{\imath} + m45\sqrt{2}\ \hat{\jmath} \Rightarrow |\vec{P}| = m \times 90$

Final momentum $2m \times V$

By conservation of momentum $2m \times V = m \times 90$

$\therefore V = 45m \rightleftarrows/\rightleftarrows s$

14. (c)



Before collision After collision

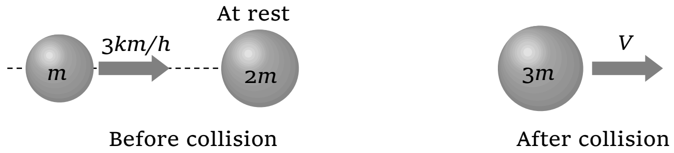
Initial momentum = mv

Final momentum = $3mV$

By the law of conservation of momentum $mv = 3mV$

$\therefore V = v/3$

15. (c)



Initial momentum = $m \times 3 + 2m \times 0 = 3m$

Final momentum = $3m \times V$

By the law of conservation of momentum

$3m = 3m \times V \Rightarrow V = 1\ km/h$

16. (d) Loss in K.E. = (initial K.E. – Final K.E.) of system

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 - \frac{1}{2}(m_1 + m_2)V^2$$

$= \frac{1}{2}3 \times (32)^2 + \frac{1}{2} \times 4 \times (5)^2 - \frac{1}{2} \times (3 + 4) \times (5)^2$

= 986.5 J

17. (a) Momentum of earth-ball system remains conserved.

18. (b) $v = 36km/h = 10m/s$

By law of conservation of momentum

$2 \times 10 = (2 + 3)V \Rightarrow V = 4m/s$

Loss in K.E.= $\frac{1}{2} \times 2 \times (10)^2 - \frac{1}{2} \times 5 \times (4)^2 = 60J$

19. (d) Initial momentum = $\vec{P} = mv\hat{i} + mv\hat{j}$

$|\vec{P}| = \sqrt{2}mv$

Final momentum = $2m \times V$

By the law of conservation of momentum

$2m \times V = \sqrt{2}\ mv \Rightarrow V = \frac{v}{\sqrt{2}}$

In the problem $v = 10m \rightleftarrows/\rightleftarrows s$ (given) $\therefore V = \frac{10}{\sqrt{2}} = 5\sqrt{2}\ m/s$

20. (a) Because in perfectly inelastic collision the colliding bodies stick together and move with common velocity

21. (b) $m_1v_1 + m_2v_2 = (m_1 + m_2)v_{\text{sys.}}$

$20 \times 10 + 5 \times 0 = (20 + 5)\ v_{\text{sys.}} \Rightarrow v_{\text{sys.}} = 8m/s$

K.E. of composite mass $= \frac{1}{2}(20 + 5) \times (8)^2 = 800J$

22. (c) According to law of conservation of momentum.

Momentum of neutron = Momentum of combination

$\Rightarrow 1.67 \times 10^{-27} \times 10^8 = (1.67 \times 10^{-27} + 3.34 \times 10^{-27})\ v$

$\therefore v = 3.33 \times 10^7 m/s$

23. (b)

24. (c) Loss in kinetic energy

$= \frac{1}{2}\frac{m_1m_2(u_1-u_2)^2}{m_1+m_2} = \frac{1}{2}\left(\frac{40\times60}{40+60}\right)(4-2)^2 = 48Joule$

25. (b) By momentum conservation before and after collision.

$m_1V + m_2 \times 0 = (m_1 + m_2)v \Rightarrow v = \frac{m_1}{m_1+m_2}V$

i.e. Velocity of system is less than *V.*

26. (a) By conservation of momentum, $mv + M \times 0 = (m + M)V$

Velocity of composite block $V = \left(\frac{m}{m+M}\right)v$

K.E. of composite block $= \frac{1}{2}(M+m)V^2$

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

27. (b)

28. (d) Velocity of combined mass, $v = \frac{m_1v_1 - m_2v_2}{m_1+m_2}$

$= \frac{0.1\times1-0.4\times0.1}{0.5} = 0.12\ m/s$

$\therefore$ Distance travelled by combined mass

$= v \times t = 0.12 \times 10 = 1.2\ m.$

29. (c) Loss in K.E. $= \frac{m_1m_2}{2(m_1+m_2)}(u_1-u_2)^2$

$= \frac{4\times6}{2\times10} \times (12-0)^2 = 172.8\ J$

30. (d) In case of perfectly inelastic collision, the bodies stick together after impact.