1. A body moves a distance of 10 m along a straight line under the action of a force of 5 N. If the work done is 25 joules, the angle which the force makes with the direction of motion of the body is
   (a) 0°  (b) 30°  (c) 60°  (d) 90°

2. A man pushes a wall and fails to displace it. He does
   (a) Negative work  (b) Positive but not maximum work
   (c) No work at all  (d) Maximum work

3. The potential energy of a certain spring when stretched through a distance ‘S’ is 10 joule. The amount of work (in joule) that must be done on this spring to stretch it through an additional distance ‘S’ will be
   (a) 30  (b) 40  (c) 10  (d) 20

4. If the kinetic energy of a body becomes four times of its initial value, then new momentum will
   (a) Becomes twice its initial value  (b) Become three times its initial value
   (c) Become four times its initial value  (d) Remains constant

5. A spring of force constant 800 N/m has an extension of 5 cm. The work done in extending it from 5 cm to 15 cm is
   (a) 16 J  (b) 8 J  (c) 32 J  (d) 24 J

6. A light and a heavy body have equal momenta. Which one has greater K.E
   (a) The light body  (b) The heavy body  (c) The K.E. are equal  (d) Data is incomplete

7. Two masses of 1 gm and 4 gm are moving with equal kinetic energies. The ratio of the magnitudes of their linear moment is
   (a) 4 : 1  (b) \( \sqrt{2} : 1 \)  (c) 1 : 2  (d) 1 : 16

8. If the K.E. of a body is increased by 300%, its momentum will increase by
   (a) 100%  (b) 150%  (c) \( \sqrt{300} \% \)  (d) 175%

9. A spring 40 mm long is stretched by the application of a force. If 10 N force required to stretch the spring through 1 mm, then work done in stretching the spring through 40 mm is
   (a) 84 J  (b) 68 J  (c) 23 J  (d) 8 J

10. A bullet is fired from a rifle. If the rifle recoils freely, then the kinetic energy of the rifle is
    (a) Less than that of the bullet  (b) More than that of the bullet
      (c) Same as that of the bullet  (d) Equal or less than that of the bullet
11. Two bodies of masses $2m$ and $m$ have their K.E. in the ratio $8 : 1$, then their ratio of momenta is
   (a) 1 : 1   (b) 2 : 1   (c) 4 : 1   (d) 8 : 1

12. A vertical spring with force constant $K$ is fixed on a table. A ball of mass $m$ at a height $h$ above the free upper end of the spring falls vertically on the spring so that the spring is compressed by a distance $d$. The net work done in the process is
   (a) $mg(h + d) + \frac{1}{2}Kd^2$
   (b) $mg(h + d) - \frac{1}{2}Kd^2$
   (c) $mg(h - d) - \frac{1}{2}Kd^2$
   (d) $mg(h - d) + \frac{1}{2}Kd^2$

13. A particle of mass $m$ at rest is acted upon by a force $F$ for a time $t$. Its Kinetic energy after an interval $t$ is
   (a) $\frac{F^2t^2}{m}$   (b) $\frac{F^2t^2}{2m}$   (c) $\frac{F^2t^2}{3m}$   (d) $\frac{Ft}{2m}$

14. Power of a water pump is 2 kW. If $g = 10 \text{ m/s}^2$, the amount of water it can raise in one minute to a height of 10 m is
   (a) 2000 litre   (b) 1000 litre   (c) 100 litre   (d) 1200 litre

15. An engine pumps water through a hose pipe. Water passes through the pipe and leaves it with a velocity of 2m/s. The mass per unit length of water in the pipe is 100 kg/m. What is the power of the engine
   (a) 800 W   (b) 400 W   (c) 200 W   (d) 100 W

16. A car of mass ‘m’ is driven with 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 the engine of the car is doing work will be
   (a) $RV$   (b) $maV$   (c) $(R + ma)V$   (d) $(ma - R)V$

17. The power of a pump, which can pump 200kg of water to a height of 200m in 10 sec is ($g = 10 \text{ m/s}^2$)
   (a) 40 kW   (b) 80 kW   (c) 400 kW   (d) 960 kW

18. A shell of mass 20 kg at rest explodes into two fragment whose masses are in the ratio 2 : 3. The smaller fragment moves with a velocity of 6 ms$^{-1}$. The kinetic energy of the larger fragment is
   (a) 96 J   (b) 216 J   (c) 144 J   (d) 360 J

19. A body falls on a surface of coefficient of restitution 0.6 from a height of 1 m. Then the body rebounds to a height of
   (a) 0.6 m   (b) 0.4 m   (c) 1 m   (d) 0.36 m

20. A ball is dropped from a height $h$. If the coefficient of restitution be $e$, then to what height will it rise after jumping twice from the ground
   (a) $eh/2$   (b) $2eh$   (c) $eh$   (d) $e^2h$

21. A mass of 100g strikes the wall with speed 5m/s at an angle as shown in figure and it rebounds with the same speed. If the contact time is $2 \times 10^{-3}$ sec, what is the force applied on the mass by the wall
22. A body of mass 2 kg makes an elastic collision with another body at rest and continues to move in the original direction with one fourth of its original speed. The mass of the second body which collides with the first body is
(a) 2 kg  (b) 1.2 kg  (c) 3 kg  (d) 1.5 kg

23. A body of mass 4 kg moving with velocity 12 m/s 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
(a) Zero  (b) 288 J  (c) 172.8 J  (d) 144 J

24. A body at rest breaks up into 3 parts. If 2 parts having equal masses fly off perpendicularly each after with a velocity of 12 m/s, then the velocity of the third part which has 3 times mass of each part is
(a) $4\sqrt{2}$ m/s at an angle of 45° from each body  (b) $24\sqrt{2}$ m/s at an angle of 135° from each body  
(c) $6\sqrt{2}$ m/s at 135° from each body  (d) $4\sqrt{2}$ m/s at 135° from each body

25. A uniform chain of length $L$ and mass $M$ is lying on a smooth table and one third of its length is hanging vertically downover the edge of the table. If $g$ is acceleration due to gravity, the work required to pull the hanging part on to the table is
(a) $MgL$  (b) $MgL/3$  (c) $MgL/9$  (d) $MgL/18$

26. A body of mass 2 kg moving with a velocity of 3 m/sec collides head on with a body of mass 1 kg moving in opposite direction with a velocity of 4 m/sec. After collision, two bodies stick together and move with a common velocity which in m/sec is equal to
(a) 1/4  (b) 1/3  (c) 2/3  (d) 3/4

27. A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time $t$ is proportional to
(a) $t^{1/2}$  (b) $t^{3/4}$  (c) $t^{3/2}$  (d) $t^2$

28. A shell is fired from a cannon with velocity $v$ m/sec at an angle $\theta$ with the horizontal direction. At the highest point in its path it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon and the speed in m/sec of the other piece immediately after the explosion is
(a) $3v \cos \theta$  (b) $2v \cos \theta$  (c) $\frac{3}{2}v \cos \theta$  (d) $\frac{\sqrt{3}}{2}v \cos \theta$
29. Two small particles of equal masses start moving in opposite directions from a point A in 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

(a) 4  
(b) 3  
(c) 2  
(d) 1

30. The work done by a force acting on a body is as shown in the graph. The total work done in covering an initial distance of 20 m is

(a) 225 J  
(b) 200 J  
(c) 400 J  
(d) 175 J

**ANSWERS**

1. (c)  
2. (c)  
3. (a)  
4. (a)  
5. (b)  
6. (a)  
7. (c)  
8. (a)  
9. (d)  
10. (a)  
11. (c)  
12. (b)  
13. (b)  
14. (d)  
15. (a)  
16. (c)  
17. (a)  
18. (a)  
19. (d)  
20. (d)  
21. (c)  
22. (b)  
23. (c)  
24. (d)  
25. (d)  
26. (c)  
27. (c)  
28. (a)  
29. (c)  
30. (b)

**Solutions**

1. (c)  
   \[ W = F_S \cos \theta \Rightarrow \cos \theta = \frac{W}{F_S} = \frac{25}{50} = \frac{1}{2} \Rightarrow \theta = 60^\circ \]

2. (c)  
   No displacement is there.

3. (a)  
   \[ \frac{1}{2} kS^2 = 10 \text{ J} \quad \text{(given in the problem)} \]
   \[ \frac{1}{2} k \left[ (2S)^2 - (S)^2 \right] = 3 \times \frac{1}{2} kS^2 = 3 \times 10 = 30 \text{ J} \]

4. (a)  
   \[ P = \sqrt{2mE} \quad \therefore P \propto \sqrt{E} \quad \text{i.e. if kinetic energy becomes four time then new momentum will become twice.} \]

5. (b)  
   \[ W = \frac{1}{2} k(x_2^2 - x_1^2) = \frac{1}{2} \times 800 \times (15^2 - 5^2) \times 10^{-4} = 8 \text{ J} \]
6. (a) \[ E = \frac{p^2}{2m} \text{ if } p = \text{ constant then } E \propto \frac{1}{m} \]

7. (c) \[ P = \sqrt{2mE} \text{. If } E \text{ are same then } P \propto \sqrt{m} \]

\[ \Rightarrow \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{1}{4}} = \frac{1}{2} \]

8. (a) Let initial kinetic energy, \( E_1 = E \)

Final kinetic energy, \( E_2 = E + 300\% \text{ of } E = 4E \)

As \( P \propto \sqrt{E} \Rightarrow \frac{P_2}{P_1} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{4E}{E}} = 2 \Rightarrow P_2 = 2P_1 \)

\[ \Rightarrow P_2 = P_1 + 100\% \text{ of } P_1 \]

i.e. Momentum will increase by 100%.

9. (d) Here \( k = \frac{F}{x} = \frac{10}{1 \times 10^{-3}} = 10^4 \text{ N/m} \)

\[ W = \frac{1}{2}kx^2 = \frac{1}{2} \times 10^4 \times (40 \times 10^{-3})^2 = 8 \text{ J} \]

10. (a) \[ E = \frac{p^2}{2m} \text{ if } p = \text{ constant then } E \propto \frac{1}{m} \]

i.e. kinetic energy of heavier body will be less. As the mass of gun is more than bullet therefore it possess less kinetic energy.

11. (c) \[ p = \sqrt{2mE} \Rightarrow \frac{p_1}{p_2} = \sqrt{\frac{m_1E_1}{m_2E_2}} = \sqrt{\frac{2 \times 8}{1}} = \frac{4}{1} \]

12. (b) Gravitational potential energy of ball gets converted into elastic potential energy of spring. \( mg(h+d) = \frac{1}{2}Kd^2 \)

Net work done = \( mg(h + d) - \frac{1}{2}Kd^2 = 0 \)

13. (b) Kinetic energy \( E = \frac{p^2}{2m} = \frac{(Ft)^2}{2m} = \frac{F^2t^2}{2m} \) \[ \text{[As } P = Ft\]}

14. (d) \( P = \frac{mgh}{t} \Rightarrow m = \frac{p \times t}{gh} = \frac{2 \times 10^3 \times 60}{10 \times 10} = 1200 \text{ kg} \)

As volume = \( \frac{\text{mass}}{\text{density}} \Rightarrow V = \frac{1200 \text{ kg}}{10^3 \text{ kg/m}^3} = 1.2\text{ m}^3 \)

Volume = \( 1.2\text{ m}^3 = 1.2 \times 10^3 \text{ litre} = 1200 \text{ litre} \)

15. (a0 Power = \( FV = v \left( \frac{m}{t} \right) v = v^2 (pAV) \)

\[ = pAv^3 = (100)(2)^3 = 800W. \]

16. (c) Force required to move with constant velocity

\[ \therefore \text{ Power } = FV \]

Force is required to oppose the resistive force \( R \) and also to accelerate the body of mass with acceleration \( a \).

\[ \therefore \text{ Power } = (R + ma)V \]

17. (a) \( P = \frac{mgh}{t} = \frac{200 \times 10 \times 200}{10} = 40 \text{ kW} \)

18. (a) Mass of fragments are as \( 2:3 \)

Total mass = 120 kg

\[ \therefore \text{ Larger fragment } = 12 \text{ kg} \]
∴ Smaller fragment = 8 kg

Momentum is conserved
∴ 8 × 6 = 12 × v ⇒ v = 4 = velocity of larger fragment.
∴ \( \frac{1}{2} mv^2 = \frac{1}{2} × 12 × (4)^2 = 96 \) J.

19. (d) \( h_n = he^{2n} = 1 \times e^{2 \times 1} = 1 \times (0.6)^2 = 0.36m \)

20. (d) \( h_n = he^{2n} \), if \( n = 2 \) then \( h_n = he^{4} \)

21.

22. (b) \( m_1 = 2 \) kg and \( v_1 = \left( \frac{m_1 - m_2}{m_1 + m_2} \right) u_1 = \frac{u_1}{4} \) (given)

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

= \( \frac{4 \times 6}{2 \times 10} \times (12 - 0)^2 = 172.8 \) J

24. (d)

![Diagram](image)

The momentum of third part will be equal and opposite to the resultant of momentum of rest two equal parts
let \( V \) is the velocity of third part.
By the conservation of linear momentum
\( 3m \times V = m \times 12\sqrt{2} \Rightarrow V = 4\sqrt{2} \) m/s

25. (d)

![Diagram](image)

\( W = \frac{MgL}{2n^2} = \frac{MgL}{2(3)^2} = \frac{MgL}{18} \) (n = 3 given)

26. (c) \( m_1 v_1 - m_2 v_2 = (m_1 + m_2)w \)

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

27. (c) \( P = Fv = mav = m \left( \frac{dv}{dt} \right) v = \frac{P}{m} dt = v dv \)

\( \Rightarrow \frac{P}{m} \times t = \frac{v^2}{2} \Rightarrow v = \left( \frac{2P}{m} \right)^{1/2} (t)^{1/2} \)

Now \( s = \int v dt = \int \left( \frac{2P}{m} \right)^{1/2} t^{1/2} dt \)

∴ \( \Rightarrow s = \left( \frac{2P}{m} \right)^{1/2} \left[ \frac{2t^{3/2}}{3} \right] \Rightarrow s \propto t^{1/2} \)
28. (a) Shell is fired with velocity \( v \) at an angle \( \theta \) with the horizontal.

So its velocity at the highest point

\[ = \text{horizontal component of velocity} = v \cos \theta \]

So momentum of shell before explosion = \( mv \cos \theta \)

![Diagram showing velocity components]

When it breaks into two equal pieces and one piece retrace its path to the canon, then other part move with velocity \( V \).

So momentum of two pieces after explosion

\[ = \frac{m}{2} (v \cos \theta) + \frac{m}{2} V \]

By the law of conservation of momentum

\[ m v \cos \theta = \frac{m}{2} v \cos \theta + \frac{m}{2} V \Rightarrow V = 3v \cos \theta \]

29. (c) Let initially particle \( x \) is moving in anticlockwise direction and \( y \) in clockwise direction.

As the ratio of velocities of \( x \) and \( y \) particles are \( \frac{v_x}{v_y} = \frac{1}{2} \). Therefore ratio of their distance covered will be in the ratio of 2 : 1. It means they collide at point \( B \).

![Diagram showing particle movements]

After first collision at \( B \), velocities of particles get interchanged, i.e., \( x \) will move with \( 2v \) and particle \( y \) with \( v \).

Second collision will take place at point \( C \). Again at this point velocities get interchanged and third collision take place at point \( A \).

So, after two collision these two particles will again reach the point \( A \).

30. (b)
Work done \( W \) are under \( F - S \) graph

\[
= \text{area of trapezium } ABCD + \text{area of trapezium } CEFD
\]

\[
= \frac{1}{2} \times (10 + 15) \times 10 + \frac{1}{2} \times (10 + 20) \times 5
\]

\[
= 125 + 75 = 200\text{J}.
\]