COLLISIONS

1. The strong physical interaction among bodies involving exchange of momentum is called a collision.
2. The time of duration of collision is very short
3. In the collision process, bodies need not get into physical contact.
4. If the colliding bodies move along a straight line joining their centers of mass before and after the collision; it is called head on collision or collision in one dimension.
5. When the bodies move in a plane either before or after the collision is called collision in two dimensions.
6. When no external force acts, the momentum of the system remains constant, this is called conservation of momentum ;
7. A bullet of mass 'm' is fired from a gun of mass 'm' with a velocity 'v', the recoil velocity of the gun is (V) $V = \frac{mv}{M}$
8. Two bodies of masses m_1 and m_2 are moving in the same direction with velocities u_1 & u_2 ; After collision they move in the same direction with velocities v_1 & v_2 $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
9. If the two bodies stick together after impact, they move with common velocity $v = \frac{m_1u_1 + m_2u_2}{m_1 + m_2}$
10. A truck of mass 'M' moves with a velocity 'v'; A packet of mass 'm' is gently dropped into it, the velocity of the truck becomes

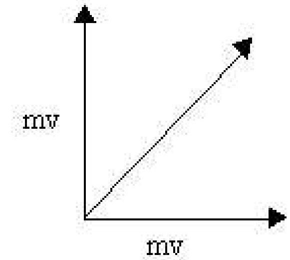
$$Mv = (M+m)v^1 \Rightarrow v^1 = \frac{Mv}{m+M};$$

11. A shell of mass 'M' at rest explodes and breaks into two pieces ; one piece of mass 'm' moves with a velocity 'v'. The other piece moves in the opposite direction, with a velocity $v^1 = \frac{Mv}{m-M}$;
12. A shell of mass 'm' moving with a velocity 'v' explodes and breaks into '2' pieces ; one piece of mass m_1 moves with a velocity v_1 and other piece of mass m_2 moves with a velocity v_2

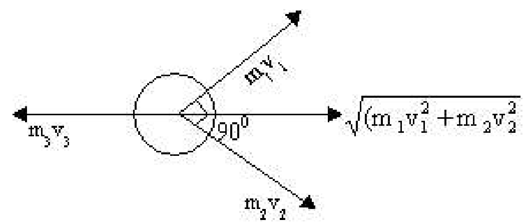
$$m.\,v = m_1v_1 + m_2v_2$$

13. Two bodies each of mass 'm' moving at right angles with a velocity 'v' collide ; After collision, if they move together, their common velocity is

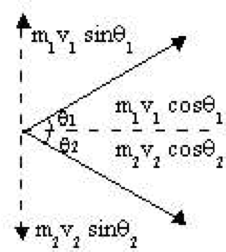
$$2mv^1 = \sqrt{2}\,mv \Rightarrow v^1 = \frac{v}{\sqrt{2}}$$



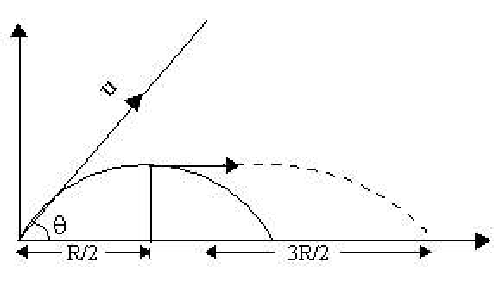
14. A shell of mass 'M' exploded of rest and breaks into '3' pieces; Two pieces of masses m_1 and m_2 move at right angles to each other with velocities v_1 and v_2 then the velocity of the third piece $m_3v_3 = \sqrt{(m_1v_1)^2 + (m_2v_2)^2}$;



15. A body of mass m_1 moving with a velocity v_1 collided another body of mass m_2 at rest; After collision, the bodies move at right angles, θ_1 and θ_2 to the original line of motion with velocities v_1 and v_2 Applying conservation of momentum in the vertical direction $m_1v_1 \sin\theta_1 = m_2v_2 \sin\theta_2$ Applying conservation of momentum in the horizontal direction $m_1v_1 = m_1v_1 \cos\theta_1 + m_2v_2 \cos\theta_2$



16. A shell of mass 'm' is projected with a velocity 'v' making an angle 'θ' with the horizontal ; At the highest point it explose and break into two pieces of equal mass ; one piece retrace it path with same velocity ; the range of the other piece from the point of projections



$$mv\cos = \frac{-\frac{m}{2}v\cos\theta + \frac{m}{2}v}{}$$

$v = 3v\cos\theta$;

Range from the point of projection

$$R^1 = \frac{R}{2} + \frac{3R}{2} = 2R$$

COEFFICIENT OF RESTITUTION

The ratio of relative velocity of separation after collision to the relative velocities of approach before collision is called coefficient of restitution.

$$e = \frac{v_2 - v_1}{u_1 - u_2}$$

'e' depends on the nature of the materials of the two colliding bodies.

$\rightarrow$ No units or dimensions

$\rightarrow$ Its value lies between 0 & 1

A body is dropped from a height 'h' it rebounds to a height 'h_1'; The coefficient of restitution

$$e = \frac{v_2 - v_2}{u_1 - u_2} = \frac{\sqrt{2gh_1}}{\sqrt{2gh}}$$

$$\therefore e = \sqrt{\frac{h_1}{h}}$$

$e^2 = \frac{h_1}{h}$ [Squaring on both sides]

First rebouncing height

$h_1 = he^2$

Second rebouncing height

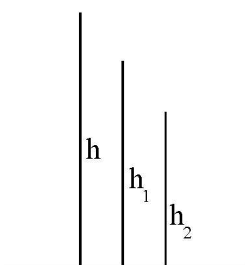
$h_2 = he^4$

Third rebouncing height

$h_3 = he^6$

nth rebouncing height

$h_n = he^{2n}$



Total distance before 3rd rebound

$S_1 = h + 2h_1 + 2h_2$

Total distance travelled by the body before coming to rest

$$S = h\left(\frac{1+e^2}{1-e^2}\right)$$

Total time taken by a body to come to rest

$$t = \sqrt{\frac{2h}{g}}\left(\frac{1+e}{1-e}\right) ;$$

$\Rightarrow$ A body is dropped from a certain height, it stricked the ground with a velocity 'v' and rebound with a velocity v_1, the coefficient of restitution

$$e = \sqrt{\frac{2gh_1}{2gh}} = \frac{v_1}{v}$$

$v_1 = ve$;

After 2nd Rebound

$v_2 = ve^2$

After n^{th} Rebound

$v_n = ve^n$

$\Rightarrow$ A body is dropped from certain height, if strikes the ground after time 't_1' and reached the highest point after

Then coefficient of restitution $e = \frac{t_1}{t}$

$\Rightarrow$ A body is dropped from a heights 'h'; if coefficient of restitution is 'e', its average speed is

$$v = \frac{\text{Total Distance}}{\text{Total Time}}$$

$$= \frac{h(1+e^2)(1-e)}{(1-e^2)\sqrt{\frac{2h}{g}}(1+e)} \qquad = \frac{1+e^2}{(1+e)^2}\sqrt{\frac{gh}{2}}$$

$\Rightarrow$ The time elapse from the moment it is dropped to the second impact with the floor is

$$t = \sqrt{\frac{2h}{g}}(1+2e)$$

$\Rightarrow$ Total change in momentum, before ball comes to rest is $\Delta P = m\sqrt{2gh}\left(\frac{1+e}{1-e}\right)$

ELASTIC COLLISION

The collision in which, both momentum and K.E. reaming constant is called Elastic Collision ;

Eg : Collision in gas molecules

Collision of particle with nucleus.

Collision bet two smooth billiard balls.

In a perfect elastic collision coefficient of restitutory is "1" ;

$v_2 - v_1 = u_1 - u_2$ (Newtons expel law)

In Elastic Collision :

The collision in which momentum remaing constant and K.E. changes is called in elastic collision.

Eg : All collisions generally seen :

In a perfectly inelastic collision, the two bodies stick together after impact and move with common velocity, so the coefficient of restitutions e = 0;

Elastic Collision in one Dimension :

Two bodies of masses m_1 and m_2 moving in the same direction with velocities u_1 & u_2 collide elastically ; The final velocities of the two bodies after collusion

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

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

Case 1 :

If $m_1 = m_2$

$v_1 = u_2$; $v_2 = u_1$;

i.e., A body moving with some velocity collide with another body moving with same mass and another direction ; They interchange their velocities;

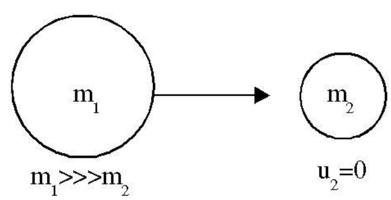
Case 2 :

If $m_1 = m_2$; $u_2 = 0$

$u_2 = v_1$; $u_2 = 0$

i.e., A body moving with some velocity collides with another body of same mass of rest; Then the first body comes to rest and second body moves with the velocity of the first body ;

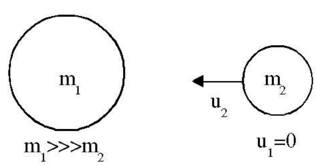
Case 3 :



$v_1 = u_1$; $v_2 = 2u_1$;

i.e., A large body moving with same velocity collides with a lighter body of rest ; Then there is almost no change in the velocity of heavy body ; But lighter body moves with double velocity of large body.

Case 4 :



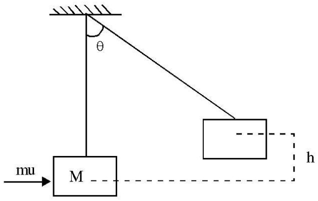
$v_1 = 0$; $v_2 = -u_1$;

i.e., A lighter body moving with same velocity collided a large body at rest ; Then the large body remaing at rest, but lighter body retrace its path with same velocity.

<u>Ballistic Pendulum:</u>

A particle of mass 'm' moving with some velocity collides elastically another body of same mass at rest, them they more at right angle with each other;

A Block of mass 'M' is suspended by means of a rope '*l*' ; A bullet of mass 'm' moving with a velocity 'u' collides with the block and get embedded on it ; If the block raised to a height 'h'



$mu = (M + m)\,v$

[$\because$ law of conservation of momentum]

$v = \sqrt{2gh}$ [conservation of energy]

$mu = (M+m)\sqrt{2gh}$ $\quad u = \left(\frac{M+m}{m}\right)\sqrt{2gh}$

Two bodies of masses m_1 and m_2 moving in the same directions with velocities u_1 & u_2 collide then the loss of K.E. is

If the collision is perfectly in elastic e = 0

$$K.E. = \frac{m_1 m_2 (u_1 - u_2)^2}{2(m_1 + m_2)} ;$$

$\Rightarrow$ If the collision is perfectly inelastic and the second body is at rest then the loss of K.E.

$$\Delta K.E. = \frac{m_1 m_2 u_1^2}{2(m_1 + m_2)} ;$$

$\Rightarrow$ If the collision is perfectly inelastic and the second body is at rest then fractional loss of K.E.

$$\frac{\Delta K.E.}{K.E.} = \frac{m_1 m_2 u_1^2}{2(m_1 + m_2) \times \frac{1}{2} m_1 u_1^2}$$

$$\frac{\Delta K.E.}{K.E.} = \frac{m_2}{m_1 + m_2} ;$$

$\Rightarrow$ In the case of Elastic collision, the ratio of initial to final K.E. of the colliding body

$$= \frac{(m_1 + m_2)^2}{(m_1 - m_2)^2}$$

$\Rightarrow$ If the collision is perfectly elastic and second body is at rest. The fractional part of K.E. transferred to the second body

$$\frac{\Delta K.E.}{K.E.} = \frac{4m_1 m_2}{(m_1 + m_2)^2}$$

$\Rightarrow$ Fraction of K.E. retained with the first body

$$1 - \frac{4m_1 m_2}{(m_1 + m_2)^2} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$$

$\Rightarrow$ A body of mass 'm' collides elastically with a body of mass nm of rest ; the fraction of K.E. transferred to the second body

$$\frac{\Delta K.E.}{K.E.} = \frac{4m^2 n}{m^2 (1+n)^2}$$

$\Rightarrow$ Fraction of energy retained with the first body

$$= 1 - \frac{4n}{(n+1)^2} = \left(\frac{n-1}{n+1}\right)^2$$

$\Rightarrow$ When shell explodes momentum remains constant but K.E increases

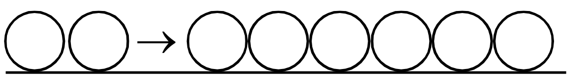
CONCEPTUAL QUESTIONS

1. Newton's first law of motion leads to the concept of
   1) force   2) inertia
   3) both   4) temperature
2. When an athelete takes part in a long jump he runs for a while and then jumps. This is because
   1) inertia of motion helps him to take a longer jump
   2) running for a time makes him alert
   3) it is a rule that one should run before he jumps
   4) he wants to show his physical power
3. A man is trying to swim across the river. Then he should spend maximum energy in
   1) first one third of the journey
   2) second one third of the journey
   3) last one third of the journey
   4)Equal in all cases.
4. Newton's second law of motion give
   1) magnitude of force   2) definition of force
   3) concept of inertia   4) all the above
5. A boat with a sail has an electric fan inside. When the fan works, due to it the boat
   1) cannot move   2) can move
   3) it depends on wind directions
   4) it depends on the speed of the fan
6. A cricketer draws his hands backwards to catch the ball, because
   1) by increasing the time in which he stops the ball, he reduces the force on his hands
   2) by increasing the distance, he allows the ball to travel a greater distance for more runs
   3) it is an art to catch the ball
   4) it is a rule in circket
7. Impulse is equal to
   1) momentum   2) change in momentum
   3) rate of change of momentum
   4) rate of change of force
8. A body is projected vertically upwards. Its momentum is gradually decreasing. In this
   1) it is a violation of law of conservation of linear momentum
   2) momentum of the body alone gets conserved
   3) momentum of the body, earth and air molecules together remains constant
   4) violates law of conservation of energy.
9. If a stationary bomb explodes into pieces, then
   1) momentum increases
   2) momentum decreases
   3) kinetic energy increases
   4) kinetic energy decreases
10. If a stationary bomb explodes into pieces, then
    1) momentum remains constant
    2) momentum decrease
    3) kinetic energy remains constant
    4) both (1) and (3)
11. If a stationary bomb explodes into two pieces of unequal masses, then
    1) both will have the same kinetic energy
    2) bigger piece will have greater kinetic energy
    3) smaller piece will have greater kinetic energy
    4) bigger piece will have greater momentum
12. Conservation of linear momentum is equivalent to
    1) Newton's first law of motion
    2) Newton's second law of motion
    3) Newton's third law of motion
    4) Newton's law of gravitation
13. The horizontal component of weight
    1) is always zero
    2) is always equal to the weight
    3) is less than the weight, but is not zero
    4) depends upon the angle of longitude
14. Jet plane works on the principal of conservation of
    1) mass   2) energy   3) linear momentum
    4) angular momentum
15. A shell initially at rest explodes into two pieces of unequal masses. Then the two pieces will
    1) fly in opposite direction with same velocity
    2) fly in opposite direction with same kinetic energy
    3) fly in opposite direction with same momentum
    4) fly in the same direction with same momentum
16. A bullet is fired into a wooden block. If the bullet gets embedded in wooden block, then
    1) momentum alone is conserved
    2) kinetic energy alone is conserved
    3) both momentum and kinetic energy are conserved
    4) neither momentum nor kinetic energy are conserved
17. The collision in which the relative velocity is zero after collision is
    1) perfectly elastic   2) perfectly inelastic
    3) partially elastic
    4) sometimes elastic and sometimes inelastic
18. In one - dimensional elastic collision, the relative velocity of approach before collision is equal to
    1) relative velocity of separation after collision
    2) e times relative velocity of separation after collision
    3) 1/e times relative velocity of separation after collision
    4) sum of the velocities after collision

19. Two identical bodies moving in opposite direction with same speed, collided with each other. If the collision is perfectly elastic then
1) after the collision both comes to rest
2) after the collision first comes to rest and second moves in the same direction with a speed 2v
3) after collision they recoil with same speed
4) all the above are possible

20. A body of mass 'm' moving with certain velocity collides with another identical body at rest. If the collision is perfectly elastic and after the collision, if both the bodies moves, they can move
1) in the same direction 2) in opposite direction
3) in perpendicular direction
4) making 45° to each other

21. As shown in the figure six steel balls of identical size are lined up along a straight frictionless groove. Two similar balls moving with speed v along the groove collide with this row on the extreme left end. Then



1) one ball from the right end will move on with speed 2v and all the remaining balls will be are rest
2) two balls from the extreme right end will move on with speed v and the remaining balls will be at rest
3) all the balls will start moving to the right will speed v/8
4) all the six balls originally at rest will move on with speed v/6 and the incident balls will come to rest

22. A lighter body moving a velocity v collides with a heavier body at rest. Then
1) the lighter body rebounces with twice the velocity of bigger body
2) the lighter body retraces its path will the same velocity in magnitude
3) the heavier body does not move practically
4) both (2) and (3)

23. A heavier body moving with certain velocity collides head on elastically with a lighter body at rest. then
1) smaller body continues to be in the same state of rest
2) smaller body starts to move in the same direction with same velocity as that of bigger body
3) the smaller body starts to move with twice the velocity of the bigger body in the same direction
4) the bigger body comes to rest

24. The co - efficient of restitution for perfect elastic collision is
1) 1 2) 0
3) lies in between 0 to 1 4) infinity

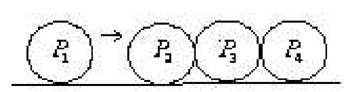
25. The co-efficient of restitution for perfect elastic collision is
1) 1 2) 0
3) lies in between 0 and 1 4) infinity

26. The area of force and time graph represents
1) impulse 2) change in momentum
3) both (1) and (2) 4) work

27. A metal ball and a rubber ball both having the same mass strikes a wall normally with the same velocity. The rubber ball rebounds and the metal ball does not rebound. It can be concluded that
1) the rubber ball suffers greater change in momentum
2) the iron ball suffers greater change in momentum
3) both suffers the same change in momentum
4) none of the above

28. Choose the false statement
1) In a perfect elastic collision the relative velocity of approach is equal to the relative velocity of separation
2) In an inelastic collision the relative velocity of approach is less than the relative velocity of separation
3) In an inelastic collision the relative velocity of separation is less than the relative velocity of approach
4) In perfect inellastic collision relative velocity of separation is zero.

29. A perfectly elastic ball p_1 of mass 'm' moving with velocity v collides elastically with three exactly similar balls p_2 p_3 p_4 lying on a smooth table. Velocities of the four balls after collision are



1) 0,0,0,0 2) v.v.v.v 3) v,v,v,0 4) 0,0,0,v

30. Two bodies P and Q of masses m_1 and m_2 $(m_2 > m_1)$ are moving with velocity v_1 and v_2 respectively, collide with each other. Then the force exerted by P on Q during the collision is
1) greater that the force exerted by Q on P
2) less than the force exerted by Q on P
3) same as the force exerted by Pon Q
4) same as the force exerted by P on Q but opposite in direction

31. Two particles of different masses collide head on. Then for the system
1) loss of KE is zero, if it were perfect elastic collision
2) if it were perfect inelastic collision, the loss of KE of the bodies moving in opposite directions is more than that of the bodies moving in the same direction
3) loss of momentum is zero for both elastic and inelastic collisions
4) all the above

32. Coefficient of restitution depends upon,
1) The relative velocities of approach and separation
2) The masses of the colliding bodies
3) the materials of the colliding bodies
4) all the above

33. A car and a lorry are moving with same momentum. If same brake force is applied then,
1) car comes to rest in shorter distance
2) lorry comes to rest in shorter distance
3) both travels the same distance before coming to rest
4) In sufficient data

34. A car and a lorry are moving with same momentum. If equal amount of brake force is applied, then
1) car comes to rest in shorter time
2) lorry comes to rest in shorter time
3) both takes same time to come to rest
4) In sufficient data

35. A charged bead is capable of sliding freely on a string held vertically in tension. An electric field is applied parallel to the string so that the bead stays at rest at mid - point of the string. If the electric field is switched off momentarily and switched on
1) the bead moves downwards and stops as soon as the field is switched on
2) the bead moves downwards when the field is switched off and moves upwards when the field is switched on
3) the bead moves downward with constant acceleration till it reaches the bottom of the string
4) the bead moves downwards with constant velocity till it reaches the bottom of the string

36. A 2 kg mass moving on a smooth frictionless surface with a velocity of $10\,ms^{-1}$ hits another 2 kg mass kept at rest, in an inelastic collision. After collision, if they move together,
1) they travel with a velocity of $5\,ms^{-1}$ in the same direction
2) they travel with a velocity of $10\,ms^{-1}$ in the same direction
3) they travel with a velocity of $10\,ms^{-1}$ in opposite direction
4) they travel with a velocity of $5\,ms^{-1}$ in opposite direction

37. The coefficient of restitution (e) for a perfectly elastic collision is
1) -1 2) 0 3) ∞ 4) 1

38. A ball of mass M moving with a velocity V collides head on elastically with another of same mass but moving with a velocity v in the opposite direction. After collision,
1) the velocities are exchanged between the two balls
2) both the balls come to rest
3) both of them move at right angles to the original line of motion
4) one ball comes to rest and another ball travels back with velocity 2V

39. A ball is dropped from a height h on the ground. If the coefficient of restitution is e, the height to which the ball goes up after it rebounds for the nth time is
1) he^{2n} 2) he^{n} 3) e^{2n}/h 4) h/e^{2n}

40. A sphere of mass m moving with a constant velocity u hits another stationary sphere of the same mass. If e is the coefficient of restitution, then the ratio of velocities of the two spheres after collision will be
1) $\frac{1-e}{1+e}$ 2) $\frac{1+e}{1-e}$ 3) $\frac{e+1}{e-1}$ 4) $\frac{e-1}{e+1}$

41. A neutron travelling 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 fraction of the total kinetic energy retained by the 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) $\left(\frac{A+1}{A}\right)^2$

42. A particle of mass m moving with a velocity v makes a head on elastic collision with another particle of the same mass initially at rest. The velocity of the first particle after collision is
1) v 2) v/2 3) 2v 4) 0

43. A ball of mass m moving with a speed u undergoes a head - on elastic collision with a ball of mass nm initially at rest. The fraction of the initial kinetic energy transferred to the heavier ball is
1) $\frac{n}{n+1}$ 2) $\frac{n}{(1+n)^2}$ 3) $\frac{2n}{(1+n)^2}$ 4) $\frac{4n}{(1+n)^2}$

44. A parachutist of weight w strikes the ground with his legs fixed and comes to rest with an upward acceleration of magnitude 3g. The force exerted on him by the ground during landing is
1) w 2) 2w 3) 3w 4) 4w

45. The small bob A of a simple pendulum released from 30° to the vertical hits another bob of the same mass and size lying at rest on the table vertically below the point of suspension. After elastic collision, the angular amplitude of the bob A will be
1) 30° 2) 60° 3) 15° 4) zero

46. A body of mass m moving with a constant velocity V hits another body of the same mass moving with the same velocity V but in opposite direction and sticks to it. The velocity of the compound body after the collision is
1) 2V 2) V 3) V/2 4) zero

47. Which of the following is a non - conservative force?
1) force on a particle executing S.H.M
2) gravitational force between two masses
3) centripetal force on a particle executing uniform circular motion
4) electrostatic force between two charges

48. An object is kept on a smooth inclined plane of 1 in L can be kept stationary relative to the incline by giving a horizontal acceleration of

1) $\frac{g}{L^2-1}$ to the inclined plane

2) $\frac{g}{L^2+1}$ to the inclined plane

3) $\frac{g}{\sqrt{L^2-1}}$ to the inclined plane 4) $\frac{g}{\sqrt{L^2+1}}$ to the inclined plane

49. The coefficient of restitution is
1) a number of which varies from - 1 to 1
2) a number which varies from 0 to 1
3) a number which varies from 0 to -1
4) a positive number

50. Two spheres x and Y collide. After collision, of the momentum of X is doubled,
1) the initial momentum of X and Y are equal 2) the initial momentum of X is greater than that of Y
3) the initial momentum of Y is double that of X
4) the loss in momentum of Y is equal to the initial momentum of X

51. A shell is fired from a cannon with a velocity V at an angle θ with the horizontal. At the highest point in its path it explodes into two pieces of equal mass. One of the pieces retraced the path to the cannon. The speed of the other piece immediately after explosion is
1) $3V\cos\theta$ 2) $1.5V\cos\theta$
3) $2V\cos\theta$ 4) $(\sqrt{3}/2)V\cos\theta$

52. In an inelastic collision, the kinetic energy after collision
1) is same as before collision
2) is always less than that before collision
3) is always greater than that before collision
4) may be less or greater than that before collision

53. A ball hits the floor and rebounds after an inelastic collision. In this case
1) the momentum of the ball just after the collision is same as that just before the collision
2) The mechanical energy of the ball remains the same in the collision
3) the total momentum of the ball and the earth is conserved
4) the total kinetic energy of the ball and the earth is conserved

54. Two particles of same mass have an elastic collision, the target particle being initially at rest. If it were not head on collision, the two particles move after collision
1) parallel to each other
2) anti - parallel to each other
3) perpendicular to each other
4) making an angle 120°

55. An object initially at rest explodes into three fragments A,B and C. The momentum of A is pi and that of B is $\sqrt{3}pj$ where p is a positive number. The momentum of C will be
1) $(1+\sqrt{3})p$ in a direction making an angle 120° with that of A
2) $(1+\sqrt{3})p$ in a direction making 150° with that of B
3) 2p in a direction making 150° with that of A
4) 2p in a direction making 150° with that of B

KEY

01) 3	02) 1	03) 1	04) 1	05) 1
06) 1	07) 2	08) 3	09) 3	10) 1
11) 3	12) 3	13) 1	14) 3	15) 3
16) 1	17) 2	18) 1	19) 3	20) 3
21) 2	22) 4	23) 3	24) 1	25) 2
26) 3	27) 1	28) 2	29) 4	30) 3
31) 4	32) 3	33)2	34) 3	35)4
36) 1	37) 4	38) 1	39) 1	40) 1
41) 1	42) 4	43) 4	44) 4	45)4
46) 4	47) 3	48) 3	49) 2	50) 4
51)1	52) 4	53)3	54) 3	55) 4

LEVEL - I

Conservation of momentum & Ballistic pendulum

1. A wagon of mass 10 tons moving at a speed of 12 KMPH collides with another wagon of mass 8 tons moving on the same track in the same direction at a speed of 10 KMPH. If the speed of the first wagon decreases to 8 KMPH. Find the speed of the other after collision
1) 18 kmph 2) 25 kmph 3) 5 kmph 4) 15 kmph

2. A 5kg mass moving at a speed of $3\ ms^{-1}$ collides head on with a body of mass 1 kg at rest, if they move with a common velocity after collision in the same direction, find the velocity.
1) $25\ ms^{-1}$ 2) $250\ ms^{-1}$
3) $2.5\ ms^{-1}$ 4) $20\ ms^{-1}$

3. The mass of a loaded truck 10 tones is going at a speed of 20 KMPH. A box of mass 2 tones slips from it and falls on the road. Find the final velocity of truck (assume that the power of the engine is constant)
1) 2.5 kmph 2) 25 kmph
3) 5.5 kmph 4) 3.5 kmph

4. A bomb at rest explodes into two pieces of masses 20 kg and 30 kg if the first one move with a velocity of $30\ ms^{-1}$. Find the velocity of the other
1) $-20\ ms^{-1}$ 2) $0.5\ ms^{-1}$
3) $+20\ ms^{-1}$ 4) $0.3\ ms^{-1}$

5. A bullet of mass 20 gm is fired from a riffle of mass 20 kg. with a muzzle velocity of $200\ ms^{-1}$. Find the velocity of recoil of the rifle.
1) $0.4\ ms^{-1}$ 2) $0.5\ ms^{-1}$
3) $0.2\ ms^{-1}$ 4) $0.3\ ms^{-1}$

6. A bullet of mass 125 gm. leaves a rifle with a velocity of $500\ ms^{-1}$. The riffle recoils with a velocity $5\ ms^{-1}$. Find the mass of the rifle.
1) 100 kg 2) 12.5 kg 3) 1.25 kg 4) 125 kg

7. A boy of mass 40 kg jumps off a boat with a velocity of $3\ ms^{-1}$. With what momentum does the boat move ?
1) $-210\ kg.ms^{-1}$ 2) $-120\ kg.ms^{-1}$
3) $-125\ kg.ms^{-1}$ 4) $-215\ kg.ms^{-1}$

8. A bullet is fired from a gun with a velocity 600 m/s. The recoil velocity of the gun is 3m/s. What is the ratio of the mass of the gun and bullet ?
1) 100 2) 400 3) 200 4) 300

9. A bullet weighing 200 gm and moving at $200\ ms^{-1}$ strikes a 4kg block of ice at rest on a frictionless surface and drops dead. The speed of the block is
1) 200 m/s 2) 100 m/s 3) 50 m/s 4) 10 m/s

10. A body of mass m moving at a constant velocity v hits another body of the same mass moving at the same velocity but in the opposite direction and sticks to it. The common velocity after collision is
1) v 2) 0 3) 2v 4) v/2

11. A 500 gm gun fires a 2 gm projectile with a muzzle velocity of $1600\ ms^{-1}$. The velocity of the gun is
1) $-0.64\ ms^{-1}$ 2) $-6.4\ ms^{-1}$
3) $6.4\ ms^{-1}$ 4) $0.64\ ms^{-1}$

12. The U^{238} nucleus is unstable and decays into a Th^{234} and an aplha particle. The alpha particle is emitted with a speed of $1.4\times10^{6}\ m/sec$. The recoil speed of Th^{234} is
1) $\frac{4\times1.4\times10^{6}}{234}\ m/s$ 2) $-\frac{4\times1.4\times10^{6}}{234}\ m/s$
3) $\frac{234}{4\times1.4\times10^{6}}\ ms^{-1}$ 4) $0\ ms^{-1}$

13. An 8 gm bullet is fired horizontally into a 9 kg block of wood and sticks in it. The block which is free to move, has a velocity of 40 cm/s after impact. The initial velocity of the bullet is
1) 450 m/s 2) 450 cm/s
3) 220 m/s 4) 220 cm/s

14. A 16 gm mass is moving in the +x direction at 30 cm/s while a 4 gm is moving in the -x direction at 50 cm/s. They collides head - on and stick together. Their common velocity after impact is
1) 0.14 cm/s 2) 0.14 m/s
3) $0\ ms^{-1}$ 4) 0.3 m/s

15. A bullet of mass 50 grams going at a speed of $200\ ms^{-1}$ strikes a wood block of mass 950 gm and gets embedded in it. Find the velocity o the block after the impact
1) $5\ ms^{-1}$ 2) $10\ ms^{-1}$ 3) $20\ ms^{-1}$ 4) $50\ ms^{-1}$

16. A block of wood of mass 9.8 kg is suspended by a string. A bullet of mass 200 gm strikes horizontally with a velocity of $100\ ms^{-1}$ and gets imbedded in it. To what height will the block rise ? $\left(g=10\ ms^{-2}\right)$
1) 0.1 m 2) 0.2 m 3) 0.3 m 4) 0

17. A 15 gm bullet is fired horizontally into a 3 kg block of wood suspended by a string. The bullet sticks in the block, and the impact causes the block to swing 10 cm above the initial level. The velocity of the bullet nearly is

1) 281 ms^{-1} 2) 326 ms^{-1} 3) 184 ms^{-1} 4) 58 ms^{-1}

18. A truck of mass 10 metric ton runs at 3 ms^{-1} along a level track and collides with a loaded truck of mass 20 metric ton, standing at rest. If the trucks couple together, the common speed after collision is

1) 1 ms^{-1} 2) 1 ms^{-1} 3) 0.5 ms^{-1} 4) 0.3 ms^{-1}

19. A nucleus of mass number 'A' originally at rest emits an α particle with a speed 'v' the recoil speed of the daughter nucleus is

1) $\frac{2\nu}{4-A}$ 2) $\frac{4\nu}{A+4}$ 3) $\frac{\nu}{A+4}$ 4) $\frac{4\nu}{A-4}$

COEFFICIENT OF RESTITUTION & ELASTIC, INELASTIC COLLISIONS

20. A rubber ball drops from a height h and after rebounding twice from the ground, it rises to h/2. The co - efficient of restitution is

1) 1 / 2 2) $\left(\frac{1}{2}\right)^{1/2}$ 3) $\left(\frac{1}{2}\right)^{1/4}$ 4) $\left(\frac{1}{2}\right)^{1/6}$

21. In the above problem if the ball rises to h / 2 after rebounding three times e, is

1) 1 / 2 2) $\left(\frac{1}{2}\right)^{1/2}$ 3) $\left(\frac{1}{2}\right)^{1/4}$ 4) $\left(\frac{1}{2}\right)^{1/6}$

22. A body dropped freely from a height h on to a horizontal plane, bounces up and down and finally comes to rest. The coefficient of restitution is e. The ratio of velocities at the beginningand after two rebounds is

1) 1 : e 2) e : 1 3) 1 : e^2 4) e^2 : 1

23. In the above problem, the ratio of times of two consequtive rebounds

1) 1 : e 2) e : 1 3) 1 : e^2 4) e^2 : 1

24. In the above problem the ratio of distance travelled in two consequitive rebounds

1) 1 : e 2) e : 1 3) 1 : e^2 4) e^2 : 1

25. A metal ball falls from a height of 1m on to a steel plate and jumps upto a height of 81 cm. Find the coefficient of restitution of the ball material.

1) 0.2 2) 9 3) 0.9 4) 90

26. A ball is dropped on to a horizontal floor. It reaches a height of 144 cm on the first bounce and 81 cm on the second bounce. The coefficient of restitution is

1) 0 2) 0.75 3) 81/144 4) 1

27. In the above problem, the height it attains on the third bounce is

1) 45.6 cm 2) 81 cm 3) 144 cm 4) 0 cm

28. A ball is dropped from a height h above a tile floor and rebounds to a height of 0.64h. The coefficient of restitution between the ball and the floor is

1) 0.64 2) 0.8 3) 1/0.64 4) 1/0.8

29. A ball is dropped from height 'H' on to a horizontal surface. If the coefficient of restitution is 'e' then the total time after which it comes to rest is

1) $\sqrt{\frac{2H}{g}}\left(\frac{1-e}{1+e}\right)$ 2) $\sqrt{\frac{2H}{g}}\left(\frac{1+e}{1-e}\right)$

3) $\sqrt{\frac{2H}{g}}\left(\frac{1+e^2}{1-e^2}\right)$ 4) $\sqrt{\frac{2H}{g}}\left(\frac{1-e^2}{1+e^2}\right)$

30. A ball falls from a height of 10m on to a horizontal plane. If the coefficient of restitution is 0.4 the velocity with which it rebounds from the plane after second collision is

1) 2.24 ms^{-1} 2) 5.6 ms^{-1}

3) 2.8 ms^{-1} 4) 0.9 ms^{-1}

31. A ball is dropped from a height of 3 m. If coefficient of restitution between the surface and ball is 0.5 the total distance covered by the ball before it comes to rest is

1) 3m 2) 4 m 3) 5 m 4) 6 m

32. A glass sphere of mass 5 gm, falls from a height of 3 meters on to a horizontal surface. If the coefficient of restitution is 0.5, after the impact the sphere will rise to a height of

1) 0.075 m 2) 0.75 m 3) 7.5 m 4) 75 m

33. A body of mass 20 gms is moving with a certain velocity. It collides with another body of mass 80 gm at rest. The collision is perfectly inelastic. Find the ratio of the kinetic energies before and after collision of the system is

1) 2 : 1 2) 4 : 1 3) 5 : 1 4) 3 : 2

34. A truck of mass 15 tons moving with 1 ms^{-1} collides with a stationary truck of mass 10 tons and automatically connected to move together. The common velocity is

1) 1 ms^{-1} 2) 0 ms^{-1} 3) 0.4 ms^{-1} 4) 0.6 ms^{-1}

35. In the above problem the total K.E before collision is

1) 4500 J 2) 7500 J 3) 3000 J 4) 0 J

36. In the above problem the total K.E after collision

1) 4500 J 2) 7500 J 3) 3000 J 4) 0 J

37. In the above problem loss of K.E during collision is

1) 4500 J 2) 7500 J 3) 3000 J 4) 0 J

38. A block of mass 1 kg moving with a speed of $4\ ms^{-1}$, collides with another block of mass 2 kg which is at rest. The lighter block comes to rest after collision. The loss in the K.E of the system.
1) 8 J 2) 4×10^{-7} J 3) 4 J 5) 0 J

39. A car of mass 10 metric ton rolls at $2\ ms^{-1}$ along a level track and collides with a loaded car of mass 20 metric ton, standing at rest. If the cars couple together, the common speed after collision is
1) $1\ ms^{-1}$ 2) $0.67\ ms^{-1}$ 3) $0.5\ ms^{-1}$ 4) $0.3\ ms^{-1}$

40. In the above problem loss in K.E during collision is
1) 1 KJ 2) 1.33 J
3) 1.33 KJ 4) 1.33×10^{4} J

41. In the above problem the speed of the heavy car in the opposite direction so that, after collision they come to rest
1) $1\ ms^{-1}$ 2) $0.67\ ms^{-1}$
3) $0.5\ ms^{-1}$ 4) $0.3\ ms^{-1}$

42. A moving body makes a perfectly inelastic collision with a second body of equal mass at rest K.E lost during collision is ___________ of initial K.E
1) 1/4 2) 1/2 3) 1 4) 0

43. A 6 kg mass travelling at $2.5\ ms^{-1}$ collides head on with a stationary 4 kg mass. After the collision the 6 kg mass travels in its original direction with a speed of $1\ ms^{-1}$. The final velocity of 4 kg mass is
1) 1 m/s 2) $2.25ms^{-1}$ 3) $2\ ms^{-1}$ 4) $0\ ms^{-1}$

44. In the above problem, coefficient of restitution is
1) 1/4 2) 1/2 3) 3/4 4) 5/8

45. A marble going at a speed of $2\ ms^{-1}$ hits another marble of equal mass at rest. If the collision is perfectly elastic. Find the velocity of the first after collision.
1) 4 2) 0 3) 2 4) 3

46. A body of mass 10 kg moving with a velocity of $5\ ms^{-1}$ hits a body of 1 gm at rest. Find the velocity of the second body after collision assuming it to be perfectly elastic
1) $10\ ms^{-1}$ 2) $5\ ms^{-1}$
3) $15\ ms^{-1}$ 4) $0.10\ ms^{-1}$

47. A ping - pong ball strikes a wall with a velocity of $10\ ms^{-1}$. If the collision is perfectly elastic Find the velocity of ball after impact
1) $-20\ ms^{-1}$ 2) $-5\ ms^{-1}$
3) $1.0\ ms^{-1}$ 4) $-10\ ms^{-1}$

48. A ball of 4 kg mass and a speed of $3\ ms^{-1}$ has a head on elastic collision with a 6 kg mass initially at rest. The speeds of both the bodies after collision are respectively
1) $0.6\ ms^{-1}$ $2.4\ ms^{-1}$
2) $-0.6\ ms^{-1}$ $-2.4\ ms^{-1}$
3) $-0.6\ ms^{-1}$ $2.4\ ms^{-1}$
4) $-0.6\ ms^{-1}$ $-2.4\ ms^{-1}$

49. A proton collides with a helium atom at rest. The helium atom has mass 4 time of proton and moves forward at speed of $5\times10^{5}\ ms^{-1}$. If the collision is elastic, the initial speed of proton before collision is
1) $12.5\times10^{6}\ ms^{-1}$ 2) $1.25\times10^{6}\ ms^{-1}$
3) $2.5\times10^{6}\ ms^{-1}$ 4) $0\ ms^{-1}$

50. In the above problem the velocity of proton after collision is
1) $0.75\times10^{5}\ ms^{-1}$ 2) $7.5\times10^{5}\ ms^{-1}$
3) $-7.5\times10^{5}\ ms^{-1}$ 4) $0\ ms^{-1}$

51. In the above problem the fraction of K.E transferred from proton to helium is
1) 0.64 2) 0.36 3) 0.48 4) 1

52. A body of mass 2kg makes an elastic collision with another body at rest and continues to move in the original direction at a speed equal to 1/3 of its original speed. The mass of the second body is
1) 2 kg 2) 3 kg 3) 1 kg 4) 4 kg

53. A body of mass 10 gm. moving with a velocity of $20\ cm^{-1}$ collides a stationary mass of 90 gm. The collusion is perfectly elastic. Find the percentage loss of kinetic energy of the first body
1) 36 2) 48 3) 64 4) 0

54. A 90 gm ball moving with 100 cm/s collides with 10 gm. ball at rest. If collision is perfectly elastic, their respective velocities are
1) 80 cm/s ; 180 cm/s 2) 180 cm/s ; 80 cm/s
3) 50 cm/s ; 120 cm/s 4) 120 cm/s ; 50 cm/s

55. Two identical balls collide head on. The initial velocity of one is $0.75\ cm^{-1}$. While that of the other is $-0.43\ ms^{-1}$. If the collision is perfectly elastic. Their respective final velocities are
1) $0.75\ ms^{-1}$;$-0.43\ ms^{-1}$
2) $-0.43\ ms^{-1}$; $0.75\ ms^{-1}$
3) $-0.75\ ms^{-1}$; $0.43\ ms^{-1}$
4) $0.43\ ms^{-1}$; $0.75\ ms^{-1}$

56. A particle of mass m_1 moving with certain velocity collides with elastically head on with a particle of mass m_2 at rest. After collision their velocities will be in the ratio of

1) $\frac{m_1 - m_2}{m_1 + m_2}$ 2) $\frac{m_1 - m_2}{2(m_1 + m_2)}$

3) $\frac{2m_1}{m_1 - m_2}$ 4) $\frac{m_1 - m_2}{2m_1}$

KEY

01) 4	02) 3	03) 2	04) 1	05) 3
06) 2	07) 2	08) 3	09) 4	10) 2
11) 2	12) 1	13) 1	14) 2	15) 2
16) 2	17) 1	18) 1	19) 4	20) 3
21) 4	22) 3	23) 1	24) 3	25) 3
26) 2	27) 1	28) 2	29) 2	30) 1
31) 3	32) 2	33) 3	34) 4	35) 2
36) 1	37) 3	38) 3	39) 2	40) 4
41) 1	42) 2	43) 2	44) 2	45) 2
46) 2	47) 4	48) 3	49) 2	50) 3
51) 1	52) 3	53) 3	54) 1	55) 2
56) 4				

LEVEL II

1. A body of mass 5kg moving with a speed of $3ms^{-1}$ collides head on with a body of mass 3kg moving in the opposite direction at a speed of $2ms^{-1}$. The first body stops after the collision. Find the final velocity of the second body.
1) $3ms^{-1}$ 2) $5ms^{-1}$ 3) $-9ms^{-1}$ 4) $30ms^{-1}$

2. A boy weighing 50kg throws a stone of mass 10kg horizontally with a velocity of $8ms^{-1}$. With what velocity does he move?
1) $-1.6ms^{-1}$ 2) $-16ms^{-1}$
3) $-160ms^{-1}$ 4) $-1.9ms^{-1}$

3. A shell is fired from gun with a velocity of $300ms^{-1}$ making an angle 60^0 with the horizontal. It explodes into two fragments when it reaches the highest position. The ratio of the masses of the two pieces is 1 : 3. If the smaller piece stops immediately after the collision. Find velocity of the other.
1) $0ms^{-1}$ 2) $200ms^{-1}$
3) $250ms^{-1}$ 4) $300ms^{-1}$

4. Ashell is fired from gun with a velocity of 300 ms^{-1} making an angle 60^0 with the horizontal it bursts into two pieces whose masses are in the ratio 1 : 3. The smaller piece retraces its path after the explosion and enters the gun. Find the velocity of the larger piece, immediately after the explosion.
1) $0ms^{-1}$ 2) $200ms^{-1}$ 3) $250ms^{-1}$ 4) $300ms^{-1}$

5. A bomb of mass 4m at rest explodes into three pieces of masses in the ratio 1:1:2 Two identical pieces fly in mutually perpendicular directions each with a velocity v. The magnitude of velocity of third piece is
1) v 2) v/2 3) $\frac{v}{\sqrt{2}}$ 4) $\frac{v}{\sqrt{3}}$

6. In the above problem third piece is making---- angle with the motion of each piece.
1) 45^0 2) 90^0 3) 135^0 4) 180^0

7. In the above problem the total K.E. produced in the explosion is
1) 1/2 mv^2 2) 3/2mv^2 3) mv^2 4) 2/3mv^2

8. A projectile of mass 50 kg is shot vertically upwards with an initial velocity of $100ms^{-1}$. After 5 seconds it explodes into two fragments, one of which having mass 20 kg, travels vertically up with a velocity of $150ms^{-1}$. The velocity of the other fragment at that instant is
1) $100ms^{-1}$ 2) $150ms^{-1}$ 3) $-150ms^{-1}$ 4) $-15ms^{-1}$

9. From the top of a tower of height 100m a 10 gm block is dropped freely and a 6gm bullet is fired vertically upwards from the foot of the tower with velocity $100ms^{-1}$ simultaneously. They collide and stick together. The common velocity after collision is ($g=10ms^{-2}$)
1) $27.5ms^{-1}$ 2) $150ms^{-1}$ 3) $40ms^{-1}$ 4) $100ms^{-1}$

10. A block of mass 19M is suspended by a string of length 1m. A bullet of mass M hits it and gets embedded in it. The block just complete the circle in the vertical plane. Find the velocity of the bullet.
1) $140ms^{-1}$ 2) $20\sqrt{19.6}\ ms^{-1}$
3) $20\sqrt{9.8}\ ms^{-1}$ 4) $20ms^{-1}$

11. A bullet of mass 50gm moving with velocity of 10m/s strikes a ballistic pendulum of mass 950gm at rest and gets embeded in it. The loss in K.E. of system is
1) 100% 2) 95% 3) 5% 4) 50%

12. A particle is projected with a velocity of $20ms^{-1}$ at an angle 60^0 with the horizontal. At the maximum height it splits into two parts of equal masses. If one part just drops down, the velocity of the other part is

1) $10ms^{-1}$ 2) $20ms^{-1}$

3) $10\sqrt{3}\ ms^{-1}$ 4) $20\sqrt{3}\ ms^{-1}$

13. A simple pendulum of length 0.2m has bob of mass 5gm, it is pulled aside through an angle 60^0 from the vertical. A spherical body of mass 2.5 gm is placed at the lowest position of the bob. When the bob is released it strikes the spherical body and comes to rest. What is the velocity of the spherical body? ($g=9.8ms^{-2}$) (in m/s)

1) 1.4 2) 2.8 3) 3.5 4) 4.9

14. A tennis ball bounces down a flight of stairs, striking each step in turn and rebounding to the half of height of the step. The coefficient of restitution is

1) 1/2 2) $\frac{1}{\sqrt{2}}$ 3) $\left(\frac{1}{\sqrt{2}}\right)^{1/2}$ 4) $\left(\frac{1}{\sqrt{2}}\right)^{1/4}$

15. A ball hits the ground and loses 20% of its momentum. Coefficient of restitution is

1) 0.2 2) 0.4 3) 0.6 4) 0.8

16. A plastic ball falling from a height 4.9m rebounds number of times. If total time for second collision is2.4 sec then co-efficient of restitution is

1) 0.3 2) 0.4 3) 0.7 4) 0.6

17. Asteel ball of radius 2cm is initially at rest. It is struck head on by another steel ball of radius 4cm travelling with a velocity of 81 cm/s. If the collision is elastic their respective final velocities are

1) 63 cm/s, 144 cm/s 2) 144 cm/s, 63 cm/s

2) 19 cm/s, 100 cm/s 4) 100 cm/s, 19 cm/s

18 In the above problem, the common velocity if it is perfectly inelastic collision

1) 144cm/s 2) 61 cm/s 3) 81 cm/s 4) 72 cm/s

19. A hail stone falling freely from a height h strikes the roof of a parked car with aspeed of $10ms^{-1}$ and rebounds to a height of 0.2m the fraction of K.E. lost in the impact is ($g=10ms^{-1}$)

1) 0.04 2) 0.96 3) 0.5 4) 0

20. If two perfectly elastic balls of masses 2gm and 3gm moving in opposite directions with speeds of 8 m/s and 6 m/s respectively collide elastically, their final velocities are respectively.

1) $5.2\ ms^{-1}$, $8.8\ ms^{-1}$ 2) $8.8\ ms^{-1}$, $5.2\ ms^{-1}$

3) $-8.8\ ms^{-1}$, $-5.2\ ms^{-1}$ 4) $-8.8\ ms^{-1}$, $5.2\ ms^{-1}$

21. A ball of mass 0.1kg makes an elastic collision with a ball of unknown mass initially at rest and rebounds with 1/3 of its original speed. The mass of the other ball is

1) 0.1 kg 2) 0.2 kg 3) 0.3 kg 4) 0.4 kg

22. A body of mass 10gm moving with a velocity of 20 cms^{-1} collides with a stationary mass of 90gm. The collision is perfectly inelastic. Find the percentage loss of kinetic energy of the system.

1) 0 2) 50 3) 90 4) 100

23. A 90gm ball moving at 100 cm/s collide head on with a stationary 10gm ball. The coefficient of restitution is 0.5 . Their respective velocities after collision are

1) 135 cm/s, 85 cm/s 2) 85 cm/s, 135 cm/s

3) -85 cm/s, 135 cm/s 4) 85 cm/s,-135 cm/s

24. In the above problem collision is

1) elastic 2) inelastic

3) perfect inelastic 4) none

25. In the above problem loss of K.E. is

1) 45,000 erg 2) 22,500 erg

3) 33,750 erg 4) 0 erg

26. A sphere of mass m moving with constant velocity hits another sphere of same mass at rest. If e is the coefficient of restitution. The ratio of their velocities after collision is

1) 1 2) $\frac{1+e}{2}$ 3) $\frac{1+2e}{1-2e}$ 4) $\frac{1-e}{1+e}$

27. When two perfectly elastic spheres collide the impulse of the blow on the sphere is, if their initial velocities are u_1 and u_2 in same direction and masses m and m^1

1) $\frac{2mm^1}{(m+m^1)}(u_1-u_2)$ 2) $\frac{2mm^1}{(m-m^1)}(u_1-u_2)$

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

28. A body of mass 50gm collides elastically with another body of mass 30 gm at rest. Then the percentage loss of the velocity of the colliding body during collision is

1) 25% 2) 75% 3) 50% 4) 67%

KEY

1) 1	2) 1	3) 2	4) 3
5) 3	6) 3	7) 2	8) 4
9) 1	10) 1	11) 2	12) 2
13) 2	14) 2	15) 4	16) 3
17) 2	18) 4	19) 2	20) 4
21) 2	22) 3	23) 2	24) 2
25) 3	26) 4	27) 1	28) 2

HINTS FOR LEVEL II

1. $m_1u_1 - m_2u_2 = m_1v_1 + m_2v_2$

$15-6 = 0+3V_2 \Rightarrow V_2 = 3ms^{-1}$

2. $m_2V_2 = -m_1v_1$

$50\ v_2 = -10(8) \Rightarrow V_2 = -1.6ms^{-1}$

3. $4\cancel{m}\ (u\ \cos\theta) = 3\ \cancel{m}V$

$4\times 300\times\frac{1}{2} = 3 \Rightarrow V = 200\ ms^{-1}$

4. $4m(u\ \cos\theta) = m(-u\cos\theta) + 3mV$

$3V = 5u\ \cos\theta$

5. $\sqrt{2}mV = 2mV_1 \Rightarrow V_1 = \frac{V}{\sqrt{2}}$

7. $KE = \frac{1}{2}mV^2 + \frac{1}{2}mV^2 + \frac{1}{2}(2m)V_1^2 = \frac{3}{2}mV^2$

8. $V = u - g/-$

$= 100-(9.8)5$

$= 100-49$

$= 51$ *and*

$MV = m_1v_1 + m_2v_2$

$50\times 51 = 20\times 150 + 30V_2$

$2550 - 3000 = 30V_2$

$-45\cancel{0} = 3\cancel{0}\,V_2 \Rightarrow V_2 = -15ms^{-1}$

9. $time,\ t = \frac{h}{u} = \frac{100}{100} = 1\sec$

freely falling : $u_1 = gt = 10ms^{-1}$

upward projected, $u_2 = u - gt = 90ms^{-1}$

$-m_1u_1 + m_2u_2 = (m_1+m_2)V$

$-10(10) + 6(90) = 16\ V \Rightarrow 16V = 440$

$V = 27.5\ ms^{-1}$

10. $m_1u_1 + m_2u_2 = (m_1+m_2)\sqrt{5gr}$

11. $\%\ loss\ of\ KE = \frac{m_2}{m_1+m_2}(100)$

12. $2m\ (u\ \cos\theta) = mV \Rightarrow V = 2u\cos\theta$

13. *Velocity of bob at mean* $u = \sqrt{2gl(1-\cos\theta)}$

$m_1u + m_2(0) = m_1(0) + m_2V$

$5\left[\sqrt{2gl(1-\cos\theta}\right] = 2.5V \Rightarrow V = 2.8ms^{-1}$

14. $e = \sqrt{\frac{h_2}{h_1}} = \sqrt{\frac{h/2}{h}} = \frac{1}{\sqrt{2}}$

15. $80\%\ mu = mv\ \frac{80}{100} = \frac{v}{u} \Rightarrow e = 0.8$

16. $T = t + 2t_1$

$= \sqrt{\frac{2h}{g}}\left[1+2e\right]$

$2.4 = 1+2e \Rightarrow e = 0.7$

17. *As mass,* $m = d(volume) = d\frac{4}{3}\pi r^3$

$m\ \alpha\ r^3$ *so,* $V_1 = \left(\frac{r_1^3 - r_2^3}{r_1^3 + r_2^3}\right)u_1$ *and* $V_2 = \frac{2r_1^3u_1}{r_1^3 + r_2^3}$

18. $r_1^3u_1 + r_2^3u_2 = (r_1^3 + r_2^3)\ V$

19. $\frac{KE-PE}{KE} = \frac{\frac{1}{2}mv^2 - mgh}{\frac{1}{2}mv^2} = \frac{v^2 - 2gh}{v^2}$

20. $V_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \frac{2m_2u_2}{m_1+m_2}$ *and*

$V_2 = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2 + \frac{2m_1u_1}{m_1+m_2}$

21. $-\frac{u}{3} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u \Rightarrow m_2 = 2m_1$

22. % loss of KE $= \frac{m_2}{m_1 + m_2}(100)$

$= \frac{90}{100}(100) = 90$

23. $mu_1 + mu_2 = mv_1 + mv_2$

$90\times 100 = 90v_1 + 10v_2$

$9v_1 + v_2 = 900 \quad \rightarrow 1$

and $0.5 = \frac{v_2 - v_1}{100-0} \Rightarrow v_2 - v_1 = 50 \quad \rightarrow 2$

v_1 *and* v_2 *values are calculated by solving equations 1&2*

24. $As \quad e = 0.5 \quad so \ it \ is \ an \ inelastic.$

25. loss of KE= $KE_1 - KE_2$

26. $mu = m \ v_1 + m \ v_2 \Rightarrow v_2 + v_1 = u \qquad \to 1$

$$e = \frac{v_2 - v_1}{u - 0} \Rightarrow v_2 - v_1 = eu \qquad \to 2$$

$$by \ solving \ 1 \ and \ 2, \ v_1 = \frac{(1-e)}{2} u$$

$$v_2 = \frac{(1+e)}{2} u$$

27. $\text{Im}pulse, \ I = m(u_1 - v_1)$

$$= m\left\{u_1 - \left[\left(\frac{m - m^1}{m + m^1}\right)u_1 + \frac{2m^1 u_2}{m + m^1}\right]\right\}$$

$$= \frac{2mm^1}{m + m^1}(u_1 - u_2)$$

28. Colliding body is first body so, % loss of velocity of

$$1^{st} \text{ body} = \frac{u_1 - v_1}{u_1}(100)$$

$$= \left[u_1 - \left[\frac{m_1 - m_2}{m_1 + m_2}\right]u_1\right]100$$

$$= \left[1 - \left[\frac{m_1 - m_2}{m_1 + m_2}\right]\right]100$$

$$= \frac{2m_2}{m_1 + m_2}(100)$$

$$= \frac{2 \times 30}{80} \times 100 = 75\%$$

LEVEL III

1. A block of wood of mass 3M is suspended by a string of length 10/3m. A bullet of mass M hits is with acertain velocity and gets embeded it. The block and the bullet swing to one side till the string makes 120^0 with the initial position. Find the velocity of the bullet ($g=10ms^{-2}$)

1) $\frac{40}{\sqrt{3}} ms^{-1}$ 2) $20ms^{-1}$ 3) $30ms^{-1}$ 4) $40ms^{-1}$

2. The pendulum ball of mass m_1 let swing from height h, strikes and sticks to the pendulum ball m_2 at rest. The combination then swings to a height h/3. m_2 in terms of m_1 is

1) 1.732 m_1 2) $0.732m_1$ 3) $0.732m_1$ 4) m_1

3. Three identical particles with velocities $v_0\bar{i}, -3v_0\bar{j}$ and $5v_0\bar{k}$ collide successively with each other in such a way that they form a single particle. The velocity of resultant particle in i, j, k form is

1) $v_0(\bar{i} - 3\bar{j} + 5\bar{k})$ 2) $\frac{v_0}{3}(\bar{i} - 3\bar{j} + 5\bar{k})$

3) $\bar{i} - 3\bar{j} + 5\bar{k}$ 4) $\frac{1}{3}(\bar{i} - 3\bar{j} + 5\bar{k})$

4. A particle of mass m has a velocity $-v_0 i$. while a second particle of same mass has a velocity $v_0 j$. After the particles collide, first particle is found to have a velocity $\frac{-1}{2}v_0\bar{i}$ then the velocity of other particle is

1) $\frac{-1}{2}v_0\vec{i} + v_0\vec{j}$ 2) $\frac{1}{2}v_0\vec{i} + v_0\vec{j}$

3) $v_0\vec{i} + v_0\vec{j}$ 4) $-v_0\vec{i} + v_0\vec{j}$

5. Fivespheres of masses 1, 2, 3, 4, 5 kg are moving along a straight line in the same direction with velocities 5, 4, 3, 2, 1 m/s respectively. The first sphere collides with the second and both stick together. The compound mass collides with the third sphere and so on. The velocity of the compound mass when all stick together is

1) 3/7 m/s 2) 7/3 m/s 3) 1 m/s 4) none

6. A 50 gm ball collides with another ball of mass 150gm, moving in its direction of motion, After collision the tow balls move at a an angle 30^0 with their initial direction. Ratio of their velocities after collision is

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

7. Particles A and B of masses 20 gm and 40 gm are simultaneously projected at angles 45^0 and 135^0 from two points P and Q with a velocity 49 m/s each. They collide in their path, after collision if A retraces its path, velocity of B is

1) 49 m/s 2) 24. 5 m/s 3) zero 4) 98 m/s

8. At high altitude a body at rest explodes into two fragments of equal masses with one fragment receiving horizontal velocity of $10 ms^{-1}$. Time taken by the two radius vectors connecting point of explosion to fragment to make 90^0 is ($g=10 ms^{-2}$)

1) 10 s 2) 4 s 3) 2 s 4) 1 s

9. A wooden block of mass 10gm is dropped from the top of a cliff 100m high simultaneously a bullet of same mass is fired from thefoot of the clif vertically upwards with a velocity of $100ms^{-1}$. If thebullet after collision gets embedded in the block, the common velocity of the bullet and the block immediately after collision is ($g=10\ ms^{-2}$)
1) $40\ ms^{-1}$ downward 2) $40ms^{-1}$ upward
3) $80ms^{-1}$ upward 4) zero

10. A ball of mass 100 gm is projected vertically upward from theground with a velocity of $50ms^{-1}$. At the same time another identical ball is dropped from a height of 100m to fall freely along the same path as that followed by the first ball. After some time the two balls collide, stick together and finally fall to the ground. The time taken by the combined mass to fall to the ground is approximately ($g=10ms^{-2}$)
1) 4.5 s 2) 6.5 s 3) 9 s 4) 13 s

11. A test tube of mass 20 gm is filled with a gas and fitted with a stopper of 2gm. It is suspended horizontally by means of a thread of 1m length and heated. When the stopper kicks out, the tube just completes a circle in verticle plane. The velocity with which the stopper is kicked out is
1) $7ms^{-1}$ 2) $10ms^{-1}$ 3) $70ms^{-1}$ 4) $0.1ms^{-1}$

12. A block of mass m moving at a speed v collides with another block of mass 3 m at rest. If the light block comes to rest after collision, the coefficient of restitution is
1) $\frac{1}{3}$ 2) $\frac{1}{6}$ 3) $\frac{1}{2}$ 4) $\frac{1}{4}$

13. Two bodies move towards each other and collide in elastically. The velocity of the first body before impact is 2m/s and of the second is 4m/sec. The common velocity after collision is 1m/s in the direction of the first body. How many times did the K.E. of the first body exceed that of the second body before collision.
1) 4.25 2) 3.25 3) 2.25 4) 1.25

14. A moving particle of mass 'm' makes head-on elastic collision with a particle of mass '2m' which is initially at rest. The fraction of K.E. lost by colliding particle is
1) 1/3 2) 1/9 3) 8/9 4) 2/3

15. A 1 kg ball moving at $12ms^{-1}$ collides head-on with a 2kg, ball moving in the opposite direction at $24ms^{-1}$. If e=2/3 the velocities after impact are respectively.
1) $-28ms^{-1}$, $-4ms^{-1}$ 2) $28ms^{-1}$, $-4ms^{-1}$
3) $-28ms^{-1}$, $4ms^{-1}$ 4) $28ms^{-1}$, $4ms^{-1}$

16. A moving sphere P collides another sphere Q at rest. If the collision takes place along the line joining their centres of mass such that their total kinetic energy is conserved and the fraction of K.E. transferred by the colliding particle is $\frac{8}{9}$, the mass of P and the mass of Q bear a ratio
1) $\sqrt{8}:3$ 2) 9 : 8 3) 2 : 3 4) 1 : 2

17. A 3kg ball moving to the right at 4 m/sec collides with a 4kg ball moving to the right at 2 m/sec. Find the final velocities of the balls in m/sec if the coefficient of restitution is 0.6
1) 2.2, 3.4 2) 1, 2 3) 4, 5 4) 6,8

18. A ball strikes a horizontal floor at an angle 45^0. The value of 'e' between the ball and the floor is 1/2. Find the fraction of K.E. loss during the collision
1) $\frac{5}{8}$ 2) $\frac{3}{8}$ 3) $\frac{7}{8}$ 4) $\frac{3}{4}$

19. Asmooth steel ball strikes a fixed smooth steel plate at an angle 'θ' with the vertical. If 'e' is the coefficient of restitution, the angle at which the rebounce will take place with the vertical is
1) $\alpha = Tan^{-1}\left(\frac{Tan\theta}{e}\right)$ 2) $\alpha = Tan^{-1}\left(\frac{Cot\theta}{e}\right)$
3) $\alpha = Tan^{-1}\left(\frac{\sin\theta}{e}\right)$ 4) $\alpha = Tan^{-1}\left(\frac{e}{Tan\theta}\right)$

20. A particle strikes a horizontal friction less floor with a speed 'u' at an angle 'θ' with the verticle and rebounds with a speed 'v' at an angle 'α' with theverticle. Find the value of 'v' if 'e' is the coefficient of restitution.
1) $v = u\sqrt{e^2\sin^2\theta + \cos^2\theta}$
2) $v = u\sqrt{e^2\cos^2\theta + \sin^2\theta}$
3) $v = u\sqrt{e^2\cos^2\theta + \tan^2\theta}$
4) $v = u\sqrt{\cot^2\theta + e^2\cos^2\theta}$

21. Hail stones are observed to strike the surface of frozenlake at 30^0 to the verticle and rebound at 60^0 to the vertical. The coefficient of restitution is

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

22. A bullet of mass 0.01 kg moves at a speed of 500 m/sec, strikes a block of 2 kg suspended by a rope of length 5m. The block raises to a height of 0.1m, with what velocity the bullet emerges from the block.

1) 220 m/sec 2) 340 m/sec
3) 120 m/sec 4) 250 m/sec

23. Two bodies of masses m_1 and m_2 moving on the same direction with velocities u_1 and u_2 collide. The velocities after collision are v_1 and v_2. If each sphere loses the same amount of kinetic energy, then

1) $u_1 + u_2 + v_1 - v_2 = 0$

2) $u_1 - u_2 + v_1 + v_2 = 0$

3) $u_1 + u_2 + v_1 + v_2 = 0$

4) $u_1 + u_2 - v_1 - v_2 = 0$

24. Two spheres A and B of equal mass lie on the smooth horizantal circular groove at opposit ends of diameter and at the end of time 't' impinges on B. If 'e' is the coefficient of restitution, the second impinge will occur after a time

1) $\frac{2t}{e}$ 2) $\frac{t}{e}$ 3) $\frac{\pi t}{e}$ 4) $\frac{2\pi t}{e}$

25. A ball moving with a speed of 2.2 m/sec strikes an identical stationary ball. After collision the first ball moves at 1.1 m/sec at 60^0 with the original line of motion. The magnitude and direction of the after ball is

1) 5 m/sec, 90^0 2) 2 m/sec, 60^0

3) $\sqrt{3}(1.1)$ m/sec, 30^0 4) 10 m/sec, 60^0

26. A body of mass 0.2 kg dropped from a height '6m'. If e = $\frac{1}{\sqrt{6}}$ then K.E. last during its first bounce from the ground is

1) 1.96 J 2) 9.8 J 3) 19.6 J 4) zero

27. A ball is thrown at an angle of incidence 'θ' on a horizontal plane such that the incident direction and the reflected direction are at right angles to each other if the coefficient of restitution is 'e' then 'θ' is equal to

1) Tan^{-1} (e) 2) Tan^{-1} (2e)
3) Tan^{-1} ($\sqrt{2}$ e) 4) $Tan^{-1}\left(\sqrt{e}\right)$

KEY

1) 4	2) 2	3) 2	4) 1	5) 2
6) 1	7) 3	8) 3	9) 2	10) 1
11) 3	12) 1	13) 4	14) 3	15) 1
16) 4	17) 1	18) 2	19) 1	20) 2
21) 3	22) 1	23) 3	24) 1	25) 3
26) 2	27) 4			

HINTS FOR LEVEL -III

1. $M \times u = (3M + M)\sqrt{2gl(1-\cos\theta)}$

2. $m_1 \times \sqrt{2gh} = (m_1 + m_2)\sqrt{2gh/3}$

3. $mV_0\bar{i} - 3mV_0\bar{j} + 5mV_0\bar{K} = (m+m+m)V$

$\therefore V = \frac{mV_o(\bar{i} - 3\bar{j} + 5\bar{K})}{3m}$

4. $\begin{pmatrix} Total\ momentum \\ before\ collision \end{pmatrix} = \begin{pmatrix} Total\ momentum \\ after\ collision \end{pmatrix}$

5. $\begin{pmatrix} Total\ momentum \\ before\ collision \end{pmatrix} = \begin{pmatrix} Total\ momentum \\ after\ collision \end{pmatrix}$

6. Applying law of conservation of momentum in the vertical direction

$0 = m_1 v_1 Sin30^0 - m_2 v_2 \sin 30^0$

$\Rightarrow \frac{V_1}{V_2} = \frac{m_2}{m_1} = \frac{150}{50} = \frac{3}{1}$

9. Time after which collision takes place

$t = \frac{h}{u} = \frac{100}{100} = 1\,sec$

Intial velocity of the wooden block (u_1)

$= gt = 10 \times 1 = 10 m/s$

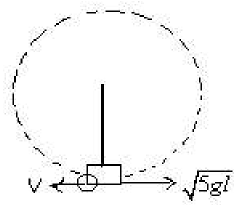
Intial velocity of the bullet (u_2)

= u-gt

$= 100 - 10 \times 1 = 90 m/s$

$= m_1 u_1 - m_2 u_2 = (m_1 + m_2)V$

$\therefore V = 40 m/s$

11. 

$$(M+m)0 = m\times v - M\sqrt{5gl}$$

$$\therefore v = \frac{M\sqrt{5gl}}{m}$$

$$(M = 20\times10^{-3}Kg,\ \ m = 2\times10^{-3}Kg$$

15. $m_1u_1+m_2u_2=m_1v_1+m_2v_2$

$$e=\frac{v_2-v_1}{u_1-u_2}$$

on solving v_1 and v_2 can be calculated.

19. $e=\dfrac{V\cos\theta}{u\cos\theta}$

$$u\sin\theta = V\sin\alpha$$

20. $V=\sqrt{(V\sin\alpha)^2+(V\cos\alpha)^2}$

$$V=\sqrt{(u\sin\theta)^2+(eu\cos\theta)^2}$$

$$u\sqrt{e^2\cos^2\theta+\sin^2\theta}$$

21. $Tan\alpha=\dfrac{Tan\theta}{e}$

23. $\dfrac{1}{2}m_1u_1^{\ 2}-\dfrac{1}{2}m_1V_1^{\ 2}=\dfrac{1}{2}m_2u_2^{\ 2}-\dfrac{1}{2}m_2V_2^{\ 2}$

$$m_1u_1+m_2u_2=m_1V_1+m_2V_2$$

$$\Rightarrow u_1+V_1=-(V_2+u_2)$$

$$u_1+V_1+V_2+u_2=0$$

24. $e=\dfrac{V_2-V_1}{u}$

$$V_{net}=V_2-V_1=eu$$

$$at\ second\ impact\ t_1=\frac{2\pi r}{V_{net}}=\frac{2\pi r}{eu}$$

25. In obligue collision along $\times$ - direction from law of consevation of linear momentum

$$u_1=V_1\cos60+V_2\cos\alpha$$

$$along\ Y-direction$$

$$0=V_1\sin60-V_2\sin\alpha$$

26. $e=\sqrt{\dfrac{h_2}{h_1}}\ find\ \ mg\,(h_1-h_2)$

27. $Tan\alpha = e\,Tan\theta$

$$given\ \ \theta+\alpha=90^0$$

New Type of Questions

01. Two spheres of different masses moving in the same direction undergo perfect head on elastic collision. Then,
a) Their velocities are interchanged if they are of same mass
b) If the heavier sphere were at rest before collision. it continues to be at rest after collision and the lighter sphere retraces its path will the same velocity
c) If the lighter sphere were at rest before collision, it moves with the velocity of the heavier sphere and the heavier sphere continues to move with its original velocity after collision.
d) If the lighter sphere were at rest before collision, it moves with double the velocity of the heavier sphere and the heavier sphere continues to move with its original velocity, after collision.
1. a,b,c are correct 2. a,b are correct
3. b,c are correct 4. a,b,d are correct

02. A small metal sphere falls from a height h onto a plane surface strikes it with velocity v and rebounds. If e is the coefficient of restitution
a) the height to which it rebounds after n collisions is e^n h
b) the height to which it rebound after 3 collision is e^6 h
c) the velocity with which it rebounds after 4 th collision is e^4 v
d) the velocity with which it strikes the surface for the second collision is ev
1) only a and b are correct
2) only b and c are correct
3) b , c and d are correct 4) a, b and c are correct

03. In the case of explosion of a bomb
a) KE changes
b) the mechanical energy conserves
c) linear momentum changes
d) chemical energy changes
1) a & b are true 2) c & d are true
3) a & c are true 4) a & d are true

04. When a bullet is fired from a gun
a) KE of bullet is more than that of gun
b) acceleration of bullet is more than that of gun
c) momentum of bullet is more that of gun

d) velocity of bullet is more than that of gun
1) only a & b are true 2) only b & c are true
3) a, b & d are true 4) a, b, c & d are true

05. About a collision which are not correct
a) physical contact is must
b) colliding particles cannot change
c) the effect of external force is not considered
d) linear momentum does not conserve
1) only a & d 2) only a & b
3) a, b, c 4) a, b, d

06. During collision
a) The colliding bodies experience large force during small interval of time
b) The colliding bodies need not touch each other
c) The kinetic energy conserves d) The linear momentum conserves
1) only a & b happen
2) only b and c happen 3) a , b & c happen
4) a, b & d happen

07. During collision
a) There is a change in momenta of individual bodies
b) The change in total momentum of the system of colliding particle is zero
c) The change in total energy is zero
d) The law of conservation of momentum is not valid
1) only a & b are true
2) only b & c are true 3) a, b & c are true
4) b, c & d are true

08. During one dimensional collision or head on collision
a) The bodies move along the line joining their centre of mass before and after collision
b) The bodies should move in opposite direction
c) The bodies change their direction after collision
d) The bodies move along the line joining their centre of mass before and after collision either in same direction or in opposite direction
1) only a is correct 2) only a & b are correct
3) a, b & c are correct
4) only a and d are correct

09. During "inelastic collision "
a) There is a loss of kinetic energy
b) some of the kinetic energy is used to deform the body
c) some of the kinetic energy is liberated as heat
d) There is a loss of mass energy
1) only a is true 2) only b and c are true
3) a,b & c are true 4) b, c & d are true

10. During "elastic collision "
a) there is no loss of kinetic energy 2) the bodies are perfectly elastic
c) temporarily some of the kinetic energy is used to deform the bodies
d) after collision the bodies regain the original shape keeping the total energy constant
1) only "a" is true 2) a, b, d are true
3) b, c, d are true 4) a, b, c are true

11. Identify the correct statements from the following
a) The collisions between the nuclei and fundamental particles are considered as elastic collisions
b) Emission of an alpha particle by U^{235} is an "elastic collision"
c) The collision between two ivory balls is considered as " elastic collision"
d) A running man jumps into a train. It is an "elastic collision"
1) only a & b are true 2) only b & c are true
3) a, b & c are true 4) b, c & d are true

12. Identify the correct statements from the following.
a) A bullet is fired into a wooden block is an "inelastic collision"
b) A running man jumps into a train is an "inelastic collision"
c) If the coefficient of restitution is zero the collision is perfectly "inelastic"
d) There is no loss of kinetic energy during inelastic collision.
1) a & b are true 2) a, b & c are true
3) a, b & c are true 4) a, b, c & d are true

13. A body of mass m_1 moving with a velocity "u" collides elastically with another body of mass m_2 at rest.
a) The fraction of kinetic energy transferred to second body is $\frac{4m_1m_2}{(m_1+m_2)^2}$
b) The fraction of energy retained by the first body is $\left(\frac{m_1-m_2}{m_1+m_2}\right)^2$
c) If $m_1 = m_2$ the energy transferred is 100 %
d) The energy lost during the collision is found as heat
1) only a & b are true 2) only b & c are true
3) b, c & d are true 4) a, b, c & d are true

14. Statement A : A bomb of mass M at rest explodes into two parts of mass " m_1 " and " m_2 " . The total energy released is E. The energy carried by mass m_1 is $\frac{Em_2}{M}$
Statement B : The kinetic energy is not conserved during inelastic collision
1) A and B are true 2) A is true but B is false
3) A is false but B is true 4) A and B are false

15. Statement A : A neutron travelling with a velocity collides head on an atom of atomic mass number A at rest. The fraction of the total energy retained by neutron is $\left(\frac{A-1}{A+1}\right)^2$

Statement B : The kinetic energy conserves during an elastic collision

1) A and B are true 2) A is true but B is false 3) A is false but B is true 4) A and B are false

16. Match the following

List - I	List - II
a) Perfectly inelastic collision	e) KE of the system conserved
b) perfectly elastic collision	f) $0 \le e \le 1$
c) Law of conservation of linear momentum	g) Change of momentum
d) Impulse	h) Coefficient of restitution = zero
	i) Coefficient of restitution > 1

1) a - f ; b - e ; c - h ; d -g
2) a - h ; b - e ; c - f ; d -g
3) a - e ; b - h ; c - g ; d -i
4) a - g ; b - f ; c - e ; d -h

17. Match the following

List - I	List - II
a) Relative velocity before collision = Relative velocity after collision	e) Newton's II law of motion
b) Bodies stick together after collision motion	f) Newton's III law
c) Force	g) Coefficient of restitution = 1
d) Recoil of the gun	h) Coefficient of restitution = 0
	i) Binding energy

1) a - g ; b - h ; c - e ; d - f
2) a - h ; b - g ; c - f ; d -e
3) a - g ; b - e ; c - f ; d -h
4) a - e ; b - f ; c - g ; d -i

Assertion & Reason Type

While answering the **Assertion and Reason** questions you are required to choose any one of the type following responses.

1) Both Assertion (A) and Reason (R) are correct and R is the correct explanation
2) Both Assertion (A) and Reason (R) are correct but the reason does not give the correct explanation
3) A is true but R is false 4) A is false but R is true

18. Assertion (A) : When a bullet is fired from a gun, the momentum of the bullet is conserved.
Reason (R) : Law of conservation of momentum holds good only for any collision.

19. Assertion (A) : When a particle of certain mass collides with identical particle at rest, the two particles move after perfectly elastic collision in mutually perpendicular direction, if it were not head on collision
Reason (R) : Both momentum and KE are conserved in the case of perfectly elastic collision

20. Assertion (A) : The value of coefficient of restitution is independent of the masses and velocities of the colliding bodies but depends on their materials
Reason (R) : Coefficient of restitution is the ratio of the relative velocity of separation or the relative velocity of approach

21. Assertion (A) : When a body moving with certain velocity collides with another body of same mass at rest, the collision being perfectly elastic head on collision, 100% of its K.E is transferred to the latter
Reason (R) : Both momentum and K.E are conserved in the case of perfectly elastic collision

22. Assertion (A) : If the momentum of a body increases by 20 %, then its K.E also increases by 20 %
Reason (R) : The K.E of a body is directly proportional to the square of its momentum

23. Assertion (A) : When a ball hits a floor obliquely and gets reflected after inelastic collision, only the vertical component of its velocity gets changed.
Reason (R) : During collision the floor exerts a force on the ball only along the normal but not parallel to the surface

24. Assertion (A) : Newton's laws can be applied to bigger bodies
Reason (R) : During any kind of collision the centre of mass of the system is not accelerated

25. Assertion (A) : A freely falling body experiences a constant horizontal force due to wind velocity, its path is a straight line
Reason (R) : The motion is decided by the unbalanced force acting on it

26. Assertion (A) : A body of mass " m_1 " collides elastically with another body of mass " m_2 " at rest the ratio of the the final energy of the first body to the final energy of the second body is $\frac{(m_1 - m_2)^2}{4m_1m_2}$
Reason (R) : The collision is perfectly elastic and the coefficient of restitution si 1

27. **Assertion (A) :** A body of " m_1 " collides another body of mass " m_2 " at rest elastically. The fraction of energy transferred to the seond body is $\frac{m_1}{m_1+m_2}$

Reason (R) : In an "inelastic collision" only linear momentum is conserved

28. **Assertion (A)** : A body of mass 'm' collides another body of mass "nm' at rest. The energy transferred to the second body is $\frac{4n}{(n+1)^2}$

Reason (R) : The above collision is a perfectly inelastic collision

KEY

01) 4	02) 3	03) 4	04) 3	05) 4
06) 4	07) 3	08) 4	09) 3	10) 4
11) 3	12) 2	13) 3	14) 1	15) 1
16) 2	17) 1	18) 4	19) 1	20) 2
21) 1	22) 4	23) 1	24) 4	25) 1
26) 1	27) 4	28) 3		

QUESTIONS FROM PREVIOUS EAMCET EXAM

01. 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 **[2004 - M]**

1) $\frac{2J}{P}-1$ 2) $\frac{J}{P}+1$ 3) $\frac{J}{P}-1$ 4) $\frac{J}{2P}-1$

02. A 2 kg ball moving at $24\ ms^{-1}$ undergoes head on elastic collision with a 4 kg ball moving in the opposite direction at $48\ ms^{-1}$. If the coefficient of restitution is 2/3, their velocities, in ms^{-1} after impact are **[2004 - E]**

1) - 56, - 8 2) - 28, - 4 3) - 14, - 2 4) -7 , -1

03. Consider the following statements A and B. Identify the correct choice in the given answer :**[2003 - M]**

A : In a one - dimensional perfectly elastic collision between two moving bodies of equal masses, the bodies merely exchange their velocities after collision

B : If a lighter body at rest suffers perfectly elastic collision with a very heavy body moving with a certain velocity, after collision both travel with same velocity

1) A and B are correct
2) Both A and B are wrong
3) A is correct B is wrong
4) A is wrong B is correct

04. A stationary body of mass 3 kg explodes into three equal pieces. Two of the pieces fly off at right angles to each other, one with a velocity $2\bar{i}$ m/s and the other with velocity $3\bar{j}$ m/s. If the explosion takes place in 10^{-5} s, the average force acting on the third piece in newtons is **[2003 - M]**

1) $(2i+3j)\times10^{-5}$ 2) $-(2i+3j)\times10^{5}$
3) $(3j-2i)\times10^{5}$ 4) $(2i-3j)\times10^{-5}$

05. Two identical blocks A and B, each of mass m, resting on smooth floor are connected by a light spring of natural length L and the spring constant k, with the spring at its natural length. A third identical block C (mass m) moving with a speed v along the line joining A and B collides inelastically with A. The maximum compression in the spring is **[2003 -E]**

1) $v\sqrt{\frac{m}{2k}}$ 2) $m\sqrt{\frac{v}{2k}}$ 3) $\sqrt{\frac{mv}{k}}$ 4) $\frac{mv}{2k}$

06. Two particles having position vectors $\bar{r}_1=(3\bar{i}+5\bar{j})$ mand $\bar{r}_2=(-5\bar{i}+3\bar{j})$ m are moving with velocities $\bar{v}_1=(-4\bar{i}+3\bar{j})$ m/s and $\bar{v}_2=(-a\bar{i}+7\bar{j})$ m/s. If they collide after 2 seconds, the value of 'a' is **[2003 E]**

1) 2 2) 4 3) 6 4) 8

07. A body of mass 2 kg moving with a velocity of $6\ ms^{-1}$ strikes inelastically with another body of same mass at rest. The amount of heat evolved during collision is **[2002 - M]**

1) 36 J 2) 18 J 3) 9 J 4) 3 J

08. A body 'A' experience perfectly elastic collision with a stationary body 'B'. If after collision the bodies fly apart in the opposite directions with equal velocities, the mass ratio of 'A' and 'B' is **[2001 - M]**

1) $\frac{1}{2}$ 2) $\frac{1}{3}$ 3) $\frac{1}{4}$ 4) $\frac{1}{5}$

09. 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 it comes to rest is **[2001 - E]**

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) $\frac{h}{2}\left(\frac{1+e^2}{1-e^2}\right)$

10. A body of mass m_1 moving with a velocity $10\ ms^{-1}$ collides with another body at rest of mass m_2. After collision the velocities of the two bodies are $2\ ms^{-1}$ and $5\ ms^{-1}$ respectively along the direction of motion of m_1. The ratio of $\frac{m_1}{m_2}$ is **[2000 - E]**

1) $\frac{5}{12}$ 2) $\frac{5}{8}$ 3) $\frac{8}{5}$ 4) $\frac{12}{5}$

11. An object initially at rest explodes into three fragments A, B & C. The momentum of A is P and that of B is $\sqrt{3}$ P where P is a positive number. Which are moving perpendicular to each other. The momentum of C will be **[1999 - E]**

1) $\left(1+\sqrt{3}\right)$P in a direction making 120° with that of A
2) $\left(1+\sqrt{3}\right)$P in a direction making 150° with that of B
3) 2P in a direction making 150° with that of A
4) 2P in a direction making 150° with that of B

12. A car of mass 400 kg travelling at 72 kmph crashes a truck of mass 4000 kg and travelling at 9 kmph in the same direction. The car bounces back with a speed of 18 kmph. The speed of the truck after the impact is **[98 - E]**

1) 9 kmph 2) 18 kmph 3) 27 kmph 4) 36 kmph

13. A ball 'A' moving with a speed of $90\ ms^{-1}$ collides directly with another identical ball B moving with a speed 'v' in the opposite direction. A comes to rest after collision. If the coefficients of restitution is 0.8, the speed of B before collision is **[1998 - E]**

1) $10\ ms^{-1}$ 2) $81\ ms^{-1}$
3) $22.5\ ms^{-1}$ 4) $90\ ms^{-1}$

14. In the inelastic collision between two bodies, the physical quantity that is conserved **[1999 - M]**

1) KE 2) Momentum
3) PE 4) KE and Momentum

15. The quantities that are conserved in elastic collision are **[1998 - M]**

1) momentum, kinetic energy and temperature
2) momentum and kinetic energy
3) momentum only 4) kinetic energy only

16. A gun mounted on the top of a moving truck is aimed in the backward direction at an angle of 30° to the vertical. If the muzzle velocity of the gun is $4\ ms^{-1}$ the value of the speed of the truck that will make the bullet come out vertically is **[1998 - M]**

1) $1\ ms^{-1}$ 2) $\frac{\sqrt{3}}{2}\ ms^{-1}$ 3) $0.5\ ms^{-1}$ 4) $2\ ms^{-1}$

17. A mass of 12 kg initially at rest bursts into two fragments of 8 kg and 4 kg. If the velocity of 8 kg mass is $16\ ms^{-1}$, the KE of 4 kg mass is **[1997 - M]**

1) 2048 J 2) 128 J 3) 144 J 4) 64 J

18. A solid wooden block resting on a friction less surface is hit by a bullet. The bullet gets embedded. During this process **[1996 - E]**

1) only kinetic energy is conserved 2) only momentum is conserved
3) both kinetic energy and momentum are conserved
4) neither momentum nor energy are conserved

19. A body P moving with a velocity of $20\ ms^{-1}$ collides with another body Q of same mass at rest. After collision P comes to rest. What is the velocity of the body Q ? **[1996 - M]**

1) $10\ ms^{-1}$ 2) $20\ ms^{-1}$ 3) $30\ ms^{-1}$ 4) $5\ ms^{-1}$

20. A 5 kg body moving with $10\ ms^{-1}$ strikes a 20 kg body at rest. The collision is elastic and the 5 kg body comes to rest. and the 20 kg body is set into motion. The velocity of the second body **[1994-M]**

1) $2.5\ ms^{-1}$ in the opposite direction of motion
2) $2.5\ ms^{-1}$ in the original direction of motion
3) $5\ ms^{-1}$ in the direction of motion
4) $5\ ms^{-1}$ in the opposite direction of motion

21. A 2 Kg ball is moving at $10\ ms^{-1}$ and collides with another 2 Kg ball at rest. After collision they move together with **[1994 - E]**

1) $5\ ms^{-1}$ in the opposite direction
2) $5\ ms^{-1}$ in the same direction
3) $10\ ms^{-1}$ in the opposite direction
4) $10\ ms^{-1}$ in the same direction

22. A bullet of mass 'x' moves with a velocity y, hits a wooden block of mass z at rest and gets embedded in it. After collision, the wooden block and bullet in it moves, the velocity is **[1993 - E]**

1) $\frac{x}{x+z}y$ 2) $\frac{x+y}{x}y$ 3) $\frac{z}{x+y}y$ 4) $\frac{x+y}{z}y$

23. A ball is dropped from a height 'h' to the ground. If the coefficient of restitution is 'e' the height to which the ball goes up after it rebounded for the n^{th} time is **[1993 - M]**

1) he^2 2) he^{2n} 3) he^{4n} 4) h

24. A bomb of mass 9 kg explodes into two pieces of mass 3 kg and 6 kg. The velocity of 3 kg, mass is 16 m/s. The KE of the 6 kg piece is **[1993 - E]**
1) 96 J 2) 192 J 3) 384 J 4) 768 J

25. A ball of mass 'M' moving with a velocity $\vec{V}$ collides head on elastically with another body of the same mass 'M' moving with a velocity - $\vec{V}$ in the opposite direction. After the collision **[1992-E]**
1) The velocities are exchanged by the two balls
2) Both the balls come to rest
3) Both of them move at right angles to the original line of motion
4) One ball comes to rest and the other ball travels back with a velocity 2v

26. A railway truck of mass 2×10^4 kg travelling at 0.5 m/s collides with another of half of its mass moving in opposite direction with a velocity of 0.4 m/sec. If they collide with each other then their common velocity is
1) $0.2\ ms^{-1}$ 2) $0.4\ ms^{-1}$
3) $0.6\ ms^{-1}$ 4) $0.8\ ms^{-1}$

27. A particle of mass 4 m which is at rest explodes into three fragments. Two of the fragments each of mass "m" are found to move with a speed of 'v' each in mutually perpendicular directions. The total energy released in this process is **[1991-M]**
1) $\frac{1}{2}mv^2$ 2) $2.\frac{1}{2}mv^2$ 3) $3.\frac{1}{2}mv^2$ 4) $4.\frac{1}{2}mv^2$

28. A gun fires a bullet of mass 50 g with a velocity of mass $30\,ms^{-1}$. Because of this, the gun is pushed back with a velocity of $1\,ms^{-1}$. The mass of the gun is **[1989-E]**
1) 15 kg 2) 30 kg 3) 1.5 kg 4) 20 kg

29. A shell at rest explodes into two pieces of equal mass. The two **[1988 - E]**
1) be at rest
2) move with different velocities in different directions
3) same speed in opposite direction
4) same velocity in the same direction

30. A body of mass 'M' collides against a wall with a velocity 'v' and retraces its path with the same velocity, the change in momentum is ....**[1982]**
1) zero 2) 2 Mv 3) Mv 4) - Mv

31. A heavy steel ball of mass greater than 1 kg moving with a speed of 2m/ s collides head on with a stationary ping pong ball of mass less than 0.1 g. The collision is elastic. After the collision the ping pong ball moves approximately with a speed **[1982]**
1) 2 m / s 2) 4 m/ s
3) $2\times10^4\ m/s$ 4) $2\times10^3\ m/s$

32. A railway truck of mass 16,000 kg moving with a velocity of $5\ ms^{-1}$ strikes another truck of mass 4,000 kg at rest. If they move together after impact, their common velocity is
1) $2\ ms^{-1}$ 2) $4\ ms^{-1}$ 3) $6\ ms^{-1}$ 4) $8\ ms^{-1}$

33. Consider the following statements A and B and identify the correct answer:
A: Coefficient of restitution varies between 0 and 1.
B: In inelastic collision, the law of conservation of energy is satisfied. **[2005-M]**
1. A and B are true 2. A and B are false
3. A is true but B is false 4. A is false but B is true.

34. Consider the following statements A and B and identify the correct answer: **[2005-E]**
A: In an elastic collision, if a body suffers a head on collision with another of same mass at rest, the first body comes to rest while the other starts moving with the velocity of the first one.
B: Two bodies of equal masses suffering a head-on elastic collision merely exchanges their velocities.
1. A and B are true 2. A and B are false
3. A is true but B is false 4. A is false but B is true

KEY

01) 1	02) 1	03) 3	04) 2	05) 1
06) 4	07) 2	08) 2	09) 1	10) 2
11) 4	12) 3	13) 1	14) 2	15) 1
16) 4	17) 1	18) 2	19) 2	20) 1
21) 2	22) 1	23) 2	24) 2	25) 1
26) 1	27) 3	28) 3	29) 3	30) 2
31) 2	32) 2	33)2	34)1	

LEVEL-IV

I. When U-238 releases an α - particle, it turns into Thorium. If α particle produced from uranium has a velocity of 3×10^5 m/s is used in Rutherfords α -ray scattering experiment on nucless of mass number 'A' it deviates by angle of 180^0 with original path. The rebound α -particle collides daughter nucleus and looses $\frac{1}{5}^{th}$ of its velocity.

Answer the following Questions:

1. The above example reveals .
   1. Collision between α - particle and nucleus.
   2. No collision between α - particle and nucleus.
   3. A perfectly elastic collision between α - particle and nucleus.
   4. A semi elastic collision between α - particle and nucleus.
2. Velocity of Throium when α - ray is released.
   1. $5\times10^3\ ms^{-1}$ 2. $5\times10^4 ms^{-1}$
   3. $5\times10^5 ms^{-1}$ 4. $5\times10^2 ms^{-1}$
3. Velocity of Thorium after it collides the rebounding $\alpha -$ particle.
   1. $602\times10^3 ms^{-1}$ 2. $6.02\times10^3 ms^{-1}$
   3. $60.2\times10^3 ms^{-1}$ 4. $0.602\times10^3 ms^{-1}$
4. Heat energy will be released in
   a) Uranium disintigration
   b) $\alpha - ray$ reflection
   c) collision between rebounding α $-$ particle & thorium.
   1) a is correct 2) a & b correct
   3) a,b,c are correct 4) a&c are correct

KEY

1. 3 2.1 3.2 4.1

II. An object is projected at certain angle with certain velocity on the horizontal hard surface. Then it under-goes bounces. The coefficient of restitution is 'e'.
H,T&R are initial maximum hight, Time of flight and range respectively.
Then answer the following questions.

1. What is the total vertical distance travelled before stopping bouncing .
   1. $H\left[1+e^2\right]$ 2. $\frac{H}{1-e^2}$
   3. $\frac{H}{1+e^2}$ 4. $H\left[1-e^2\right]$
2. What is the total time elapsed before stopping bouncing.
   1. $T\left[1-e\right]$ 2. $T\left[1+e\right]$
   3. $\frac{T}{1-e}$ 4. $\frac{T}{1+e}$
3. What is the total horizontal distance travelled by it before stopping bouncing.
   1. $R\left[1-e\right]$ 2. $R\left[1+e\right]$
   3. $\frac{R}{1-e}$ 4. $\frac{R}{1+e}$

KEY

1.2 2.3 3.3

III. A rollerskater of mass 50Kg on a friction less surface is having two balls of masses 1kg and 2 kg in his two hands. If he throws the lighter mass he recoils with velocity of 2m/s and when heavier mass is thrown he recoils with 1 m/s . Answer the following questions.

1. The ratio of velocity of projection of the two balls approximately is
   1. 1:4 2. 4:1 3. 2:1 4. 1:2
2. Ratio of kinetic energies after he recoils in each case approximately is
   1. 1:16 2. 16:1 3. 4:1 4. 1:4
3. If he throws the two balls at a time with their respective velocities, the velocity of recoil of the skater is
   1. 3.1m/s 2. 6.2 m/s 3. 1.5m/s 4. 12 m/s

KEY

1.2 2.2 3.1

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