the second elastically, the second one similarly with the third and so on. The velocity of the last ball is [UP SEE]
(a) 0.4 m s\(^{-1}\)  (b) 0.2 m s\(^{-1}\)  (c) 0.1 m s\(^{-1}\)  (d) 0.05 m s\(^{-1}\)

31. Consider elastic collision of a particle of mass \(m\) moving with a velocity \(u\) with another particle of the same mass at rest. After the collision the projectile and the struck particle move in directions making angles \(\theta_1\) and \(\theta_2\) respectively with the initial direction of motion. The sum of the angles \(\theta_1 + \theta_2\) is [UP SEE]
(a) 45°  (b) 90°  (c) 135°  (d) 180°

32. A 2 kg ball moving at 24 m s\(^{-1}\) undergoes inelastic head-on collision with a 4 kg ball moving in the opposite direction at 48 m s\(^{-1}\). If the coefficient of restitution is 2/3, their velocities in m s\(^{-1}\) after impact are [EAMCET]
(a) -56, -8  (b) -28, -4  (c) -14, -2  (d) -7, -1

33. A body at rest explodes into two equal parts. Then, [OJEE]
(a) they move with different speeds in different directions
(b) they move with different speeds in the same direction
(c) they move with the same speed in the opposite direction
(d) they move with the same speed in the opposite directions

34. A body of mass \(m\) is at rest. Another body of the same mass moving with velocity \(v\) makes head on elastic collision with the first body. After collision the first body starts to move with velocity [OJEE]
(a) \(v\)  (b) remain at rest
(c) \(2v\)  (d) not predictable

35. A body of mass \(M\) moves with velocity \(v\) and collides elastically with another body of mass \(m\) \((M > m)\) at rest, then the velocity of body of mass \(m\) is [BCECE]
(a) \(v\)  (b) \(2v\)
(c) \(v/2\)  (d) zero

36. If a shell fired from a cannon, explodes in mid air, then [Guj CET]
(a) its total kinetic energy increases
(b) its total momentum increases
(c) its total momentum decreases
(d) None of the above

2003

37. Two spherical bodies of the same mass \(M\) are moving with velocities \(v_1\) and \(v_2\). These collide perfectly inelastically, then the loss in kinetic energy is [AIEEE]
(a) \(\frac{1}{2} M (v_1 - v_2)^2\)  (b) \(\frac{1}{2} M (v_1^2 - v_2^2)\)
(c) \(\frac{1}{4} M (v_1 - v_2)^2\)  (d) \(2M(v_1^2 - v_2^2)\)

38. When \(U^{238}\) nucleus originally at rest, decays by emitting an alpha particle having a speed \(u\), the recoil speed of the residual nucleus is [AIEEE]
(a) \(\frac{4u}{238}\)  (b) \(-\frac{4u}{234}\)
(c) \(\frac{4u}{234}\)  (d) \(-\frac{4u}{238}\)

39. A spacecraft of mass \(M\) and moving with velocity \(v\) suddenly breaks in two pieces of same mass \(m\). After the explosion one of the mass \(m\) becomes stationary. What is the velocity of the other part of craft? [DCE]
(a) \(\frac{Mv}{M - m}\)  (b) \(v\)
(c) \(\frac{Mv}{m}\)  (d) \(\frac{M - m}{m} v\)

40. A rod \(AB\) of mass \(M\), length \(L\) is lying on a horizontal frictionless surface. A particle of mass \(m\) travelling along the surface hits the end \(A\) of the rod with velocity \(v_0\) in a direction perpendicular to \(AB\). The collision is completely elastic. After the collision, particle comes to rest. The ratio \(\frac{m}{M}\) is [UP SEE]
(a) \(\frac{\omega L^2}{9v_0^2}\)  (b) \(\frac{9v_0^2}{\omega L^2}\)
(c) \(\frac{9v_0}{\omega L}\)  (d) \(\frac{\omega L}{9v_0}\)

41. An \(\alpha\)-particle of mass \(m\) suffers one dimensional elastic collision with a nucleus of unknown mass. After collision the \(\alpha\)-particle is scattered directly back losing 75\% of its kinetic energy. Then the mass of the nucleus is [Kerala CEE]
(a) \(m\)  (b) \(2m\)
(c) \(3m\)  (d) \(\frac{3}{2}m\)

42. An elastic ball is dropped from a height \(h\) and rebounds many times from the floor. If the coefficient of restitution is \(e\), the time interval between the second and the third impact, is [Kerala CEE]
(a) \(\frac{e v}{g}\)  (b) \(\frac{e^2 v}{g}\)
(c) \(\frac{e^2}{\sqrt{\frac{8h}{g}}}\)  (d) \(\frac{e^2}{\sqrt{\frac{h}{g}}}\)
(e) \(\frac{e^2}{\sqrt{\frac{2h}{g}}}\)
61. **Consider the following statements A and B. Identify the correct answer given below.**

**A.** A body initially at rest is acted upon by a constant force. The rate of change of its kinetic energy varies linearly with time.

**B.** When a body is at rest, it must be in equilibrium.

(a) A and B are correct
(b) A and B are wrong
(c) A is correct and B is wrong
(d) A is wrong and B is correct

---

**Topic 3**

**Power**

2011

1. At time \( t = 0 \) s, a particle starts moving along the x-axis. If its kinetic energy increases uniformly with time \( t \), the net force acting on it must be proportional to \([\text{AIEEE}]\)

(a) \( \sqrt{t} \)  
(b) constant  
(c) \( t \)  
(d) \( \frac{1}{\sqrt{t}} \)

2. A box is moved along a straight line by a machine delivering constant power. The distance moved by the body in time \( t \) is proportional to \([\text{WB JEE}]\)

(a) \( t^{1/2} \)  
(b) \( t^{3/4} \)  
(c) \( t^{3/2} \)  
(d) \( t \)

---

2010

3. A body of mass \( M \) is moving with a uniform speed of 10 m/s on a frictionless surface under the influence of two forces \( F_1 \) and \( F_2 \). The net power of the system is \([\text{MP PET}]\)

(a) \( 10F_1F_2/M \)  
(b) \( 10(F_1 + F_2)/M \)  
(c) \( (F_1 + F_2)/M \)  
(d) zero

---

2009

4. A constant power \( P \) is applied to a car starting from rest. If \( v \) is the velocity of the car at time \( t \), then \([\text{UP SEE}]\)

(a) \( v \propto t \)  
(b) \( v \propto \frac{1}{t} \)  
(c) \( v \propto \sqrt{t} \)  
(d) \( v \propto \frac{1}{\sqrt{t}} \)

5. A car of mass \( m \) is driven with an acceleration \( a \) along a straight level road against a constant external resistive force \( R \). When the velocity of the car is \( v \), the rate at which engine of the car is doing work, will be \([\text{BVP}]\)

(a) \( R \cdot v \)  
(b) \( ma \cdot v \)  
(c) \( (R + ma) \cdot v \)  
(d) \( (ma - R) \cdot v \)

---

2008

6. The height of the dam in a hydroelectric power station is 10 m. In order to generate 1 MW of electric power, the mass of water (in kg) that must fall per second on the blades of the turbines is \([\text{Kerala CEE}]\)

(a) \( 10^7 \)  
(b) \( 10^3 \)  
(c) \( 10^5 \)  
(d) \( 10^4 \)

7. An engine pumps 100 kg of water through a height of 10 m in 5 s. Given that the efficiency of the engine is 60%, if \( g = 10 \text{ m/s}^2 \), the power of the engine is \([\text{KECE}]\)

(a) 3.3 kW  
(b) 0.33 kW  
(c) 0.033 kW  
(d) 33 kW

---

2007

8. An electric pump is used to fill an overhead tank of capacity 9 m\(^3\) kept at a height of 10 m above the ground. If the pump takes 5 min to fill the tank by consuming 10 kW power, the efficiency of the pump should be \([\text{Kerala CEE}]\)

(a) 60%  
(b) 40%  
(c) 20%  
(d) 30%

9. An engineer claims to have made an engine delivering 10 kW power with a fuel consumption of 1 g/s\(^{-1}\). The calorific value of fuel is 2 kcal/g\(^{-1}\). This claim is \([\text{MIT CET}]\)

(a) valid  
(b) invalid  
(c) dependent on engine design  
(d) dependent on load

10. A body of mass 2 kg is projected at 20 m/s\(^{-1}\) at an angle 60\(^o\) above the horizontal. Power due to the gravitational force at its highest point is \([\text{J&K CET}]\)

(a) 200 W  
(b) 100\sqrt{3} W  
(c) 50 W  
(d) zero

---

2005

11. A motor is used to deliver water at a certain rate through a given horizontal pipe. To deliver \( n \)-times the water through the same pipe in the same time, the power of the motor must be increased as follows \([\text{EAMCET}]\)

(a) \( 2n \)  
(b) \( \sqrt{n} \)  
(c) \( n \)  
(d) \( \frac{1}{n} \)
12. The machine gun fires 240 bullets per minute. If the mass of each bullet is 10 g and the velocity of the bullets is 600 ms\(^{-1}\), the power (in kW) of the gun is

\[
\text{(a) } 43200 \quad \text{(b) } 432 \quad \text{(c) } 72 \quad \text{(d) } 7.2
\]

13. If the heart pushes 1 cc of blood in 1 s under pressure 20000 Nm\(^{-2}\), the power of heart is

\[
\text{(a) } 0.02 \text{ W} \quad \text{(b) } 400 \text{ W} \quad \text{(c) } 5 \times 10^{-10} \text{ W} \quad \text{(d) } 0.2 \text{ W}
\]

14. A man does a given amount of work in 10 s. Another man does the same amount of work in 20 s. The ratio of the output power of first man to the second man is

\[
\text{(a) } 1 \quad \text{(b) } 1/2 \quad \text{(c) } 2/1 \quad \text{(d) None of these}
\]

2004

15. A body of mass \( m \) accelerates uniformly from rest to \( v_1 \) in time \( t_1 \). The instantaneous power delivered to the body as a function of time \( t \) is

\[
\text{(a) } \frac{mv_1^t}{t_1} \quad \text{(b) } \frac{mv_1^t}{t_1} \quad \text{(c) } \frac{mv_1^t}{t_1} \quad \text{(d) } \frac{mv_1^t}{t_1}
\]

2009

16. If \( F \) is the force required to keep a train moving at a constant speed \( v \), the power required is \( [\text{UPSEE}] \)

\[
\text{(a) } \frac{1}{2} Fv^2 \quad \text{(b) } Fv^2 \quad \text{(c) } \frac{1}{2} Fv \quad \text{(d) } Fv
\]

17. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time \( t \) is proportional to \( [\text{AMU}] \)

\[
\text{(a) } t^{1/2} \quad \text{(b) } t \quad \text{(c) } t^{3/2} \quad \text{(d) } t^2
\]

18. A force \( F = (2i + 4j) \) N displaces the body by \( s = (3j + 5k) \) m in 2 s. Power generated will be \( [\text{Jamia Millia Islamia}] \)

\[
\text{(a) } 11 \text{ W} \quad \text{(b) } 6 \text{ W} \quad \text{(c) } 22 \text{ W} \quad \text{(d) } 12 \text{ W}
\]

2010

1. A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverses its direction and moves with a speed of 2 ms\(^{-1}\). Which of the following statement(s) is/are correct for the system of these two masses? \( [\text{IIT JEE}] \)

\[(a) \text{ Total momentum of the system is 3 kg ms}^{-1}\]
\[(b) \text{ Momentum of 5 kg mass after collision is 4 kg ms}^{-1}\]
\[(c) \text{ Kinetic energy of the centre of mass is 0.75 J}\]
\[(d) \text{ Total kinetic energy of the system is 4 J}\]

2. Statement I Two particles moving in the same direction do not lose all their energy in a completely inelastic collision.

Statement II Principle of conservation of momentum holds true for all kinds of collisions.

\[(a) \text{ Statement I is true, Statement II is true, Statement II is the correct explanation of Statement I}\]
\[(b) \text{ Statement I is true Statement II is true, Statement II is not the correct explanation of Statement I}\]
\[(c) \text{ Statement I is false, Statement II is true}\]
\[(d) \text{ Statement I is true, Statement II is false}\]

2008

3. Two small particles of equal masses start moving in opposite directions from a point \( A \) in a horizontal circular orbit. Their tangential velocities are \( v \) and \( 2v \) respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at \( A \), these two particles will again reach the point \( A \)? \( [\text{IIT JEE}] \)

\[(a) \text{ 4}\]
\[(b) \text{ 3}\]
\[(c) \text{ 2}\]
\[(d) \text{ 1}\]

4. A block of mass 0.50 kg is moving with a speed of 2.00 ms\(^{-1}\) on a smooth surface. It strikes another mass of 1.00 kg and then they move together as a single body. The energy loss during the collision is \( [\text{AIEEE}] \)

\[(a) \text{ 0.16 J}\]
\[(b) \text{ 1.00 J}\]
\[(c) \text{ 0.67 J}\]
\[(d) \text{ 0.34 J}\]
5. For inelastic collision between two spherical rigid bodies (DCE)
   (a) the total kinetic energy is conserved
   (b) the total mechanical energy is not conserved
   (c) the linear momentum is not conserved
   (d) the linear momentum is conserved

6. 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 [BITSAT]
   (a) \( h(1-2e^2) \)
   (b) \( h(1+2e^2) \)
   (c) \( h(1+e^2) \)
   (d) \( he^2 \)

7. Two identical mass \( m \) moving with velocities \( u_1 \) and \( u_2 \) collide perfectly inelastically. Find the loss in energy [OJEE]
   (a) \( m(u_1 - u_2)^2 \)
   (b) \( \frac{m}{4}(u_1 - u_2)^2 \)
   (c) \( \frac{m}{2}(u_1 - u_2)^2 \)
   (d) \( m(u_1 - u_2)^2 \)

8. A body of mass 2 kg moving with a velocity of 3 ms\(^{-1}\) collides head on with a body of mass 1 kg moving in opposite direction with a velocity of 4 ms\(^{-1}\). After collision two bodies stick together and move with a common velocity which in ms\(^{-1}\) is equal to [Manipal]
   (a) 1/4
   (b) 1/3
   (c) 2/3
   (d) 3/4

2007

9. Statement I In an elastic collision between two bodies, the relative speed of the bodies after collision is equal to the relative speed before the collision.

   Statement II In an elastic collision, the linear momentum of the system is conserved. [IIT JEE]
   (a) Statement I is true, statement II is true; statement II is a correct explanation for statement I
   (b) Statement I is true, statement II is true; statement II is not a correct explanation for statement I
   (c) Statement I is true, statement II is false
   (d) Statement I is false, statement II is true

10. A ball is dropped from height 20 m. If the coefficient of restitution is 0.9, what will be the height attained after first bounce? [DCE]
    (a) 1.62 m
    (b) 16.2 m
    (c) 18 m
    (d) 14 m

11. In two separate collisions, the coefficient of restitution \( e_1 \) and \( e_2 \) are in the ratio 3 : 1. In the first collision the relative velocity of approach is twice the relative velocity of separation, then the ratio between relative

12. A 10 kg object collides with stationary 5 kg object and after collision they stick together and move forward with velocity 4 ms\(^{-1}\). What is the velocity with which the 10 kg object hit the second one? [WB JEE]
    (a) 4 ms\(^{-1}\)
    (b) 6 ms\(^{-1}\)
    (c) 10 ms\(^{-1}\)
    (d) 12 ms\(^{-1}\)

13. In elastic collision [WB JEE]
    (a) both momentum and kinetic energies are conserved
    (b) both momentum and kinetic energies are not conserved
    (c) only energy is conserved
    (d) only mechanical energy is conserved

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

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

2006

16. A block \( C \) of mass \( m \) is moving with velocity \( v_0 \) and collides elastically with block \( A \) of mass \( m \) and connected to another block \( B \) of mass 2\( m \) through spring constant \( k \). What is \( k \) if \( x_0 \) is compression of spring when velocity of \( A \) and \( B \) is same? [UP SEE]

17. A bullet of mass 20 g and moving with 600 ms\(^{-1}\) collides with a block of mass 4 kg hanging with the string. What is the velocity of bullet when it comes out of block if block rises to height 0.2 m after collision? [UP SEE]
18. A 20 kg ball moving with a velocity \(6 \text{ ms}^{-1}\) collides with a 30 kg ball initially at rest. If both of them coalesce, then the final velocity of the combined mass is 

\[
\begin{align*}
\text{(a)} & \quad 6 \text{ ms}^{-1} \\
\text{(b)} & \quad 5 \text{ ms}^{-1} \\
\text{(c)} & \quad 3.6 \text{ ms}^{-1} \\
\text{(d)} & \quad 2.4 \text{ ms}^{-1} \\
\text{(e)} & \quad 1.2 \text{ ms}^{-1}
\end{align*}
\]

[KEC]

19. For a system to follow the law of conservation of linear momentum during a collision, the condition is 

\[
\begin{align*}
(1) & \quad \text{total external force acting on the system is zero} \\
(2) & \quad \text{total external force acting on the system is finite and time of collision is negligible.} \\
(3) & \quad \text{total internal force acting on the system is zero.}
\end{align*}
\]

[EMCET]

(a) (1) only 
(b) (2) only 
(c) (3) only 
(d) (1) or (2)

(20) A neutron moving with velocity \(v\) collides with a stationary \(\alpha\)-particle. The velocity of the neutron after the collision is 

\[
\begin{align*}
\text{(a)} & \quad -\frac{3v}{5} \\
\text{(b)} & \quad \frac{3v}{5} \\
\text{(c)} & \quad \frac{2v}{5} \\
\text{(d)} & \quad -\frac{2v}{5}
\end{align*}
\]

[OJEE]

21. A bomb at rest explodes into 3 parts of the same mass. The momentum of the 2 parts is \(-2p\hat{i}\) and \(p\hat{j}\). The momentum of the third part will have a magnitude of 

\[
\begin{align*}
\text{(a)} & \quad p \\
\text{(b)} & \quad \sqrt{3}p \\
\text{(c)} & \quad p\sqrt{3} \\
\text{(d)} & \quad \text{zero}
\end{align*}
\]

[Jamia Millia Islamia]

22. In a head on elastic collision of a very heavy body moving at \(v\) with a light body at rest, velocity of heavy body after collision is 

\[
\begin{align*}
\text{(a)} & \quad v \\
\text{(b)} & \quad \frac{2v}{3} \\
\text{(c)} & \quad \text{zero} \\
\text{(d)} & \quad \frac{v}{2}
\end{align*}
\]

[J&K CET]

2005

23. A mass \(m\) moves with a velocity \(v\) and collides inelastically with another identical mass. After collision the 1st mass moves with velocity \(\frac{v}{\sqrt{3}}\) in a direction perpendicular to the initial direction of motion. Find the speed of the second mass after collision. 

\[
\begin{align*}
\text{(a)} & \quad v \\
\text{(b)} & \quad \sqrt{3}v \\
\text{(c)} & \quad \frac{2v}{\sqrt{3}} \\
\text{(d)} & \quad \frac{v}{\sqrt{3}}
\end{align*}
\]

[AIEEE]

24. A body of mass \(m\) moving with velocity \(v\) collides head on another body of mass \(2m\) which is initially at rest. The ratio of KE of colliding body before and after collision is 

\[
\begin{align*}
\text{(a)} & \quad 1 : 1 \\
\text{(b)} & \quad 2 : 1 \\
\text{(c)} & \quad 4 : 1 \\
\text{(d)} & \quad 9 : 1
\end{align*}
\]

[AIEEE]

25. 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 mass suffering a head on elastic collision merely exchange their velocities.

1. Both \(A\) and \(B\) are true 
2. Both \(A\) and \(B\) are false 
3. \(A\) is true and \(B\) is false 
4. \(A\) is false but \(B\) is true

[EMCET]

26. 1 kg body explodes into three fragments. The ratio of their masses is 1:1:3. The fragments of same mass move perpendicular to each other with speeds 30 m s\(^{-1}\) while the heavier part remains in the initial direction. The speed of heavier part is 

\[
\begin{align*}
\text{(a)} & \quad \frac{10}{\sqrt{2}} \text{ ms}^{-1} \\
\text{(b)} & \quad 10\sqrt{2} \text{ ms}^{-1} \\
\text{(c)} & \quad 20\sqrt{2} \text{ ms}^{-1} \\
\text{(d)} & \quad 30\sqrt{2} \text{ ms}^{-1}
\end{align*}
\]

[BCECE]

27. A body of mass 4 kg moving with velocity 12 m s\(^{-1}\) collides with another body of mass 6 kg at rest. If two bodies stick together after collision, then the loss of kinetic energy of system is 

\[
\begin{align*}
\text{(a)} & \quad \text{zero} \\
\text{(b)} & \quad 288 \text{ J} \\
\text{(c)} & \quad 172.8 \text{ J} \\
\text{(d)} & \quad 144 \text{ J}
\end{align*}
\]

[J&K CET]

2004

28. A bomb is kept stationary at a point. It suddenly explodes into two fragments of masses 1g and 3g. The total KE of the fragments is \(6.4 \times 10^4 \text{ J}\). What is the KE of the smaller fragment? 

\[
\begin{align*}
\text{(a)} & \quad 2.5 \times 10^7 \text{ J} \\
\text{(b)} & \quad 3.5 \times 10^4 \text{ J} \\
\text{(c)} & \quad 48 \times 10^4 \text{ J} \\
\text{(d)} & \quad 5.2 \times 10^4 \text{ J}
\end{align*}
\]

[DCE]

29. A body moving with a velocity \(v\), breaks up into two equal parts. One of the part retracts back with velocity \(v\). Then, the velocity of the other part is 

\[
\begin{align*}
\text{(a)} & \quad v \text{ in forward direction} \\
\text{(b)} & \quad 3v \text{ in forward direction} \\
\text{(c)} & \quad v \text{ in backward direction} \\
\text{(d)} & \quad 3v \text{ in backward direction}
\end{align*}
\]

[DCE]

30. Four smooth steel balls of equal mass at rest are free to move along a straight line without friction. The first ball is given a velocity of 0.4 m s\(^{-1}\). It collides head on with