Collisions

1. In head on elastic collision of two bodies of equal mass

1) The faster body speeds up further and the slower body slows down.

2) The faster body slows down and the slower body speeds up.

3) Both of the above.

4) None of the above.

2. When two bodies of same mass undergo head on elastic collision,

1) Their velocities are interchanged 2) Their speeds are interchanged

3) Their momenta are interchanged 4) All the above are true

3. A heavier sphere moving eastward with a certain velocity 'v' collides with a lighter sphere at rest. If it is perfect elastic head on collision, then after collision

1) Heavier sphere moves west ward with same speed

2) Heavier sphere comes to rest

3) Lighter sphere moves eastward with velocity 2v approximately

4) Lighter sphere moves eastward with velocity approximately

4. Choose the correct statement

1) In an elastic collision, momentum is conserved but K.E. is not conserved.

2) In an elastic collision, K.E. is conserved but momentum is not conserved.

3) In an inelastic collision, both momentum and K.E. are conserved.

4) In an inelastic collision, momentum is conserved but K.E. is not conserved.

5. 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) None of the above.

6. When a ball hits a floor and rebounds after an inelastic collision

1) The momentum of the ball just before collision is equal to its momentum just after collision.

2) The total mechanical energy of the ball just before collision is equal to its total mechanical energy after collision.

3) The total momentum of the ball and earth is conserved.

4) All the above are true.

7. 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.

8. The collision in which the relative velocity of approach before collision is equal to relative velocity of separation after collision is

1) Completely inelastic collision 2) Elastic collision

3) Inelastic collision 4) Both elastic and inelastic collision

9. A body collides head on and elastically with another identical body at rest then after collision

1) First body comes to rest, and then second body begins to move with the initial velocity of first body.

2) Both the bodies move with same initial velocity of first body.

3) First body reversed in direction and move with same speed but second body continues to be at rest.

4) Both the bodies come to rest after collision.

10. In an inelastic collision between two bodies, the physical quantity that is conserved is

1) Kinetic energy 2) Momentum

3) Potential energy 4) Kinetic energy and Momentum

11. **A: Collision between two particles is not necessarily associated with physical contact between them.**

R: Only in physical contact, momentum transfer takes place.

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

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

3) (A) is true but (R) is false.

4) (A) is false but (R) is true.

12. **Match the following.**

List - I	**List - II**
a) Elastic collision	**e) e= 0**
b) Inelastic collision	**f) 0 < e < 1**
c) Explosion	**g) e = 1**
d) Plastic collision	**h) Final K.E. > Initial K.E.**

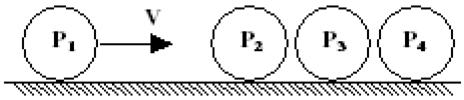
1) a-e, b-f, c-g,d-h 2) a-g,b-e,c-f,d-h 3) a-h,b-g,c-f,d-e 4) a-g, b-f, c-h, d-e

13. **Match the following.**

List - I	**List - II**
a) Impulse	**e) Area under f-t graph**
b) $\left[\frac{m_1 - m_2}{m_1 + m_2}\right]^2$	**f) Elastic collision between similar bodies**
c) $\frac{4m_1m_2}{(m_1+m_2)^2}$	**g) Fraction of K.E retained in an elastic collision**
d) Interchange of velocities collision	**h) Fraction of K.E transfer in an elastic**

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

14. **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 as shown. Velocities of the four balls after the collision are**



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

15. (A): When a ball is thrown up, the magnitude of its momentum decreases and then increases. This violates the momentum conservation principle.

(R): The principle of momentum conservation applies to the entire system, here earth-plus-ball system.

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

(2) Both A and R are correct and R is not the correct explanation of A.

(3) A is true but R is false.

(4) A is false but R is true.

16. (A): When stationary bomb explodes into two pieces their speeds are in the inverse ratio of their masses.

(R): Explosion does not violate Law of conservation of linear momentum.

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

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

(3) (A) is true but (R) is false.

(4) (A) is false but (R) is true.

17. A) When two spheres collide momentum transfer takes place along normal to tangent drawn at contact surface.

B) When a ball hits a wall at an angle to horizontal its momentum along the wall remain constant.

C) When a ball bounces 'n' times before coming to rest the total time elapsed is

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

(1) A, B are true (2) A, C are false (3) A, B, C are true (4) A, B, C are false

18. A) A 4kg body collides elastically with 2kg stationary body. (1/9) of energy is retained by it.

B) When a neutron collides elastically with stationary nucleus of mass number 'A' fraction of energy retained by it is $\frac{4A}{(A+1)^2}$.

C) A moderator is chosen in nuclear reactor in such a way that atomic mass of moderator is comparable to that of neutron.

1) A, B are true 2) A, C are false 3) A, B, C are true 4) A, B, C are false

19. 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

20. 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) $-215\,kg.ms^{-1}$

21. 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) $\frac{2v}{4-A}$ 2) $\frac{4v}{A+4}$ 3) $\frac{v}{A+4}$ 4) $\frac{4v}{A-4}$

22. 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

1) 15 kg 2) 30 kg 3) 1.5 kg 4) 20 kg

23. 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

24. Consider the following statements A and B. Identify the correct choice in the given answer

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

25. 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

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

26. 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?

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

27. 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

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.

28. Consider the following statements A and B and identify the correct answer:

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 exchange 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.

29. 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. The height to which the block rise is $\left(g = 10\,ms^{-2}\right)$

1) 0.1 m 2) 0.2 m 3) 0.3 m 4) 0

30. 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

1) In the opposite direction 2) In the same direction

3) In the opposite direction 4) In the same direction

31. 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

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

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

33. 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 beginning and after two rebounds is

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

34. 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

35. In the above problem loss in K.E during collision is

1) 1 KJ 2) 1.33 J 3)1.33 KJ 4) $1.33\times10^4\ J$

36. 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

37. 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

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

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

1) 2 V 2) V/ $\sqrt{2}$ 3) V/2 4) $\sqrt{2}$ V

39. A body of mass '*m*' strikes another body at rest of mass '$\frac{m}{9}$'. Assuming the impact to be inelastic the friction of the initial kinetic energy transformed into heat during the contact is

1) 0.1 2) 0.2 3) 0.5 4) 0.64

40. A rifle of 20kg mass can fire 4 bullets per second. The mass of each bullet is $35\times10^{-3}kg$ and its final velocity is $400ms^{-1}$. Then what force must be applied on the rifle so that it does not more backwards while firing the bullets

1) 80 N 2) 28 N 3) -112 N 4) -56N

41. 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) $-15ms^{-1}$

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

43. A ball is dropped from a height 'h' on a floor of coefficient of restitution 'e'. The total distance covered by the ball just before second hit is

1) $h\left(1-2e^2\right)$ 2) $h\left(1+2e^2\right)$ 3) $h\left(1+e^2\right)$ 4) he^2

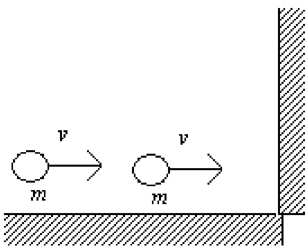
44. In two separate collisions, the coefficient of restitutions e_1 and e_2S are in the ratio 3:1. In the first collision the relative velocity of approach is twice the relative velocity of separation, and then the ratio between relative velocity of approach and the relative velocity of separation in the second collision is

1) 1:6 2) 2:3 3) 3:2 4) 6:1

45. 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 sphere is

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

46. 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 mass and with the wall are perfectly elastic the possible number of collisions between the bodies and wall together is



1) 1 2) 2 3) 3 4) Infinity

47. A shell is fired from gun with a velocity of $300ms^{-1}$ making an angle 60^0 with the horizontal. At the highest point, 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) $300ms^{-1}$

48. 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 vertical plane. The velocity with which the stopper is kicked out is

1) $7ms^{-1}$ 2) $10ms^{-1}$ 3) $70ms^{-1}$ 4) $0.1ms^{-1}$

49. A moving sphere P collide another sphere Q at rest. If the collision takes place along the line joining their centre's of mass such that their total kinetic energy is conserved and the fraction of K.E. transferred by the colliding particle $\frac{8}{9}$ is , 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

50. A particle strikes a horizontal friction less floor with a speed 'u' at an angle 'θ' with the vertical and rebounds with a speed 'v' at an angle 'α' with the vertical. 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) $v=u\sqrt{\cot^2\theta+e^2\cos^2\theta}$

51. 10 bullets each of mass 10 gm are fired in succession into a block of mass 450 gm at rest. If velocity of each bullet is 110 ms^{-1} and all the bullets are embedded in the block, the velocity of the block is

1) $0ms^{-1}$ 2) $20ms^{-1}$ 3) $25ms^{-1}$ 4) $30ms^{-1}$

52. Two steel spheres approach each other head-on with the same speed and collide elastically. After the collision one of the sphere's of radius r comes to rest. The radius of the other sphere is

1) $\frac{r}{(3)^{1/3}}$ 2) $\frac{r}{3}$ 3) $\frac{r}{9}$ 4) $(3)^{1/2}$ r

Key

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

Hints

19. $m_1v_1 + m_2v_2 = 0$

20. $P_{boat} = mu$

21. $m_1v_1 + m_2v_2 = 0$

22. mv + MV = 0

23. $\frac{\Delta K.E}{K.E} \times 100$

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

25. $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

26. $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

27. $m_1u_1 - m_2u_2 = m_1v_1 + m_2v_2$

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

30. $V_c = \frac{m_1v_1 + m_2v_2}{m_1 + m_2}$

31. $V_c = \dfrac{m_1v_1 + m_2v_2}{m_1 + m_2}$

32. $e = \sqrt{\dfrac{h_1}{h_2}}$

33. $v_n = e^n . v$

34. $e = \sqrt{\dfrac{h_1}{h_2}}$

35. $\Delta K.E = \dfrac{m_1m_2u_1^2}{2(m_1 + m_2)}$

36. $\Delta K.E = \dfrac{m_1m_2u_1^2}{2(m_1 + m_2)}$

37. $d = h + 2h_1 + 2h_2 + \text{---------}; h_n = e^{2n}h$

38. $Vi + Vj + \overline{P_3} = 0 \Rightarrow \overline{P_3} = -V(i + j)$

$P_3 = \sqrt{2}V$

$V_3 = \dfrac{P_3}{m_3} = \dfrac{\sqrt{2}V}{2} = \dfrac{V}{\sqrt{2}}$

39. $\dfrac{\Delta KE_{transformed}}{\Delta KE} = \dfrac{\frac{1}{2}\frac{m_1m_2}{m_1 + m_2}(u_1 - u_2)^2}{\frac{1}{2}m_1u_1^2}$

40. $F = \dfrac{nmu}{t}$

41. $V = u - gt = 100 - (9.8)5 = 100 - 49 = 51$

$MV = m_1v_1 + m_2v_2$

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

$2550 - 3000 = 30V_2$

$-45\not{0} = 3\not{0}\, V_2 \quad \Rightarrow V_2 = -15ms^{-1}$

42. $e = \sqrt{\dfrac{h_2}{h_1}} = \sqrt{\dfrac{h/2}{h}} = \dfrac{1}{\sqrt{2}}$

43. $h_n = he^{2n}$

44. $e_1 : e_2 = 3:1$

$\Delta V_1 = 2\Delta V_1 \Rightarrow e_1 = \dfrac{\Delta V_2}{\Delta U_2} = \dfrac{1}{2}$

$$\frac{\Delta V_1}{\Delta U_1} : \frac{\Delta V_2}{\Delta U_2} = 3:1$$

$$\Rightarrow \frac{1}{2} : \frac{\Delta V_2}{\Delta U_2} = 3:1 \Rightarrow \frac{\Delta U_2}{\Delta V_2} = 6:1$$

45. $V_1 = \left(\frac{m_1 - em_2}{m_1 + m_2}\right) u_1 + 0$

$$V_2 = 0 + \frac{m_1(1+e)}{m_1 + m_2} u_1$$

46. $V_1 = \left(\frac{m_1 - em_2}{m_1 + m_2}\right) u_1 + \frac{m_2(1+e)}{m_1 + m_2} u_2$

$$V_2 = \left(\frac{m_2 - em_1}{m_1 + m_2}\right) u_2 + \frac{m_1(1+e)}{m_1 + m_2} u_1$$

With $u_2 = 0$ and $m_1 = m_2$

47. $4m(u \cos\theta) = m(-u\cos\theta) + 3mV$

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

48.

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

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

$$(M = 20 \times 10^{-3} Kg, \quad m = 2 \times 10^{-3} Kg$$

49. Kinetic energy retained is

$$1 - \frac{8}{9} = \frac{1}{9}$$

$$\left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 = \frac{1}{9}$$

$$\frac{m_1 - m_2}{m_1 + m_2} = \frac{1}{3} \qquad \frac{m_1}{m_2} = \frac{1}{2}$$

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

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

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

51. $\frac{10x10x110 + 450(0)}{100 + 450} = v_c$

$$v_c = 20 ms^{-1}$$

52. $v_1 = 0$

$m_1 = 3m_2$

$R^3 = 3.R_2^3$

$R_2 = \frac{r}{3^{1/3}}$