IMPULSE AND MOMENTUM
SOLUTIONS
LEVEL – 1

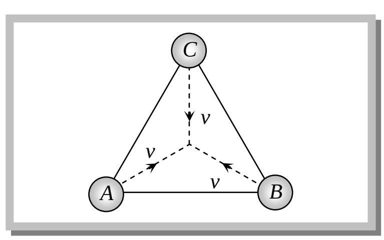
MOMENTUM CONSERVATION

1. The law of conservation of momentum is based on Newton's is
(1) First law of motion
(2) Second law of motion
(3) Third law of motion
(4) Law of gravitation

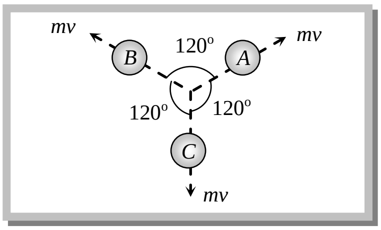
2. A car of mass $400kg$ and travelling at 72 *kmph* crashes into a truck of mass $4000kg$ and travelling at 9 *kmph*, in the same direction. The car bounces back at a speed of 18 *kmph*. The speed of the truck after the impact is
(1) 9 *kmph*
(2) 18 *kmph*
(3) 27 *kmph*
(4) 36 *kmph*
Solution :
(2) By the law of conservation of linear momentum $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
$\Rightarrow \quad 400 \times 72 + 4000 \times 9 = 400 \times (-18) + 4000 \times v_2 \quad \Rightarrow v_2 = 18 km/h$.

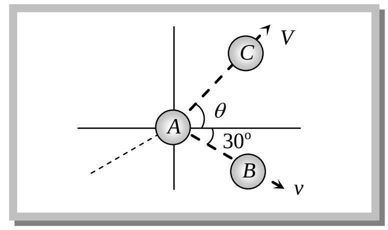
3. A body of mass *m* moving along a straight line collides with a body of mass *nm* which is also moving with a velocity *kv* in the same direction. If the first body comes to rest after the collision, then the velocity of second body after the collision would be
(1) $\frac{nv}{(1+nk)}$
(2) $\frac{nv}{(1-nk)}$
(3) $\frac{(1-nk)v}{n}$
(4) $\frac{(1+nk)v}{n}$
Solution :
(4) Initial momentum = $mv + nm(kv)$ and final momentum $= 0 + nmV$
By the conservation of momentum, $mv + nm(kv) = 0 + nmV$
$\Rightarrow v + nkv = nV \Rightarrow nV = (1+nk)v \Rightarrow V = \frac{(1+nk)v}{n}$

4. Three particles *A*, *B* and *C* of equal mass are moving with the same velocity *v* along the medians of an equilateral triangle. These particle collide at the centre *G* of triangle. After collision *A* becomes stationary, *B* retraces its path with velocity *v* then the magnitude and direction of velocity of *C* will be
(1) *v* and opposite to *B*
(2) *v* and in the direction of *A*
(3) *v* and in the direction of *C*
(4) *v* and in the direction of *B*



Solution :
(4) From the figure (I) it is clear that before collision initial momentum of the system = 0
After the collision, *A* becomes stationary, *B* retraces its path with velocity *v*. Let *C* moves with velocity *V* making an angle θ from the horizontal. As the initial momentum of the system is zero, therefore horizontal and vertical momentum after the collision should also be equal to zero.





From figure (II) Horizontal momentum $v\cos\theta + v\cos 30^o = 0$ …..(i)

Vertical momentum $v\sin\theta - v\sin 30^o = 0$ …..(ii)

By solving (i) and (ii) we get $\theta = -30^o$ and $V = v$ *i.e.* the *C* will move with velocity *v* in the direction of *B*.

5. A ball B_1 of mass *M* moving northwards with velocity *v* collides elastically with another ball B_2 of samce mass but moving eastwards with the same velocity *v*. Which of the following statements will be true

(1) B_1 comes to rest but B_2 moves with velocity $\sqrt{2}v$

(2) B_1 moves with velocity $\sqrt{2}v$ but B_2 comes to rest

(3) Both move with velocity $v/\sqrt{2}$ in north east direction

(4) B_1 moves eastwards and B_2 moves north wards

Solution :

(4) Horizontal momentum and vertical momentum both should remain conserve before and after collision. This is possible only for the (4) option.

6. The change of momentum in each ball of mass $60gm$, moving in opposite directions with speeds $4m/s$ collide and rebound with the same speed, is

(1) $0.98 kg\text{-}m/s$ (2) $0.73 kg\text{-}m/s$

(3) $0.48 kg\text{-}m/s$ (4) $0.22 kg\text{-}m/s$

Solution :

(3) Momentum before collision = *mv*, Momentum after collision = – *mv*

$\therefore$ Change in momentum $= 2mv = 2\times 60\times 10^{-3}\times 4 = 480\times 10^{-3} kg\text{-}m/s = 0.48 kg\text{-}m/s$

7. A ball strikes the floor and after collision rebounds back. In this state

(1) Momentum of the ball is conserved

(2) Mechanical energy of the ball is conserved

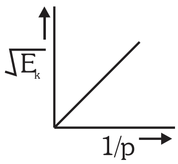
(3) Momentum of ball earth system is conserved

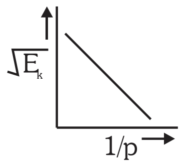
(4) The kinetic energy of ball earth system is not conserved

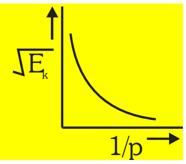
8. A bomb of mass9 kg explodes into two pieces of 3 kg and 6 kg. The velocity of 3 kg piece is 16 m/s. The kinetic energy of 6 kg piece is

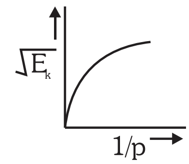
(1) 768 Joule (2) 786 Joule (3) 192 Joule (4) 687 Joule

9. The graph between $\sqrt{E_k}$ and $\frac{1}{p}$ is (E_k = kinetic energy and p = momentum)-

(1) 

(2) 

(3) 

(4) 

10. If similar bullets are fired from two guns out of which one is lighter and another one is heavier. Which gun will give more violent jerk

(1) Same by both
(2) Lighter one
(3) Heavier one
(4) Will depend upon the type of gun

11. Bullets of mass 40 gm each are fired from a machine gun with a velocity of 10^3 m/s. If the person firing the bullets experiences an average force of 200N, then the number of bullets fired per minute will be

(1) 300
(2) 600
(3) 150
(4) 75

ELASTIC COLLISION

12. *n* small balls each of mass *m* impinge elastically each second on a surface with velocity *u*. The force experienced by the surface will be

(1) *mnu*
(2) 2 *mnu*
(3) 4 *mnu*
(4) $\frac{1}{2}$ *mnu*

Solution :

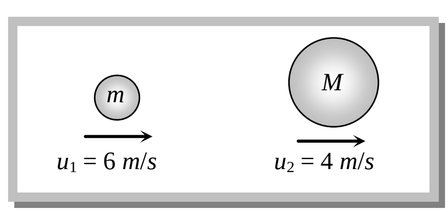
(2) As the ball rebounds with same velocity therefore change in velocity = 2*u* and the mass colliding with the surface per second = *nm*

Force experienced by the surface $F = m\frac{dv}{dt}$ $\therefore$ $F = 2\,mnu$.

13. A particle of mass *m* moving with horizontal speed 6 *m/sec*. If *m*<<*M* then for one dimensional elastic collision, the speed of lighter particle after collision will be

(1) 2 *m/sec* in original direction
(2) 2 *m/sec* opposite to the original direction
(3) 4 *m/sec* opposite to the original direction
(4) 4 *m/sec* in original direction

Solution :



(1) $v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \frac{2m_2u_2}{m_1 + m_2}$

Substituting $m_1 = 0$, $v_1 = -u_1 + 2u_2$

$\Rightarrow v_1 = -6 + 2(4) = 2m/s$

i.e. the lighter particle will move in original direction with the speed of 2 *m/s*.

14. A ball of mass *m* moving with velocity *V*, makes a head on elastic collision with a ball of the same mass moving with velocity 2*V* towards it. Taking direction of *V* as positive velocities of the two balls after collision are

(1) $-V$ and $2V$ (2) $2V$ and $-V$ (3) V and $-2V$ (4) $-2V$ and V

Solution :

(4) Initial velocities of balls are $+V$ and $-2V$ respectively and we know that for given condition velocities get interchanged after collision. So the velocities of two balls after collision are $-2V$ and V respectively.

15. Consider the following statements

Assertion (1) : In an elastic collision of two billiard balls, the total kinetic energy is conserved during the short time of collision of the balls (*i.e.*, when they are in contact)

Reason (R) : Energy spent against friction does not follow the law of conservation of energy of these statements

(1) Both A and R are true and the R is a correct explanation of A

(2) Both A and R are true but the R is not a correct explanation of the A

(3) A is true but the R is false

(4) Both A and R are false

Solution :

(4) (i) When they are in contact some part of kinetic energy may convert in potential energy so it is not conserved during the short time of collision. (ii) Law of conservation of energy is always true.

16. A big ball of mass M, moving with velocity u strikes a small ball of mass m, which is at rest. Finally small ball attains velocity u and big ball v. Then what is the value of v

(1) $\frac{M-m}{M+m}u$ (2) $\frac{m}{M+m}u$ (3) $\frac{2m}{M+m}u$ (4) $\frac{M}{M+m}u$

Solution :

(1) From the standard equation $v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 = \left(\frac{M-m}{M+m}\right)u$.

17. A smooth sphere of mass M moving with velocity u directly collides elastically with another sphere of mass m at rest. After collision their final velocities are V and v respectively. The value of v is

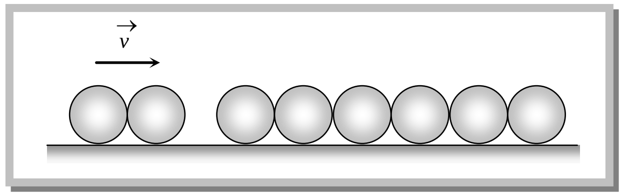
(1) $\frac{2uM}{m}$ (2) $\frac{2um}{M}$ (3) $\frac{2u}{1+\frac{m}{M}}$ (4) $\frac{2u}{1+\frac{M}{m}}$

Solution :

(3) Final velocity of the target $v_2 = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2 + \frac{2m_1u_1}{m_1 + m_2}$

As initially target is at rest so by substituting $u_2 = 0$ we get $v_2 = \frac{2Mu}{M+m} = \frac{2u}{1+\frac{m}{M}}$.

18. Six identical balls are lined in a straight groove made on a horizontal frictionless surface as shown. Two similar balls each moving with a velocity v collide with the row of 6 balls from left. What will happen



(1) One ball from the right rolls out with a speed $2v$ and the remaining balls will remain at rest
(2) Two balls from the right roll out with speed v each and the remaining balls will remain stationary
(3) All the six balls in the row will roll out with speed $v/6$ each and the two colliding balls will come to rest
(4) The colliding balls will come to rest and no ball rolls out from right

Solution :
(2) Only this condition satisfies the law of conservation of linear momentum.

19. Which one of the following statement does not hold good when two balls of masses m_1 and m_2 undergo elastic collision
(1) When $m_1 < m_2$ and m_2 at rest, there will be maximum transfer of momentum
(2) When $m_1 > m_2$ and m_2 at rest, after collision the ball of mass m_2 moves with four times the velocity of m_1
(3) When $m_1 = m_2$ and m_2 at rest, there will be maximum transfer of kinetic energy
(4) When collision is oblique and m_2 at rest with $m_1 = m_2$, after collision the balls move in opposite directions

Solution :
(2,4) We know that transfer of momentum will be maximum when target is massive and transfer of kinetic energy will be maximum when target and projectile are having same mass. It means statement (1) and (3) are correct, but statement (2) and (4) are incorrect because when target is very light, then after collision it will move with double the velocity of projectile and when collision is oblique and m_2 at rest with $m_1 = m_2$, after collision the ball move perpendicular to each other.

20. A body falling from a height of $20m$ rebounds from hard floor. If it loses 20% energy in the impact, then coefficient of restitution is
(1) 0.89 (2) 0.56 (3) 0.23 (4) 0.18

Solution :
(1) It loses 20% energy in impact and only 80% energy remains with the ball
So ball will rise upto height $h_2 = 80\%$ of $h_1 = \frac{80}{100} \times 20 = 16\,m$
Now coefficient of restitution $e = \sqrt{\frac{h_2}{h_1}} = \sqrt{\frac{16}{20}} = \sqrt{0.8} = 0.89.$

21. A rubber ball is dropped from a height of $5m$ on a planet where the acceleration due to gravity is not known. On bouncing, it rises to $1.8m$. The ball loses its velocity on bouncing by a factor of
(1) 16/25 (2) 2/5 (3) 3/5 (4) 9/25

Solution :

(3) If ball falls from height h_1, then it collides with ground with speed

$v_1 = \sqrt{2gh_1}$ …..(i)

and if it rebound with velocity v_2, then it goes upto height h_2 from ground,

$v_2 = \sqrt{2gh_2}$ …..(ii)

From (i) and (ii) $\frac{v_2}{v_1} = \sqrt{\frac{2gh_2}{2gh_1}} = \sqrt{\frac{h_2}{h_1}} = \sqrt{\frac{1.8}{5}} = \sqrt{\frac{9}{25}} = \frac{3}{5}$.

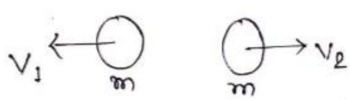
22. Two identical spheres move in opposite directions with speeds v_1 and v_2 and pass behind an opaque screen, where they may either cross without touching (Event 1) or make an elastic head - on collision (Event 2)

(1) We can never make out which event has occurred

(2) We cannot make out which event has occurred only if $v_1 = v_2$

(3) We can always make out which event has occurred

(4) We can make out which event has occurred only if $v_1 = v_2$



$e = \frac{\text{velocity of sepration}}{\text{velocity of approch}}$

$= \frac{\text{final relative velocity}}{\text{Initial relative velocity}}$

$e = \frac{\text{final relative velocity}}{V_1 + V_2}$

for elastic head on collision $e = 1$;

$1 \times (V_1 + V_2) = u_1 + u_2$

we can not pridict the event.

Therefore, option (A) will be the correct answer.

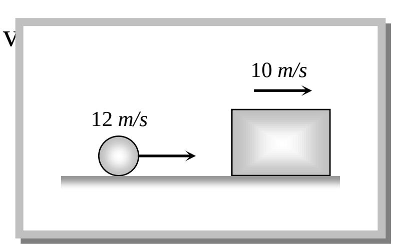
23. A light particle moving horizontally with a speed of 12 *m*/*s* strikes a v heavy block moving in the same direction at 10 *m*/*s*. The collision is one-dimensional and elastic. After the collision, the particle will

(1) Move at 2 *m*/*s* in its original direction

(2) Move at 8 *m*/*s* in its original direction

(3) Move at 8 *m*/*s* opposite to its original direction

(4) Move at 12 *m*/*s* opposite to its original direction



Conservation of momentum,

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

$$\Rightarrow m_1(v_1 - v_1') = m_2(v_2 - v_2') ....(1)$$

Conservation of kinetic energy requires,

$$\frac{1}{2}(m_1v_1^2 + m_2v_2^2) = \frac{1}{2}(m_1v_1'^2 + m_2v_2'^2)$$

$$\Rightarrow m_1(v_1^2 - v_1'^2) = m_2(v_2^2 - v_2'^2)$$

$$\Rightarrow m_1(v_1 - v_1')(v_1 + v_1') = m_2(v_2 - v_2')(v_2 + v_2') ....(2)$$

dividing (2) and (1)

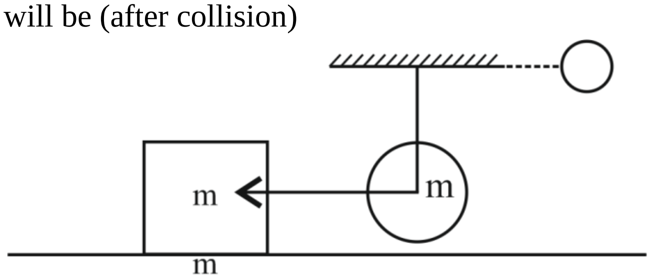
$$v_1 + v_1' = v_2 + v_2'$$

$$12 + v_1' = 10 + 10$$

$$v_1' = 8 m/s$$

24. A sphere A moving with a speed u and rotating with an angular velocity ω, makes a head- on elastic collision with an identical stationary sphere B. There is no friction between the surfaces of A and B. Disregard gravity.
(1) A will stop moving but continue to rotate with an angular velocity ω
(2) A will come to rest and stop rotating
(3) B will move with a sped u without rotating
(4) B will move with a speed u and rotate with an angular velocity ω

25. The bob of a simple pendulum (mass m and length l) dropped from a horizontal position strikes a block of the same mass elastically placed on a horizontal frictionless table. The K.E. of the block will be (after collision)

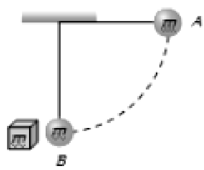


(1) 2 mgl (2) $mgl/2$
(3) mgl (4) 0

P.E. of bob at point A = mgl

This amount of energy will be converted into kinetic energy

K.E. of bob at point B = mgl



and as the collision between bob and block (of same mass) is elastic, after collision bob will come to rest and total Kinetic energy will be transferred to block. So kinetic energy of block = mgl

26. A neutron moving with a velocity 'v' and kinetic energy 'E' collides perfectly elastically head on with the nucleus of an atom of mass number 'A' at rest. The energy received by the nucleus and the total energy of the system are related by

(1) $\frac{4A}{(A+1)^2}$ (2) $\left(\frac{A-1}{A+1}\right)^2$ (3) $\frac{(A+1)}{4A^2}$ (4) $\left(\frac{A+1}{A-1}\right)^2$

27. A body of mass m moving with velocity V makes a head - on collision with another body of mass $2m$ which is initially at rest. The ratio of kinetic energies of colliding body before and after collision will be

(1) 9 : 1 (2) 1 : 1 (3) 4 : 1 (4) 2 : 1

$$\frac{KE_{before}}{kE_{after}} = \frac{\frac{1}{2}mv^2}{\frac{1}{2}mv_1^2} = \frac{V^2}{V_1^2}$$

$$\text{Since } V_1 = \frac{m_1 - m_2}{m_1 + m_2}V_1 = \frac{m - 2m}{m + 2m}V = -\frac{V}{3}$$

$$\text{Hence ratio of KE} = \frac{V^2}{V_1^2} = 9 : 1$$

28. An object A collides head on elastically with a stationary object B. The object A will recoil with maximum speed if (e = 1)

(1) $M_B >> M_A$ (2) $M_B << M_A$
(3) $M_A = M_B$ (4) Can not be predicted due to incomplete data

29. In above question the momentum transferred to B will be maximum if

(1) $M_B >> M_A$
(2) $M_B << M_A$
(3) $M_A = M_B$
(4) Can not be predicted as information is incomplete

30. A ball collides elastically with another ball of the same mass. The collision is oblique and initially one of the body was at rest. After the collision, the two balls move with same speeds. What will be the angle between the initial and final velocities of the colliding ball

(1) 30^o (2) 45^o (3) 60^o (4) 90^o

31. A frictionless steel ball of radius 2 cm, moving on a horizontal plane with a velocity of 5 cm/s, collides head-on with another stationary steel ball of radius 3 cm. The velocities of two bodies after collision will respectively be (in cm/s)

(1) 2.7, 2.3 (2) – 2.7, 2.3 (3) 2.7 , – 2.3 (4) – 2.7, – 2.3

INELASTIC COLLISION

32. One sphere collides with another sphere of same mass at rest inelastically. If the value of coefficient of restitution is $\frac{1}{2}$, the ratio of their speeds after collision shall be

(1) 1 : 2 (2) 2 : 1 (3) 1 : 3 (4) 3 : 1

Solution :

(3) $\frac{v_1}{v_2} = \frac{1-e}{1+e} = \frac{1-1/2}{1+1/2} = \frac{1/2}{3/2} = \frac{1}{3}$.

33. The co-efficient of restitution depends upon

(1) The masses of the colliding bodies (2) The direction of motion of the colliding bodies

(3) The inclination between the colliding bodies (4) The materials of the colliding bodies

34. During inelastic collision of two particles

(1) $(KE)_{final} = (KE)_{initial}$ (2) $(KE)_{final}$ must be greater than $(KE)_{initial}$

(3) $(KE)_{final}$ must be less than $(KE)_{initial}$ (4) $(KE)_{final}$ may be greater or less than $(KE)_{initial}$

35. Inelastic collision is the

(1) Collision of ideal molecules with the walls of the container

(2) Collision of electron and positron to annihilate each other

(3) Collision of two rigid solid spheres lying on a frictionless table

(4) Scattering of α-particles with the nucleus of gold atom

PERFECTLY INELASTIC COLLISION

36. Which of the following is not a perfectly inelastic collision

(1) Striking of two glass balls (2) A bullet striking a bag of sand

(3) An electron captured by a proton (4) A man jumping onto a moving cart

Solution :

(1) For perfectly elastic collision relative velocity of separation should be zero *i.e.* the colliding body should move together with common velocity.

37. A neutron having mass of $1.67\times10^{-27} kg$ and moving at $10^8 m/s$ collides with a deutron at rest and sticks to it. If the mass of the deutron is $3.34\times10^{-27} kg$; the speed of the combination is

(1) $2.56\times10^3 m/s$ (2) $2.98\times10^5 m/s$

(3) $3.33\times10^7 m/s$ (4) $5.01\times10^9 m/s$

Solution :

(3) $m_1 = 1.67\times10^{-27} kg$, $u_1 = 10^8 m/s$, $m_2 = 3.34\times10^{-27} kg$ and $u_2 = 0$

Speed of the combination $V = \frac{m_1u_1 + m_2u_2}{m_1 + m_2} = \frac{1.67\times10^{-27}\times10^8 + 0}{1.67\times10^{-27} + 3.34\times10^{-27}} = 3.33\times10^7 m/s.$

38. A particle of mass $'m'$ moving with velocity $'v'$ collides in elastically with a stationary particle of mass $'2m'$. The speed of the system after collision will be

(1) $\frac{v}{2}$ (2) $2v$ (3) $\frac{v}{3}$ (4) $3v$

Solution :

(3) By the conservation of momentum $mv + 2m\times0 = 3mV$ $\therefore V = \frac{v}{3}.$

39. A bullet of mass a is fired with velocity b in a large block of mass c. The final velocity of the system will be

(1) $\frac{c}{a+c}$ (2) $\frac{ab}{a+c}$ (3) $\frac{(a+b)}{c}$ (4) $\frac{(a+c)}{a}b$

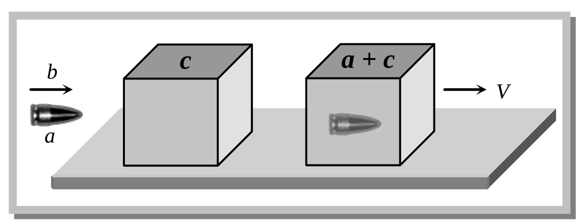
Solution :

(2) 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

$a \times b + 0 = (a + c) V$

$\therefore V = \frac{ab}{a+c}$



40. A particle of mass $1g$ having velocity $3\hat{i} - 2\hat{j}$ has a glued impact with another particle of mass $2g$ and velocity as $4\hat{j} - 6\hat{k}$. Velocity of the formed particle is

(1) $5.6ms^{-1}$ (2) 0 (3) $6.4ms^{-1}$ (4) $4.6ms^{-1}$

Solution :

(4) By conservation of momentum $m\vec{u}_1 + m_2\vec{u}_2 = (m_1 + m_2)\vec{V}$

$\therefore \vec{V} = \frac{m_1\vec{u}_1 + m_2\vec{u}_2}{m_1 + m_2} = \frac{1(3i - 2\hat{j}) + 2(4j - 6\hat{k})}{m_1 + m_2} = \frac{3i + 6j - 12\hat{k}}{(1+2)} = \hat{i} + 2\hat{j} - 4\hat{k}$

$|\vec{V}| = \sqrt{(1)^2 + (2)^2 + (-4)^2} = \sqrt{1+4+16} = 4.6ms^{-1}.$

OBLIQUE COLLISION

41. A ball of mass $1kg$, moving with a velocity of $0.4m/s$ collides with another stationary ball. After the collision, the first ball moves with a velocity of $0.3m/s$ in a direction making an angle of 90^o with its initial direction. The momentum of second ball after collision will be (in *kg-m/s*)

(1) 0.1 (2) 0.3 (3) 0.5 (4) 0.7

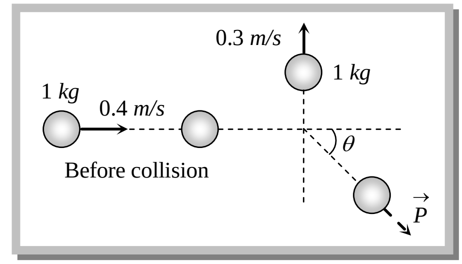
Solution :

(3) Let second ball moves with momentum P making an angle θ from the horizontal (as shown in the figure).

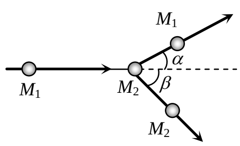
By the conservation of horizontal momentum $1 \times 0.4 = P\cos\theta$

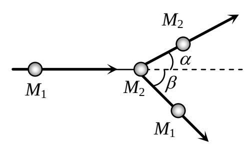
By the conservation of vertical momentum $0.3 = P\sin\theta$ ......(ii)

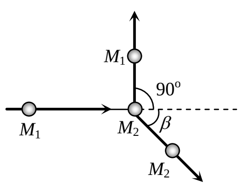
From (i) and (ii) we get $P = 0.5$ *kg-m/s*

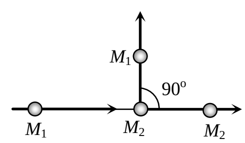


42. Keeping the principle of conservation of momentum in mind which of the following collision diagram is not correct

(1)


(2)


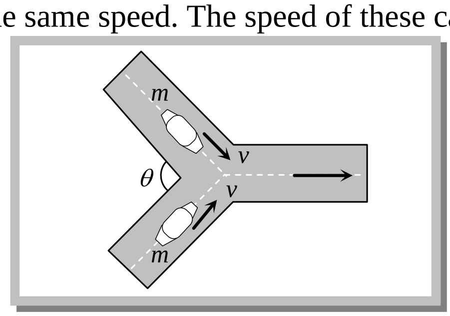
(3)


(4)


Solution :

(4) In this condition the final resultant momentum makes some angle with x-axis. Which is not possible because initial momentum is along the x-axis and according to law of conservation of momentum initial and final momentum should be equal in magnitude and direction both.

43. Two cars of same mass are moving with same speed v on two different roads inclined at an angle θ with each other, as shown in the figure. At the junction of these roads the two cars collide in elastically and move simultaneously with the same speed. The speed of these cars would be



(1) $v\cos\dfrac{\theta}{2}$

(2) $\dfrac{v}{2}\cos\theta$

(3) $\dfrac{v}{2}\cos\dfrac{\theta}{2}$

(4) $2v\cos\theta$

Solution :

(1) Initial horizontal momentum of the system $= mv\cos\dfrac{\theta}{2} + mv\cos\dfrac{\theta}{2}$.

If after the collision cars move with common velocity V then final horizontal momentum of the system $= 2mV$.

By the law of conservation of momentum, $2mV = mv\cos\dfrac{\theta}{2} + mv\cos\dfrac{\theta}{2} \Rightarrow V = v\cos\dfrac{\theta}{2}$.

44. A ball moving with velocity of 9m/s collides with another similar stationary ball. After the collision both the balls move in directions making an angle of 30^o with the initial direction. After the collision their speed will be
(1) 2.6 m/s
(2) 5.2 m/s
(3) 0.52 m/s
(4) 52 m/s

45. The law of conservation of momentum is based on Newton's is
(1) First law of motion
(2) Second law of motion
(3) Third law of motion
(4) Law of gravitation

46. A sphere has a perfectly elastic oblique collision with another identical sphere which is initially at rest. The angle between their velocities after the collision is
(1) 30^o
(2) 45^o
(3) 60^o
(4) 90^o

47. A billiard ball moving at a speed $2m/s$ strikes an identical ball initially at rest, at a glancing blow. After the collision one ball is found to be moving at a speed of $1m/s$ at 60^o with the original line of motion. The velocity of the other ball shall be
(1) $(3)^{1/2} m/s$ at 30^o to the original direction
(2) $1m/s$ at 60^o to the original direction
(3) $(3)^{1/2} m/s$ at 60^o to the original direction
(4) $1m/s$ at 30^o to the original direction

48. A particle of mass m collides perfectly elastically with another particle of mass $M = m$. The angle between the velocities of two particles will be
(1) 15°
(2) 90°
(3) 45°
(4) 60°

49. A moving neutron is deflected by an angle of 45^o after colliding with a stationary proton (assuming the masses of both particles equal). Then it again collides with another stationary proton and so on. In this way the particle is deflected through an angle 45^o in each collision. When its energy becomes 10^{-6} times the initial energy, the approximate number of collision must have been
(1) 20
(2) 40
(3) 80
(4) 100

LEVEL – 2

ELASTIC COLLISION

1. A body of mass m moving with velocity v makes a head-on collision with another body of mass $2m$ which is initially at rest. The loss of kinetic energy of the colliding body (mass m) is

(1) $\frac{1}{2}$ of its initial kinetic energy (2) $\frac{1}{9}$ of its initial kinetic energy

(3) $\frac{8}{9}$ of its initial kinetic energy (4) $\frac{1}{4}$ of its initial kinetic energy

Solution :

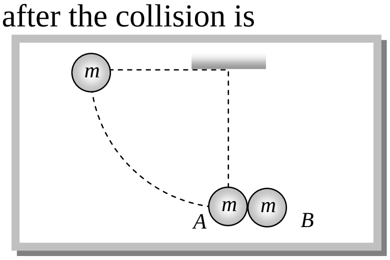
(3) Loss of kinetic energy of the colliding body

$$\frac{\Delta K}{K}=1-\left(\frac{m_1-m_2}{m_1+m_2}\right)^2=1-\left(\frac{m-2m}{m+2m}\right)^2=1-\left(\frac{1}{3}\right)^2$$

$\Delta K=\left(1-\frac{1}{9}\right)K=\frac{8}{9}K$ $\therefore$ Loss of kinetic energy is $\frac{8}{9}$ of its initial kinetic energy.

2. A sphere of mass 0.1 kg is attached to a cord of $1m$ length. Starting from the height of its point of suspension this sphere hits a block of same mass at rest on a frictionless table, If the impact is elastic, then the kinetic energy of the block after the collision is

(1) 1 J
(2) 10 J
(3) 0.1 J
(4) 0.5 J



Solution :

(1)

As two blocks are of same mass and the collision is perfectly elastic therefore their velocities gets interchanged *i.e.* the block A comes into rest and complete kinetic energy transferred to block B.

Now kinetic energy of block B after collision = Kinetic energy of block A before collision

= Potential energy of block A at the original height = mgh = 0.1 × 10 × 1 = 1 J.

3. A ball moving horizontally with speed v strikes the bob of a simple pendulum at rest. The mass of the bob is equal to that of the ball. If the collision is elastic the bob will rise to a height

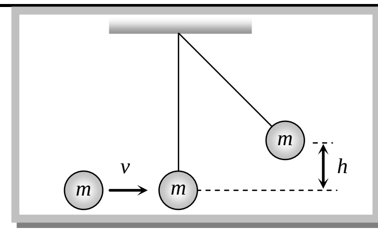
(1) $\frac{v^2}{g}$ (2) $\frac{v^2}{2g}$ (3) $\frac{v^2}{4g}$ (4) $\frac{v^2}{8g}$

Solution :

(2) Total kinetic energy of the ball will transfer to the bob of simple pendulum. Let it rises to height 'h' by the law of conservation of energy.

$\frac{1}{2}mv^2 = mgh$

$\therefore\ h = \frac{v^2}{2g}$



4. A moving body with a mass m_1 strikes a stationary body of mass m_2. The masses m_1 and m_2 should be in the ratio $\frac{m_1}{m_2}$ so as to decrease the velocity of the first body 1.5 times assuming a perfectly elastic impact. Then the ratio $\frac{m_1}{m_2}$ is

(1) 1/ 25 (2) 1/5 (3) 5 (4) 25

Solution: :

(3) $v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \frac{2m_2u_2}{m_1 + m_2} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1$ [As $u_2 = 0$ and $\left(v_1 = \frac{u_1}{1.5}\right)$ given]

$\Rightarrow \frac{u_1}{1.5} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 \Rightarrow m_1 + m_2 = 1.5(m_1 - m_2) \Rightarrow \frac{m_1}{m_2} = 5$.

5. A moving mass of 8 *kg* collides elastically with a stationary mass of 2 *kg*. If *E* be the initial kinetic energy of the mass, the kinetic energy left with it after collision will be

(1) 0.80 *E* (2) 0.64 *E* (3) 0.36 *E* (4) 0.08 *E*

Solution :

(3) Kinetic energy retained by projectile $\frac{\Delta K}{K} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$

$\Rightarrow \Delta K = \left(\frac{8-2}{8+2}\right)^2 E == \frac{9}{25}E = 0.36E$.

6. A neutron travelling with a velocity *v* and K.E. *E* collides perfectly elastically head on with the nucleus of an atom of mass number *A* at rest. The fraction of total energy retained by neutron is

(1) $\left(\frac{A-1}{A+1}\right)^2$ (2) $\left(\frac{A+1}{A-1}\right)^2$ (3) $\left(\frac{A-1}{A}\right)^2$ (4) $\left(\frac{A+1}{A}\right)^2$

Solution :

(1) Fraction of kinetic energy retained by projectile $\frac{\Delta K}{K} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$

Mass of neutron (m_1) = 1 and Mass of atom (m_2) = *A*

$\therefore \frac{\Delta K}{K} = \left(\frac{1-A}{1+A}\right)^2$ or $\left(\frac{A-1}{A+1}\right)^2$.

7. A neutron with 0.6MeV kinetic energy directly collides with a stationary carbon nucleus (mass number 12). The kinetic energy of carbon nucleus after the collision is

(1) 1.7 *MeV* (2) 0.17 *MeV* (3) 17 *MeV* (4) Zero

Solution :

(2) Kinetic energy transferred to stationary target (carbon nucleus) $\frac{\Delta K}{K}=\left[1-\left(\frac{m_1-m_2}{m_1+m_2}\right)^2\right]$

$$\frac{\Delta K}{K}=\left[1-\left(\frac{1-12}{1+12}\right)^2\right]=\left[1-\frac{121}{169}\right]=\frac{48}{169} \qquad \therefore\ \Delta K=\frac{48}{169}\times(0.6MeV)=0.17MeV.$$

8. Which of the following statements is true
(1) Kinetic energy is conserved in all types of collisions
(2) By definition there is no difference between elastic and perfectly elastic collisions
(3) By definition there is no difference between inelastic and perfectly inelastic collisions
(4) After the collision, the relative displacement of the particles can decrease with time

INELASTIC COLLISION

9. A body of mass $40kg$ having velocity $4m/s$ collides with another body of mass $60kg$ having velocity $2m/s$. If the collision is inelastic, then loss in kinetic energy will be
(1) 440 *J* (2) 392 *J* (3) 48 *J* (4) 144 *J*

Solution :

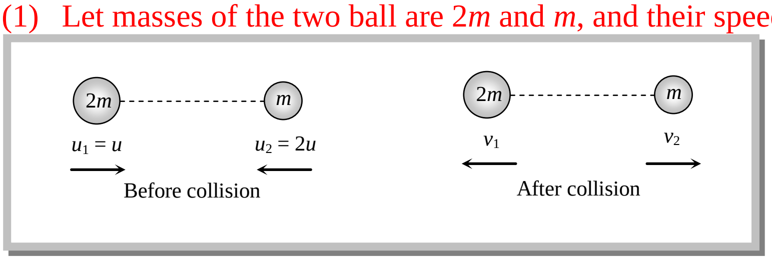
(3) Loss of K.E. in inelastic collision

$$\Delta K=\frac{1}{2}\frac{m_1m_2}{(m_1+m_2)}(u_1-u_2)^2=\frac{1}{2}\frac{40\times60}{(40+60)}(4-2)^2=\frac{1}{2}\frac{2400}{100}4=48\ J.$$

10. The ratio of masses of two balls is 2 : 1 and before collision the ratio of their velocities is 1 : 2 in mutually opposite direction. After collision each ball moves in an opposite direction to its initial direction. If *e* = (5/6), the ratio of speed of each ball before and after collision would be
(1) (5/6) times
(2) Equal
(3) Not related
(4) Double for the first ball and half for the second ball

Solution :

(1) Let masses of the two ball are 2*m* and *m*, and their speeds are *u* and 2*u* respectively.



By conservation of momentum $m_1\vec{u}_1+m_2\vec{u}_2=m_1\vec{v}_1+m_2\vec{v}_2$

$\Rightarrow 2mu-2mu=mv_2-2mv_1 \Rightarrow v_2=2v_1$

Coefficient of restitution = $-\frac{(\vec{v}_2-\vec{v}_1)}{(\vec{u}_2-\vec{u}_1)}=-\frac{(2v_1+v_1)}{(-2u-u)}=\frac{-3v_1}{-3u}=\frac{v_1}{u}=\frac{5}{6}$ [As $e=\frac{5}{6}$ given]

$\Rightarrow \frac{v_1}{u_1}=\frac{5}{6}=$ ratio of the speed of first ball before and after collision.

Similarly we can calculate the ratio of second ball before and after collision, $\frac{v_2}{u_2} = \frac{2v_1}{2u} = \frac{v_1}{u} = \frac{5}{6}$.

11. Two identical billiard balls are in contact on a table. A third identical ball strikes them symmetrically and come to rest after impact. The coefficient of restitution is

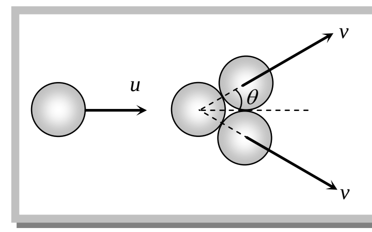
(1) $\frac{2}{3}$ (2) $\frac{1}{3}$ (3) $\frac{1}{6}$ (4) $\frac{\sqrt{3}}{2}$

Solution :

(1) $\sin\theta = \frac{r}{2r} = \frac{1}{2} \Rightarrow \theta = 30^o$ c

From conservation of linear momentum

$mu = 2mv\cos 30^o$ or $v = \frac{u}{\sqrt{3}}$



Now $e = \frac{\text{Relative velocity of separation}}{\text{Relative velocity of approach}}$ in common normal direction.

Hence, $e = \frac{v}{u\cos 30^o} = \frac{u/\sqrt{3}}{u\sqrt{3}/2} = \frac{2}{3}$

12. A body of mass $3kg$, moving with a speed of $4ms^{-1}$, collides head on with a stationary body of mass $2kg$. Their relative velocity of separation after the collision is $2ms^{-1}$. Then

(1) The coefficient of restitution is 0.5
(2) The impulse of the collision is 7.2 *N-s*
(3) The loss of kinetic energy due to collision is 3.6 *J*
(4) The loss of kinetic energy due to collision is 7.2 *J*

Solution:

(1,2,3). $m_1 = 3kg$, $m_2 = 2kg$, $u_1 = 4m/s$, $u_2 = 0$

Relative velocity of approach $u_1 - u_2 = 4m/s$

Relative velocity of separation $v_2 - v_1 = 2m/s$ (given)

Coefficient of restitution $e = \frac{\text{relative velocity of separation}}{\text{relative velocity of approach}} = \frac{2}{4} = \frac{1}{2} = 0.5$

Loss in kinetic energy $= \frac{1}{2}\frac{m_1 m_2}{m_1+m_2}(1-e)^2(u_1-u_2)^2 = \frac{1}{2}\frac{3\times 2}{3+2}\left[1-\left(\frac{1}{2}\right)^2\right](4)^2 = 7.2J$

Final velocity of m_1 mass, $v_1 = \left(\frac{m_1 - em_2}{m_1+m_2}\right)u_1 + \left[\frac{(1+e)m_2}{m_1+m_2}\right]u_2$

$$= \frac{(3-0.5\times 2)}{3+2}\times 4 + 0 = \frac{8}{5}\, m/s$$

Impulse of collision = change in momentum of mass m_1 (or m_2)

$$= m_1v_1 - m_1u_1 = 3\times\frac{8}{5} - 3\times 4 = \frac{24}{5} - 12 = 4.8 - 12 = -7.2\, N\text{-}s.$$

13. A ball falls vertically onto a floor, with momentum P and then bounces repeatedly. The coefficient of restitution is e. The total momentum imparted by the ball to the floor is

(1) $P(1+e)$ (2) $\frac{P}{1-e}$ (3) $P\left(1+\frac{1}{e}\right)$ (4) $P\left(\frac{1+e}{1-e}\right)$

14. A particle strikes a horizontal frictionless floor with a speed u, at an angle θ with the vertical and rebounds with a speed v, at an angle φ with the vertical. The coefficient of restitution between the particle and the floor is e. The magnitude of v is

(1) eu (2) $(1-e)u$ (3) $u\sqrt{\sin^2\theta+e^2\cos^2\theta}$ (4) $u\sqrt{e^2\sin^2\theta+\cos^2\theta}$

15. In the previous question the angle φ is equal to

(1) θ (2) $\tan^{-1}[e\tan\theta]$ (3) $\tan^{-1}[\frac{1}{e}\tan\theta]$ (4) $(1+e)\theta$

16. A bullet of mass $0.01kg$, travelling at a speed of $500ms^{-1}$, strikes a block of mass $2kg$, which is suspended by a string of length $5m$ and emerges out. The block rises by a vertical distance of $0.1m$. The speed of the bullet after it emerges from the block is

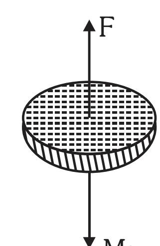
(1) $55ms^{-1}$ (2) $110ms^{-1}$ (3) $220ms^{-1}$ (4) $440ms^{-1}$

17. A ball is dropped from a height of 10 m. If 40% of its energy is lost on collision with the earth then after collision the ball will rebound to a height of

(1) 10 m (2) 8 m (3) 4 m (4) 6 m

18. A disc of mass 1.0 kg kept floating horizontally in air by firing bullets of mass 0.05 kg each vertically at it, at the rate of 10 per second. If the bullets rebound with the same speed, the speed with which these are fired will be

(1) 0.098 m/s (2) 0.98 m/s
(3) 9.8 m/s (4) 98.0 m/s



PERFECTLY INELASTIC COLLISION

19. A mass of $20kg$ moving with a speed of $10m/s$ collides with another stationary mass of 5 kg. As a result of the collision, the two masses stick together. The kinetic energy of the composite mass will be

(1) 600 J (2) 800 J (3) 1000 J (4) 1200 J

Solution :

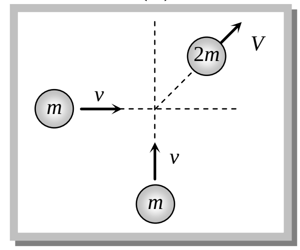
(2) By conservation of momentum $m_1u_1+m_2u_2=(m_1+m_2)V$

Velocity of composite mass $V=\frac{m_1u_1+m_2u_2}{m_1+m_2}=\frac{20\times10+5\times0}{20+5}=8m/s$

$\therefore$ Kinetic energy of composite mass $=\frac{1}{2}(m_1+m_2)V^2=\frac{1}{2}(20+5)\times8^2=800J$.

20. A particle of mass m moving eastward with a speed v collides with another particle of the same mass moving northward with the same speed v. The two particles coalesce on collision. The new particle of mass $2m$ will move in the north-easterly direction with a velocity

(1) $v/2$ (2) $2v$ (3) $v/\sqrt{2}$ (4) v



Solution :

(3) Initially both the particles are moving perpendicular to each other with momentum mv. So the net initial momentum $= \sqrt{(mv)^2 + (mv)^2} = \sqrt{2}\,mv$.

After the inelastic collision both the particles (system) moves with velocity V, so linear momentum = $2mV$

By the law of conservation of momentum $\sqrt{2}\,mv = 2mV$

$\therefore V = v/\sqrt{2}$.

21. A ball moving with speed v hits another identical ball at rest. The two balls stick together after collision. If specific heat of the material of the balls is S, the temperature rise resulting from the collision is

(1) $\frac{v^2}{8S}$ (2) $\frac{v^2}{4S}$ (3) $\frac{v^2}{2S}$ (4) $\frac{v^2}{S}$

Solution :

(2) Kinetic energy of ball will raise the temperature of the system $\frac{1}{2}mv^2 = (2m)\,S\,\Delta t$

$\Rightarrow \Delta t = \frac{v^2}{4S}$.

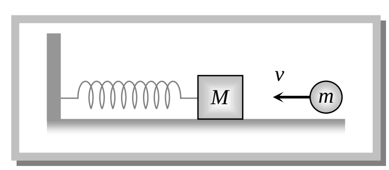
22. A body of mass $2kg$ is placed on a horizontal frictionless surface. It is connected to one end of a spring whose force constant is $250N/m$. The other end of the spring is joined with the wall. A particle of mass $0.15kg$ moving horizontally with speed v sticks to the body after collision. If it compresses the spring by $10cm$, the velocity of the particle is

(1) $3m/s$ (2) $5m/s$ (3) $10m/s$ (4) $15m/s$

Solution :

(4) By the conservation of momentum

Initial momentum of particle = Final momentum of system



$\Rightarrow m \times v = (m + M)\,V$

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

Now the spring compresses due to kinetic energy of the system so by the conservation of energy

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

$$\Rightarrow kx^2 = \frac{m^2v^2}{m+M} \Rightarrow v = \sqrt{\frac{kx^2(m+M)}{m^2}} = \frac{x}{m}\sqrt{k(m+M)}$$

Putting $m = 0.15\ kg$, $M = 2\ kg$, $k = 250\ N/m$, $x = 0.1\ m$ we get $v = 15\ m/s$.

23. A bullet of mass m moving with velocity v strikes a block of mass M at rest and gets embeded into it. The kinetic energy of the composite block will

(1) $\frac{1}{2}mv^2 \times \frac{m}{(m+M)}$ (2) $\frac{1}{2}mv^2 \times \frac{M}{(m+M)}$

(3) $\frac{1}{2}mv^2 \times \frac{(M+m)}{M}$ (4) $\frac{1}{2}Mv^2 \times \frac{m}{(m+M)}$

Solution :

(1) By conservation of momentum,

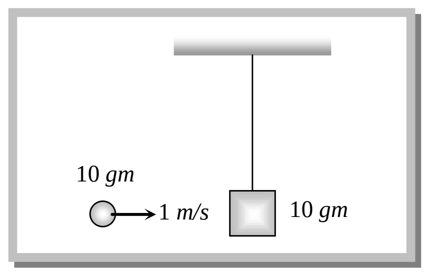
Momentum of the bullet (mv) = momentum of the composite block ($m + M$)V

$\Rightarrow$ Velocity of composite block $V = \frac{mv}{m+M}$

$\therefore$ Kinetic energy $= \frac{1}{2}(m+M)V^2 = \frac{1}{2}(m+M)\left(\frac{mv}{m+M}\right)^2 = \frac{1}{2}\frac{m^2v^2}{m+M} = \frac{1}{2}mv^2\left(\frac{m}{m+M}\right)$.

24. A mass of $10gm$, moving horizontally with a velocity of $100cm/\sec$, strikes the bob of a pendulum and strikes to it. The mass of the bob is also $10gm$ (see fig.) The maximum height to which the system can be raised is ($g = 10m/\sec^2$)

(1) Zero
(2) $5cm$
(3) $2.5cm$
(4) $1.25cm$



Solution :

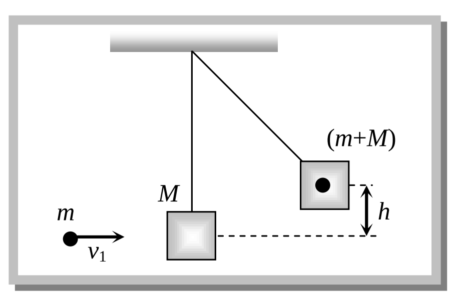
(4) By the conservation of momentum,

Momentum of the bullet = Momentum of system $\Rightarrow 10\times1 = (10+10)\times v \Rightarrow v = \frac{1}{2}m/s$

Now maximum height reached by system $H_{\max} = \frac{v^2}{2g} = \frac{(1/2)^2}{2\times10}m = 1.25cm$.

25. A bullet of mass m moving with a velocity v strikes a suspended wooden block of mass M as shown in the figure and sticks to it. If the block rises to a height h the initial velocity of the bullet is

(1) $\frac{m+M}{m}\sqrt{2gh}$
(2) $\sqrt{2gh}$
(3) $\frac{M+m}{M}\sqrt{2gh}$
(4) $\frac{m}{M+m}\sqrt{2gh}$



Solution :

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

and if the system goes upto height h then $V = \sqrt{2gh}$

$\therefore mv = (m+M)\sqrt{2gh} \Rightarrow v = \frac{m+M}{m}\sqrt{2gh}$.

26. A bag P (mass M) hangs by a long thread and a bullet (mass m) comes horizontally with velocity v and gets caught in the bag. Then for the combined (beg + bullet) system the

(1) Momentum is $\frac{mvM}{M+m}$
(2) Kinetic energy $\frac{mV^2}{2}$
(3) Momentum is $\frac{mv(M+m)}{M}$
(4) Kinetic energy is $\frac{m^2V^2}{2(M+m)}$

Solution :

(4) Velocity of combined system $V = \frac{mv}{m+M}$

Momentum for combined system $=(m+M)V = (m+M)\frac{mv}{m+M}$

Kinetic energy for combined system

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

27. A wooden block of mass M is suspended by a cord and is at rest. A bullet of mass m, moving with a velocity v pierces through the block and comes out with a velocity $v/2$ in the same direction. If there is no loss in kinetic energy, then upto what height the block will rise

(1) $m^2v^2/2M^2g$
(2) $m^2v^2/8M^2g$
(3) $m^2v^2/4Mg$
(4) $m^2v^2/2Mg$

Solution :

(2) By the conservation of momentum

Initial momentum = Final momentum

$$mv + M \times 0 = m\frac{v}{2} + M \times V \Rightarrow V = \frac{m}{2M}v$$

If block rises upto height h then $h = \frac{V^2}{2g} = \frac{(mv/2M)^2}{2g} = \frac{m^2v^2}{8M^2g}.$

28. Two bodies of same mass are moving with same velocity V in mutually opposite directions. They collide and stick together. The resultant velocity of the system will be

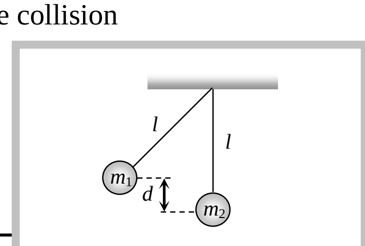
(1) Zero
(2) $\frac{V}{2}$
(3) V
(4) From zero to ∞

29. A $50g$ bullet moving with a velocity of $10ms^{-1}$ strikes a block of mass $950g$ at rest and gets embedded in it. The percentage loss in kinetic energy is

(1) 100%
(2) 95%
(3) 5%
(4) 50%

30. Two pendulums each of length l are initially situated as shown in figure. The first pendulum is released and strikes the second. Assume that the collision is completely inelastic and neglect the mass of the string and any frictional effects. How high does the centre of mass rise after the collision

(1) $d\left[\frac{m_1}{(m_1+m_2)}\right]^2$
(2) $d\left[\frac{m_1}{(m_1+m_2)}\right]$



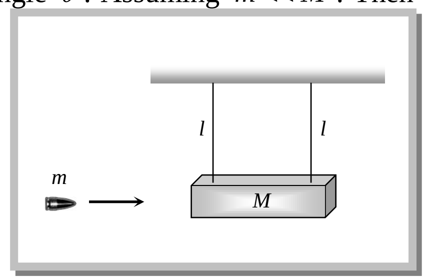
(3) $\frac{d(m_1+m_2)^2}{m_2}$ (4) $d\left[\frac{m_2}{(m_1+m_2)}\right]$

31. A body of mass $2.9kg$ is suspended from a string of length $2.5m$ and is at rest. A bullet of mass $100g$, moving horizontally with a speed of $150ms^{-1}$, strikes and sticks to it. What is the maximum angle made by the string with the vertical after the impact ($g=10\ ms^{-2}$)

(1) 30^o (2) 45^o (3) 60^o (4) 90^o

32. A horizontally flying bullet of mass *m* gets struck in a body of mass *M* suspended by two identical threads of length *l* as shown in fig. As a result, the threads swerve through an angle θ. Assuming $m << M$. Then the fraction of the bullet's initial kinetic energy that turned into heat

(1) $1-\frac{m}{M}$ (2) $\frac{2M}{m}\sqrt{2l\,g}$ (3) $1-\frac{M}{m}$



33. A bullet of mass *m* moving with velocity *v* strikes a suspended wooden block of mass *M*. If the block rises to a height h, the initial velocity of the block will be

(1) $\sqrt{2gh}$ (2) $\frac{M+m}{m}\sqrt{2gh}$ (3) $\frac{m}{M+m}\sqrt{2gh}$ (4) $\frac{M+m}{M}\sqrt{2gh}$

34. A bag of sand of mass *M* is suspended by a string. A bullet of mass *m* is fired at it with velocity *v* and gets embedded into it. The loss of kinetic energy in this process is

(1) $\frac{1}{2}mv^2$ (2) $\frac{1}{2}mv^2\times\frac{1}{M+m}$ (3) $\frac{1}{2}mv^2\times\frac{M}{m}$ (4) $\frac{1}{2}mv^2\left(\frac{M}{M+m}\right)$

35. A bullet of mass *m* and velocity *v* passed through a pendulum bob of mass *M* and emerges with velocity *v* / 2. What is the minimum value of *v* such that the pendulum bob will swing through a complete cycle

(1) $\frac{M}{m}\sqrt{2l\,g}$ (2) $\frac{2M}{m}\sqrt{2l\,g}$ (3) $\frac{M}{2m}\sqrt{5l\,g}$ (4) $\frac{2M}{m}\sqrt{5gl}$

36. Two particles each of mass m travelling with velocities u_1 and u_2 collide perfectly in elastically. The loss of kinetic energy will be

(1) $\frac{1}{2}m(u_1-u_2)^2$ (2) $\frac{1}{4}m(u_1-u_2)^2$ (3) $m(u_1-u_2)^2$ (4) $2m(u_1-u_2)^2$

Assertion and Reason

Each of the questions given below consists of two statements, an assertion (1) and reason (*R*). Select the number corresponding to the appropriate alternative as follows

(1) If both A and R are true and R is the correct explanation of A
(2) If both A and R are true but R is not the correct explanation of A
(3) If A is true but R is false
(4) If A is false but R is true
(5) Both are false

1. **Assertion :** A quick collision between two bodies is more violent than a slow collision, even when the initial and the final velocities are identical.
   Reason : Because the rate of change of momentum which determines the force is greater in the first case.

2. **Assertion :** Kinetic energy of a body becomes four times, when its linear momentum is doubled.
   Reason : This is because, K.E. = $p^2/2m$.

3. **Assertion :** Kinetic energy is conserved in both, perfectly elastic and inelastic collisions.
   Reason : Because both the types of collisions are identical.

4. **Assertion :** For any collisions, coefficient of restitution lies between 0 and 1.
   Reason : This is because no collision is 100% elastic or 100% inelastic.

5. **Assertion :** A body can have energy without having momentum.
   Reason : A body can have momentum without having mechanical energy.

6. **Assertion :** A truck and a car moving with the same kinetic energy are brought to rest by the application of breaks which provide equal retarding forces. Both come to rest in equal distance.
   Reason : It is possible that the speed of a body is zero but velocity is not zero

7. **Assertion :** If two objects of different masses have same momentum, the lighter body possess greater velocity.
   Reason : For all bodies momentum always remains same.

8. **Assertion :** In case of bullet fired from gun, the ratio of kinetic energy of gun and bullet is equal to ratio of mass of bullet and gun.
   Reason : In firing, momentum is conserved.

9. **Assertion :** A quick collision between two bodies is more violent than a slow collision; even when the initial and final velocities are identical.
   Reason : The momentum is greater in first case.

Previous Year's Questions

1. A body of mass (4m) is lying in x–y plane at rest. It suddenly explodes into three pieces. Two pieces, each of mass (m) move perpendicular to each other with equal speeds (U). The total kinetic energy generated due to explosion is : **[AIPMT 2014]**

(1) $2\ mv^2$ (2) $4\ mv^2$ (3) mv^2 (4) $\frac{3}{2}mv^2$

2. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1 kg moves with a speed of 12 ms^{-1} and the second part of mass 2 kg moves with 8 ms^{-1} speed. If the third part flies off with 4 ms^{-1} speed, then its mass is : **[NEET 2013]**

(1) 17 kg (2) 3 kg (3) 5 kg (4) 7 kg

3. If two bodies stick together after collision and move as a single body, the collision is said to be **[J&K CET 2011]**

(1) perfectly inelastic (2) elastic
(3) inelastic (4) perfectly elastic

4. A cricket ball of mass 0.25 kg with speed 10 ms^{-1} collides with a bat and returns with same speed within 0.01 s. The force acted on bat is **[WB JEE 2011]**

(1) 25 N (2) 50 N (3) 250 N (4) 500 N

5. The coefficient of restitution e, for a perfectly elastic collision is **[DUMET 2011]**

(1) 0 (2) –1 (3) 1 (4) ∞

6. A particle of mass m_1 moves with velocity v_1 and collides with another particle at rest of equal mass. The velocity of the second particle after the elastic collision is **[DUMET 2011]**

(1) $2v_1$ (2) v_1 (3) $-v_1$ (4) 0

7. A ball falls from a height of 20 m on the floor and rebounds to a height of 5 m. Time of contact is 0.02 s. Find the acceleration during impact. **[Manipal 2010]**

(1) 1200 ms^{-2} (2) 1000 ms^{-2} (3) 2000 ms^{-2} (4) 1500 ms^{-2}

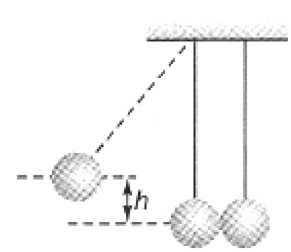
8. In a head an elastic collision of a very heavy body moving at v with a light body at rest, velocity of the heavy body after collision is **[KCET 2009]**

(1) v (2) 2v (3) zero (4) $\frac{v}{2}$

9. For a system to follow the law of conservation of linear momentum during a collision, the condition is
(1) total external force acting on the system is zero. **[AFMC 2008]**
(2) total external force acting on the system is finite and time of collision is negligible.
(3) total internal force acting on the system is zero,

(1) (1) only (2) (2) only (3) (3) only (4) (1) or (2)

10. In the figure, pendulum bob on left side is pulled a side to a height h from its initial position. After it is released it collides with the right pendulum bob at rest, which is of same mass. After the collision the two bobs stick together and rise to a height **[Punjab PMET 2008]**



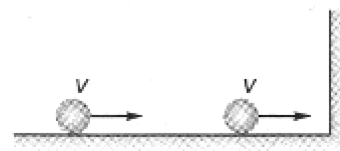
(1) $\frac{3h}{4}$ (2) $\frac{2h}{3}$

(3) $\frac{h}{2}$ (4) $\frac{h}{4}$

11. A sphere of mass m moving with constant velocity u, collides with another stationary sphere of same mass. If e is the coefficient of restitution, the ratio of the final velocities of the first and second spheres is **[Punjab PMET 2008]**
(1) $\frac{1+e}{1-e}$ (2) $\frac{1-e}{1+e}$ (3) $\frac{e}{1-e}$ (4) $\frac{1+e}{e}$

12. Two identical balls A and B collide head on elastically. If the velocity of A and B before collision are 0.5 ms^{-1} and 0.3 ms^{-1} respectively, then their velocities after collision will be **[Kerala CEE 2008]**
(1) 0.5 ms^{-1} and 0.3 ms^{-1} (2) –0.5 ms^{-1} and 0.3 ms^{-1}
(3) 0.3 ms^{-1} and -0.5 ms^{-1} (4) 0.3 ms^{-1} and 0.5 ms^{-1}
(e) –0.3 ms^{-1} and 0.5 ms^{-1}

13. Two balls of same mass each m are moving with same velocities v on a smooth surface as shown in figure. If all collisions between the masses and with the wall are perfectly elastic, the possible number of collisions between the bodies and wall together is **[EAMCET 2008]**



(1) 1 (2) 2 (3) 3 (4) infinity

14. A body of mass m strikes another body at rest of mass $\frac{m}{9}$. Assuming the impact to be inelastic the fraction of the initial kinetic energy transformed into heat during the contact is **[EAMCET 2008]**
(1) 0.1 (2) 0.2 (3) 0.5 (4) 0.64

15. A stationary particle explodes into two particles of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2. The ratio of their kinetic energies E_1 / E_2 is **[AFMC 2007]**
(1) 1 (2) $m_1 v_2 / w_2 v$, (3) m_2 / m_l (4) m_1 / m_2

16. A bomb of mass 3.0 kg explodes in air into two pieces of masses 2.0 kg and 1.0 kg. The smaller mass goes at a speed of 80 ms^{-1}. The total energy imparted to the fragments is **[UP CPMT 2007]**
(1) 1.07 kJ (2) 2.14 kJ (3) 2.4 kJ (4) 4.8 kJ

17. A body from height h is dropped. If the coefficient of restitution is e, then calculate the height achieved after one bounce. **[UP CPMT 2007]**
(1) $h_1 = e^2h$ (2) $h_1 = e^4h$ (3) $h_1 = eh$ (4) $h_x = \frac{h}{e}$

18. A body of mass m moving with velocity v makes a head-on elastic collision with another body of mass 2m which is initially at rest. The loss of kinetic energy of the colliding body (mass m) is **[Punjab PMET 2007]**
(1) $\frac{1}{2}$ of its initial kinetic energy (2) $\frac{1}{9}$ of its initial kinetic energy
(3) $\frac{8}{9}$ of its initial kinetic energy (4) $\frac{1}{4}$ of its initial kinetic energy

19. For inelastic collision between two spherical rigid bodies **[MP PMT 2007]**
(1) the total kinetic energy is conserved (2) the linear momentum is not conserved

(3) the total mechanical energy is not conserved (4) the linear momentum is conserved

20. A ball of mass m elastically collides with a wall with velocity v, the change in its momentum is equal to **[RPMT 2007]**
(1) 2 m (2) 2 mv (3) 8 mv (4) zero

21. A body of mass m_1 collides elastically with another body of mass m_2 at rest. If the velocity of m_1 after collision becomes 2/3 times its initial velocity, the ratio of their masses, is **[J&K CET 2007]**
(1) 1 : 5 (2) 5 : 1 (3) 5 : 2 (4) 2 : 5

22. A stationary bomb explodes into two parts of masses in the ratio of 1 : 3. If the heavier mass moves with a velocity 4 ms^{-1}, what is the velocity of lighter part? **[J&K CET 2007]**
(1) 12 ms^{-1} opposite to heavier mass (2) 12 ms^{-1} in the direction of heavier mass
(3) 6 ms^{-1} opposite to heavier mass (4) 6 ms^{-1} in the direction of heavier mass

23. Which of the following is not an example of perfectly inelastic collision? **[AMU 2006]**
(1) A bullet fired into a block if bullet gets embedded into block
(2) Capture of electrons by an atom
(3) A man jumping on to a moving boat
(4) A ball bearing strinking another ball bearing

24. A bullet of mass 20 g and moving with 600 ms^{-1} collides with a block of mass 4 kg hanging with the string. What is velocity of bullet when it comes out of block, if block rises to height 0.2 m after collision? **[DUMET 2006]**
(1) 200 ms^{-1} (2) 150 ms^{-1} (3) 400 ms^{-1} (4) 300 ms^{-1}

25. In two separate collisions, the coefficients of restitutions e_1 and e_2 are in the ratio 3 : 1. In the first collision the relative velocity of approach is twice the relative velocity of separation. Then the ratio between the relative velocity of approach and relative velocity of separation in the second collision is **[EAMCET 2006]**
(1) 1 : 6 (2) 2 : 3 (3) 3 : 2 (4) 6 : 1

26. A bomb of mass 30 kg at rest explodes into two pieces of masses 18 kg and 12 kg. The velocity of 18 kg mass is 6 ms^{-1}. The kinetic energy of the other mass is **[CBSE AIPMT 2005]**
(1) 256 J (2) 486 J (3) 524 J (4) 324 J

27. An electron with kinetic energy 5 eV is incident on a H-atom in its ground state. The collision **[UP CPMT 2005]**
(1) must be elastic (2) may be partially elastic
(3) may be completely elastic (4) may be completely inelastic

28. A body of mass M moves velocity ν and collides elastically with another body of mass m(M >> m) at rest, then the velocity of body of mass m is **[Punjab PMET 2005]**
(1) ν (2) 2ν (3) ν/2 (4) zero

29. A body of mass m is moving towards east and another body of equal mass is moving towards north. If after collision both stick together, their speed after collision would be **[DUMET 2005]**
(1) ν (2) ν/2 (3) $\sqrt{2}v$ (4) $v/\sqrt{2}$

30. A ball falling freely from a height of 4.9 ms^{-1} hits a horizontal surface. If $e = \frac{3}{4}$, then the ball will hit the surface second time after **[DUMET 2005]**

(1) 0.5 s (2) 1.5 s (3) 3.5 s (4) 3.4 s

31. A moving body of mass m and velocity 3 kmh^{-1} collides with a body at rest and of mss 2m and then sticks to it. Now the combined mass starts to move, then the combined velocity will be **[RPMT 2005]**
(1) 4 kmh^{-1} (2) 3 kmh^{-1} (3) 2 kmh^{-1} (4) 1 kmh^{-1}

32. 1 kg body explodes into three fragments. The ratio of their masses is 1 : 1 : 3. The fragments of same mass move perpendicular to each other with speed 30 ms^{-1}, while the heavier par remains in the initial direction. The speed of heavier part is **[BCECE 2005]**
(1) $\frac{10}{\sqrt{2}}ms^{-1}$ (2) $10\sqrt{2}ms^{-1}$ (3) $20\sqrt{2}ms^{-1}$ (4) $30\sqrt{2}ms^{-1}$

33. An α-particle of mass m suffers one dimensional elastic collision with a nucleus of unknown mass. After the collision the α-particle is scattered directly backwards losing 75% of the kinetic energy. The mass of the unknown nucleus is **[JCECE 2005]**
(1) m (2) 2m (3) 3m (4) $\frac{3}{2}m$

34. A body of mass 4 kg moving with velocity 12 ms^{-1} collides with another body of mass 6 kg at rest. If two bodies stick together after collision, then the loss of kinetic energy of system is **[J&K CET 2005]**
(1) zero (2) 288 J (3) 172.8J (4) 144 J

35. A ball is dropped from a height of 20 cm. Ball rebounds to a height of 10 cm. What is the loss of energy? **[AFMC 2004]**
(1) 25% (2) 75% (3) 50% (4) 100%

36. A 10 kg ball moving with velocity 2 ms^{-1} collides with a 20 kg mass initially at rest. If both of them coalesce, the final velocity of combined mass is **[AMU 2004]**
(1) $\frac{3}{4}ms^{-1}$ (2) $\frac{1}{3}ms^{-1}$ (3) $\frac{3}{2}ms^{-1}$ (4) $\frac{2}{3}ms^{-1}$

37. A body x with a momentum p collides with another identical stationary body y one dimensionally. During the collision y gives an impulse J to the body x. Then, the coefficient of restitution is **[EAMCET 2004]**
(1) $\frac{2J}{p}-1$ (2) $\frac{J}{p}+1$ (3) $\frac{J}{p}-1$ (4) $\frac{J}{2p}-1$

38. A neutron makes a head-on elastic collision with a stationary deuteron. The fractional energy loss of the neutron in the collision is **[AIIMS 2003]**
(1) 16/81 (2) 8/9 (3) 8/27 (4) 2/3

39. A particle of mass m moving with velocity ν collides inelsatically with a stationary particle of mass 2m. The speed of the system, will be **[Punjab PMET 2003]**
(1) 3ν (2) ν/2 (3) ν/3 (4) 2ν

40. A ball is dropped from a height h. If the coefficient of restitution is e then to what height will it rise after jumping twice from the ground? **[Kerala CEE 2003]**
(1) $\frac{eh}{2}$ (2) 2eh (3) eh (4) e^4h

41. In the elastic collision of objects **[RPET 2003]**

(1) Only momentum remains constant (2) Only kinetic energy remains constant
(3) Both remains constant (4) None of these

42. A body of mass 2kg makes an elastic collision with another body at rest and continues to move in the original direction with one fourth of its original speed. The mass of the second body which collides with the first body is **[Kerala (Engg.) 2002]**
(1) 2 *kg* (2) 1.2 *kg* (3) 3 *kg* (4) 1.5 *kg*

43. In above figure if transfer kinetic energy to *B* is maximum then **[Orissa JEE 2002; DCE 2001]**

(1) $M_B >> M_A$ (2) $M_B << M_A$
(3) $M_A = M_B$ (4) Can not be predicted as information is incomplete

44. In an elastic collision of two particles the following is conserved **[MP PET 1994; DPMT 2001]**
(1) Momentum of each particle (2) Speed of each particle
(3) Kinetic energy of each particle (4) Total kinetic energy of both the particles

45. A particle of mass *m* moving with a velocity *V* makes a head on elastic collision with another particle of same mass initially at rest. The velocity of the first particle after the collision will be **[MP PMT 1997; MP PET 2001; UPSEAT 2001]**
(1) V (2) $-V$ (3) $-2V$ (4) Zero

46. A particle *P* moving with speed *v* undergoes a head - on elastic collision with another particle *Q* of identical mass but at rest. After the collision **[Roorkee 2000]**
(1) Both *P* and *Q* move forward with speed $\frac{v}{2}$
(2) Both *P* and *Q* move forward with speed $\frac{v}{\sqrt{2}}$
(3) *P* comes to rest and *Q* moves forward with speed *v*
(4) *P* and *Q* move in opposite directions with speed

47. Two particles having position vectors $\vec{r_1} = (3\hat{i} + 5\hat{j})$ *metres* $\vec{r_2} = (-5\hat{i} - 3\hat{j})$ *metres* are moving with velocities $\vec{v_1} = (4\hat{i} + 3\hat{j})\, m/s$ and $\vec{v_2} = (\alpha\hat{i} + 7\hat{j})\, m/s$. If they collide after 2 *seconds*, the value of 'α' is **[EAMCET 2003]**
(1) 2 (2) 4 (3) 8 (4) 1

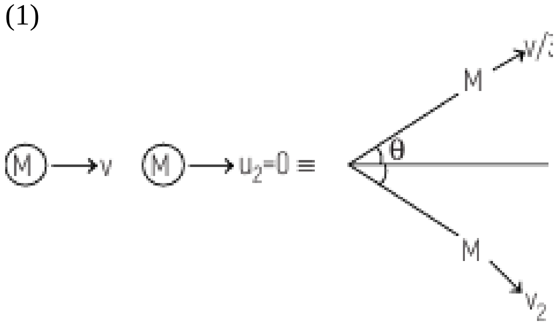
48. Two particles of masses m_1 and m_2 in projectile motion have velocities $\vec{v_1}$ and $\vec{v_2}$ respectively at time $t = 0$. They collide at time t_0. Their velocities become $\vec{v_1'}$ and $\vec{v_2'}$ at time $2t_0$ while still moving in air. The value of $|(m_1\vec{v_1'} + m_2\vec{v_2'}) - (m_1\vec{v_1} + m_2\vec{v_2})|$ is **[IIT-JEE (Screening) 2001]**
(1) Zero (2) $[m_1 + m_2]gt_0$ (3) $2(m_1 + m_2)gt_0$ (4) $\frac{1}{2}(m_1 + m_2)gt_0$

49. A particle falls from a height *h* upon a fixed horizontal plane and rebounds. If *e* is the coefficient of restitution, the total distance travelled before rebounding has stopped is **[EAMCET 2001]**
(1) $h\left(\frac{1+e^2}{1-e^2}\right)$ (2) $h\left(\frac{1-e^2}{1+e^2}\right)$ (3) $\frac{h}{2}\left(\frac{1-e^2}{1+e^2}\right)$ (4) $\frac{h}{2}\left(\frac{1+e^2}{1-e^2}\right)$

50. On a frictionless surface, a block of mass M moving at speed v collides elastically with another block of same mass M which is initially at rest. After collision the first block moves at an angle θ to its initial direction and has a speed v/3. The second block's speed after the collision is **[CBSE AIPMT 2015]**

(1) $\frac{2\sqrt{2}}{3}v$ (2) $\frac{3}{4}v$ (3) $\frac{3}{\sqrt{2}}v$ (4) $\frac{\sqrt{3}}{2}v$

(1)



According to law of conservation of kinetic energy, we have

$$\frac{1}{2}mv^2 + 0 = \frac{1}{2}M\left(\frac{v}{3}\right)^2 + \frac{1}{2}Mv_2^2$$

$$\Rightarrow v^2 = \frac{v^2}{9} + v_2^2$$

$$\Rightarrow v^2 - \frac{v^2}{9} = v_2^2 \Rightarrow \frac{8v^2}{9}$$

Velocity of second block after collision

$$v_2 = \frac{2\sqrt{2}}{3}v$$

51. Two identical balls A and B having velocities of 0.5 m/s and –0.3 m/s respectively collide elastically in one dimension. The velocities of B and A after the collision respectively will be **[NEET 2016]**

(1) –0.5 m/s and 0.3 m/s (2) 0.5 m/s and –0.3 m/s
(3) –0.3 m/s and 0.5 m/s (4) 0.3 m/s and 0.5 m/s

(3)

In elastic collision, kinetic energy of the system remains unchanged and momentum is also conserved.
It is given that mass of balls are same and collision is perfectly elastic (e = 1) so their velocities will be interchanged.

Thus, $v_A^{'} = v_B = -0.3 m/s$

$v_B^{'} = v = 0.5 m/s$

52. A moving block having mass m, collides with another stationary block having mass 4m. The lighter block comes to rest after collision. When the initial velocity of the lighter block is v, then the value of coefficient of restitution (e) will be **[NEET 2018]**

(1) 0.8 (2) 0.25 (3) 0.5 (4) 0.4

(2)

Since, the collision mentioned is an elastic head-on collision. Thus, according to the law of conservation of linear momentum, we get

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

Where, m_1 and m_2 are the masses of the two blocks, respectively and u_1 and u_2 are their initial velocities and v_1 and v_2 are their final velocities, respectively.

Here, $m_1 = m, m_2 = 4m$

$u_1 = v, u_2 = 0 \text{ and } v_1 = 0$

$mv + 4m \times 0 = 0 + 4mv_2$

$\Rightarrow \quad mv = 4mv_2 \text{ or } v_2 = \frac{v}{4}$ ....(i)

As, the coefficient of restitution is given as,

$$e = \frac{\text{relative velocity of separation after collision}}{\text{relative velocity of approach}}$$

$$= \frac{v_2 - v_1}{u_2 - u_1} = \frac{\frac{v}{u} - 0}{0 - v} \qquad [\text{from Eq.(i)}]$$

$$= \frac{1}{4}$$

$\therefore e = 0.25$

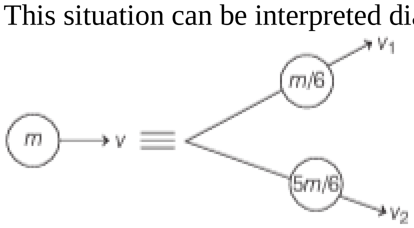
53. An object flying in air with velocity $\left(20\hat{i} + 25\hat{j} + 12\hat{k}\right)$ suddenly breaks in two pieces whose masses are in the ration 1 : 5. The smaller mass flies off with a velocity $\left(100\hat{i} + 35\hat{j} + 8\hat{k}\right)$. The velocity of the larger piece will be **[NEET Odisha 2019]**

(1) $4\hat{i} + 23\hat{j} - 8\hat{k}$ (2) $-100\hat{i} - 35\hat{j} - 8\hat{k}$ (3) $20\hat{i} + 15\hat{j} - 80\hat{k}$ (4) $-20\hat{i} - 15\hat{j} - 80\hat{k}$

(1)

Let m be the mass of an object flying with velocity v in air. When it split into two pieces of masses in ratio 1 : 5, the mass of smaller piece is m/6 and of bigger piece is $\frac{5m}{6}$

This situation can be interpreted diagrammatically as below



As the object breaks in two pieces, so the momentum of the system will remains conserved i.e. the total momentum (before breaking) = total momentum (after breaking)

$$mv = \frac{m}{6}v_1 + \frac{5n}{6}v_2$$

$$\Rightarrow v = \frac{v_1}{6} + \frac{5v_2}{6}$$

Here, $v = 20\hat{i} + 25\hat{j} - 12\hat{k}$

$v_1 = 100\hat{i} + 35\hat{j} + 8\hat{k}$

$$\Rightarrow 20\hat{i} + 25\hat{j} - 12\hat{k} = \frac{\left(100\hat{i} + 35\hat{j} + 8\hat{k}\right)}{6} + \frac{5v_2}{6}$$

$$\Rightarrow \left(120\hat{i} + 150\hat{j} - 72\hat{k}\right) = \left(100\hat{i} + 35\hat{j} + 8\hat{k}\right) + 5v_2$$

$$\Rightarrow \quad v_2 = \frac{1}{5}\left(20\hat{i} + 115\hat{j} - 80\hat{k}\right) = 4\hat{i} + 23\hat{j} - 16\hat{k}$$

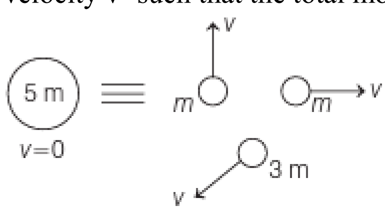
54. A particle of mass 5 m at rest suddenly breaks on its own into three fragments. Two fragments of mass m each move along mutually perpendicular direction with each speed v. the energy released during the process is

[NEET Odisha 2019]

(1) $\frac{3}{5}mv^2$ (2) $\frac{5}{3}mv^2$ (3) $\frac{3}{2}mv^2$ (4) $\frac{4}{3}mv^2$

(4)

The particle of mass 5m breaks in three fragments of mass m_1 m and 3m respectively. Two fragments of mass m each, move in perpendicular direction with velocity v and the left fragment will move in a direction with velocity v' such that the total momentum of the system must remain conserved.



By law of conservation of momentum,

$$5m\times 0 = mv\hat{i} + mv\hat{j} + 3mv'$$

$$\Rightarrow v' = -\frac{v}{3}\hat{i} - \frac{v}{3}\hat{j}$$

$$\therefore |v'| = \sqrt{\left(-\frac{v}{3}\right)^2 + \left(-\frac{v}{3}\right)^2} = \frac{v\sqrt{2}}{3}$$

$\therefore$ Energy released

$$E = \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}\times 3m\left(\frac{v\sqrt{2}}{3}\right)^2$$

$$= mv^2 + \frac{mv^2}{3} = \frac{4}{3}mv^2$$

55. Body A of mass 4m moving with speed u collides with another body B of mass 2m, at rest. The collision is head on and elastic in nature. After the collision the fraction of energy lost by the colliding body A is **[NEET National 2019]**

(1) $\frac{8}{9}$ (2) $\frac{4}{9}$ (3) $\frac{5}{9}$ (4) $\frac{1}{9}$

(1)

Final velocity of

$$V_B = \left(\frac{M_2 - M_1}{M_1 + M_2}\right)u_2 + \left(\frac{2M_1}{M_1 + M_2}\right)u_1$$

$$M_1 = 4M u_1 = u$$

$$M_2 = 2M u_2 = 0$$

$$V_B = \frac{2(4M)u}{6M} = \frac{4}{3}u$$

$$\frac{\frac{1}{2}M_2V_B^2}{\frac{1}{2}M_1u_1^2} = \frac{\frac{1}{2}\times 2M\left(\frac{4}{3}\right)^2 u^2}{\frac{1}{2}4Mu^2}$$

So, The fraction of energy lost = $\frac{8}{9}$.

—♦—♦—♦—

ANSWER KEY

LEVEL – 1

1.	(3)	2.	(2)	3.	(4)	4.	(4)	5.	(4)
6.	(3)	7.	(3)	8.	(3)	9.	(3)	10.	(2)
11.	(1)	12.	(2)	13.	(1)	14.	(4)	15.	(4)
16.	(1)	17.	(3)	18.	(2)	19.	(2,4)	20.	(1)
21.	(3)	22.	(1)	23.	(2)	24.	(1,3)	25.	(3)
26.	(1)	27.	(1)	28.	(1)	29.	(1)	30.	(2)
31.	(2)	32.	(3)	33.	(4)	34.	(3)	35.	(2)
36.	(1)	37.	(3)	38.	(3)	39.	(2)	40.	(4)
41.	(3)	42.	(4)	43.	(1)	44.	(2)	45.	(3)
46.	(4)	47.	(1)	48.	(2)	49.	(1)		

LEVEL – 2

1.	(3)	2.	(1)	3.	(2)	4.	(3)	5.	(3)
6.	(1)	7.	(2)	8.	(2)	9.	(3)	10.	(1)
11.	(1)	12.	(1,2,3)	13.	(4)	14.	(3)	15.	(3)
16.	(3)	17.	(4)	18.	(3)	19.	(2)	20.	(3)
21.	(2)	22.	(4)	23.	(1)	24.	(4)	25.	(1)
26.	(4)	27.	(2)	28.	(1)	29.	(2)	30.	(1)
31.	(3)	32.	(1)	33.	(1)	34.	(4)	35.	(4)
36.	(2)								

Assertion & Reason

1.	(1)	2.	(1)	3.	(5)	4.	(1)	5.	(2)
6.	(5)	7.	(3)	8.	(1)	9.	(3)		

Previous Year's Questions

1.	(4)	2.	(3)	3.	(1)	4.	(4)	5.	(3)
6.	(2)	7.	(4)	8.	(1)	9.	(1)	10.	(4)
11.	(2)	12.	(4)	13.	(3)	14.	(1)	15.	(3)
16.	(4)	17.	(1)	18.	(3)	19.	(3,4)	20.	(2)
21.	(2)	22.	(1)	23.	(4)	24.	(1)	25.	(4)
26.	(2)	27.	(1)	28.	(2)	29.	(4)	30.	(2)
31.	(4)	32.	(2)	33.	(3)	34.	(3)	35.	(3)
36.	(4)	37.	(1)	38.	(2)	39.	(3)	40.	(4)
41.	(3)	42.	(2)	43.	(3)	44.	(4)	45.	(4)
46.	(3)	47.	(3)	48.	(3)	49.	(1)	50.	(1)
51.	(3)	52.	(2)	53.	(1)	54.	(4)	55.	(1)