CHAPTER 5

Work, Energy and Power

1. Consider the following two statements :**[2003]**

A. Linear momentum of a system of particles is zero

B. Kinetic energy of a system of particles is zero. Then

(a) A does not imply *B* and *B* does not imply *A*

(b) *A* implies *B* but *B* does not imply *A*

(c) *A* does not imply *B* but *B* implies *A*

(d) *A* implies *B* and *B* implies *A*

2. A wire suspended vertically from one of its ends is stretched by attaching a weight of 200N to the lower end. The weight stretches the wire by 1 mm. Then the elastic energy stored in the wire is **[2003]**

(a) 0.2 J (b) 10 J

(c) 20 J (d) 0.1 J

3. A spring of spring constant 5×10^3 N/m is stretched initially by 5cm from the unstretched position. Then the work required to stretch it further by another 5 cm is **[2003]**

(a) 12.50 N-m (b) 18.75 N-m

(c) 25.00 N-m (d) 6.25 N-m

4. A body is moved along a straight line by a machine delivering a constant power. The distance moved by the body in time 't' is proportional to **[2003]**

(a) $t^{3/4}$ (b) $t^{3/2}$

(c) $t^{1/4}$ (d) $t^{1/2}$

5. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement x is proportional to **[2004]**

(a) x (b) e^x

(c) x^2 (d) $\log_e x$

6. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table ? **[2004]**

(a) 12 J (b) 3.6 J

(c) 7.2 J (d) 1200 J

7. A force $\vec{F} = (5\vec{i} + 3\vec{j} + 2\vec{k})N$ is applied over a particle which displaces it from its origin to the point $\vec{r} = (2\vec{i} - \vec{j})m$. The work done on the particle in joules is **[2004]**

(a) +10 (b) +7

(c) −7 (d) +13

8. 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 **[2004]**

(a) $\dfrac{mv_1t^2}{t_1}$ (b) $\dfrac{mv_1^2t}{t_1^2}$

(c) $\dfrac{mv_1t}{t_1}$ (d) $\dfrac{mv_1^2t}{t_1}$

9. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle, the motion of the particles takes place in a plane. It follows that **[2004]**

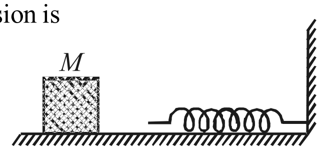
(a) its kinetic energy is constant

(b) its acceleration is constant

(c) its velocity is constant

(d) it moves in a straight line

10. The block of mass *M* moving on the frictionless horizontal surface collides with the spring of spring constant *k* and compresses it by length *L*. The maximum momentum of the block after collision is **[2005]**



(a) $\dfrac{kL^2}{2M}$ (b) $\sqrt{Mk}\ L$

(c) $\dfrac{ML^2}{k}$ (d) zero

11. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It rolls down a smooth surface to the ground, then climbs up another hill of height 30 m and finally rolls down to a horizontal base at a height of 20 m above the ground. The velocity attained by the ball is **[2005]**

(a) 20 m/s (b) 40 m/s

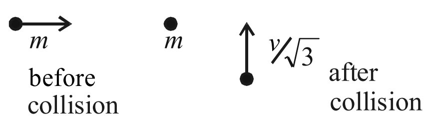
(c) $10\sqrt{30}$ m/s (d) 10 m/s

12. A body of mass m is accelerated uniformly from rest to a speed v in a time *T*. The instantaneous power delivered to the body as a function of time is given by **[2005]**

(a) $\frac{mv^2}{T^2}.t^2$ (b) $\frac{mv^2}{T^2}.t$

(c) $\frac{1}{2}\frac{mv^2}{T^2}.t^2$ (d) $\frac{1}{2}\frac{mv^2}{T^2}.t$

13. 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 2^{nd} mass after collision. **[2005]**



(a) $\sqrt{3}v$ (b) v

(c) $\frac{v}{\sqrt{3}}$ (d) $\frac{2}{\sqrt{3}}v$

14. A bomb of mass 16kg at rest explodes into two pieces of masses 4 kg and 12 kg. The velolcity of the 12 kg mass is $4\ ms^{-1}$. The kinetic energy of the other mass is **[2006]**

(a) 144 J (b) 288 J

(c) 192 J (d) 96 J

15. A particle of mass 100g is thrown vertically upwards with a speed of 5 m/s. The work done by the force of gravity during the time the particle goes up is **[2006]**

(a) –0.5 J (b) –1.25 J

(c) 1.25 J (d) 0.5 J

16. The potential energy of a 1 kg particle free to move along the x-axis is given by

$$V(x) = \left(\frac{x^4}{4} - \frac{x^2}{2}\right) J.$$

The total mechanical energy of the particle is 2 J. Then, the maximum speed (in m/s) is **[2006]**

(a) $\frac{3}{\sqrt{2}}$ (b) $\sqrt{2}$

(c) $\frac{1}{\sqrt{2}}$ (d) 2

17. A 2 kg block slides on a horizontal floor with a speed of 4m/s. It strikes a uncompressed spring, and compresses it till the block is motionless. The kinetic friction force is 15N and spring constant is 10,000 N/m. The spring compresses by **[2007]**

(a) 8.5 cm (b) 5.5 cm

(c) 2.5 cm (d) 11.0 cm

18. An athlete in the olympic games covers a distance of 100 m in 10 s. His kinetic energy can be estimated to be in the range **[2008]**

(a) 200 J - 500 J (b) 2×10^5 J - 3×10^5 J

(c) 20,000 J - 50,000 J (d) 2,000 J - 5, 000 J

19. 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 **[2008]**

(a) 0.16 J (b) 1.00 J

(c) 0.67 J (d) 0.34 J

20. The potential energy function for the force between two atoms in a diatomic molecule is approximately given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$, where a and b are constants and x is the distance between the atoms. If the dissociation energy of the molecule is

$D = \left[U(x=\infty) - U_{\text{at equilibrium}}\right]$, D is **[2010]**

(a) $\frac{b^2}{2a}$ (b) $\frac{b^2}{12a}$

(c) $\frac{b^2}{4a}$ (d) $\frac{b^2}{6a}$

21. **Statement -1:** Two particles moving in the same direction do not lose all their energy in a completely inelastic collision. **[2010]**

Statement -2 : Principle of conservation of momentum holds true for all kinds of collisions.

(a) Statement -1 is true, Statement -2 is true ; Statement -2 is the correct explanation of Statement -1.

(b) Statement -1 is true, Statement -2 is true; Statement -2 is **not** the correct explanation of Statement -1

(c) Statement -1 is false, Statement -2 is true.

(d) Statement -1 is true, Statement -2 is false.

22. At time $t = 0$ 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 **[2011 RS]**

(a) constant (b) t

(c) $\frac{1}{\sqrt{t}}$ (d) $\sqrt{t}$

23. This question has statement I and statement II. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement - I: A point particle of mass m moving with speed υ collides with stationary point particle of mass M. If the maximum energy loss possible is given as $f\left(\frac{1}{2}mv^2\right)$ then f = $\left(\frac{m}{M+m}\right)$.

Statement - II: Maximum energy loss occurs when the particles get stuck together as a result of the collision. **[2013]**

(a) Statement - I is true, Statment - II is true, Statement - II is the correct explanation of Statement - I.

(b) Statement-I is true, Statment - II is true, Statement - II is not the correct explanation of Statement - II.

(c) Statement - I is true, Statment - II is false.

(d) Statement - I is false, Statment - II is true.

24. When a rubber-band is stretched by a distance x, it exerts restoring force of magnitude $F = ax + bx^2$ where a and b are constants. The work done in stretching the unstretched rubber-band by L is: **[2014]**

(a) $aL^2 + bL^3$ (b) $\frac{1}{2}\left(aL^2 + bL^3\right)$

(c) $\frac{aL^2}{2} + \frac{bL^3}{3}$ (d) $\frac{1}{2}\left(\frac{aL^2}{2} + \frac{bL^3}{3}\right)$

25. A particle of mass m moving in the x direction with speed $2v$ is hit by another particle of mass $2m$ moving in the y direction with speed **v**. If the collision is perfectly inelastic, the percentage loss in the energy during the collision is close to : **[2015]**

(a) 56% (b) 62%

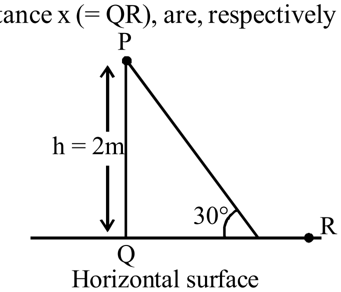
(c) 44% (d) 50%

26. A person trying to lose weight by burning fat lifts a mass of 10 kg upto a height of 1 m 1000 times. Assume that the potential energy lost each time he lowers the mass is dissipated. How much fat will he use up considering the work done only when the weight is lifted up? Fat supplies 3.8×10^7 J of energy per kg which is converted to mechanical energy with a 20% efficiency rate. Take g = 9.8 ms^{-2} : **[2016]**

(a) 44×10^4 J (b) 49×10^4 J

(c) 45×10^4 J (d) 46×10^4 J

27. A point particle of mass m, moves long the uniformly rough track PQR as shown in the figure. The coefficient of friction, between the particle and the rough track equals μ. The particle is released, from rest from the point P and it comes to rest at a point R. The energies, lost by the ball, over the parts, PQ and QR, of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR. The value of the coefficient of friction μ and the distance x (= QR), are, respectively close to : **[2016]**



(a) 0.29 and 3.5 m (b) 0.29 and 6.5 m

(c) 0.2 and 6.5 m (d) 0.2 and 3.5 m

28. A body of mass $m = 10^{-2}$ kg is moving in a medium and experiences a frictional force $F = -kv^2$. Its intial speed is $v_0 = 10\ ms^{-1}$. If, after 10 s, its energy is $\frac{1}{8}mv_0^2$, the value of k will be: **[2017]**

(a) 10^{-4} kg m^{-1} (b) 10^{-1} kg m^{-1} s^{-1}
(c) 10^{-3} kg m^{-1} (d) 10^{-3} kg s^{-1}

29. A time dependent force F = 6t acts on a particle of mass 1 kg. If the particle starts from rest, the work done by the force during the first 1 secand will be **[2017]**

(a) 9 J (b) 18 J
(c) 4.5 J (d) 22 J

Answer Key

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

SOLUTIONS

1. (c) Kinetic energy of a system of particle is zero only when the speed of each particles is zero. And if speed of each particle is zero, the linear momentum of the system of particle has to be zero.
Also the linear momentum of the system may be zero even when the particles are moving. This is because linear momentum is a vector quantity. In this case the kinetic energy of the system of particles will not be zero.
$\therefore$ A does not imply B but B implies A.

2. (d) The elastic potential energy

$$= \frac{1}{2} \times \text{Force} \times \text{extension}$$

$$= \frac{1}{2} \times 200 \times 0.001 = 0.1\ \text{J}$$

3. (b) $k = 5 \times 10^3$ N/m

$$W = \frac{1}{2}k\left(x_2^2 - x_1^2\right)$$

$$= \frac{1}{2} \times 5 \times 10^3\left[(0.1)^2 - (0.05)^2\right]$$

$$= \frac{5000}{2} \times 0.15 \times 0.05 = 18.75\ \text{Nm}$$

4. (b) We know that $F \times v = \text{Power}$

$\therefore\ F \times v = c$ where c = constant

$$\therefore\ m\frac{dv}{dt} \times v = c \qquad \left(\because F = ma = \frac{mdv}{dt}\right)$$

$$\therefore\ m\int_0^v vdv = c\int_0^t dt \qquad \therefore\ \frac{1}{2}mv^2 = ct$$

$$\therefore\ v = \sqrt{\frac{2c}{m}} \times t^{1/2}$$

$$\therefore\ \frac{dx}{dt} = \sqrt{\frac{2c}{m}} \times t^{1/2} \qquad \text{where } v = \frac{dx}{dt}$$

$$\therefore\ \int_0^x dx = \sqrt{\frac{2c}{m}} \times \int_0^t t^{1/2}dt$$

$$x = \sqrt{\frac{2c}{m}} \times \frac{2t^{3/2}}{3} \Rightarrow x \propto t^{3/2}$$

5. (c) Given : retardation $\propto$ displacement
i.e., $a = -x$

But $a = v\dfrac{dv}{dx}$

$$\therefore\ \frac{vdv}{dx} = -x \Rightarrow \int_{v_1}^{v_2} v\ dv = -\int_0^x xdx$$

$$\left(v_2^2 - v_1^2\right) = -\frac{x^2}{2}$$

$$\Rightarrow \frac{1}{2}m\left(v_2^2 - v_1^2\right) = \frac{1}{2}m\left(\frac{-x^2}{2}\right)$$

$\therefore$ Loss in kinetic energy, $\therefore\ \Delta K \propto x^2$

6. (b) Mass of over hanging chain

$$m' = \frac{4}{2} \times (0.6)\text{kg}$$

Let at the surface PE = 0
C.M.of hanging part = 0.3 m below the table

$$U_i = -m'gx = -\frac{4}{2} \times 0.6 \times 10 \times 0.30$$

$\Delta U = m'gx = 3.6\text{J}$ = Workdone in putting the entire chain on the table.

7. (b) Workdone in displacing the particle,

$$W = \vec{F}.\vec{x} = (5\hat{i} + 3\hat{j} + 2\hat{k}).(2\hat{i} - \hat{j})$$
$$= 10 - 3 = 7 \text{ joules}$$

8. (b) Let acceleration of body be a

$$\therefore v_1 = 0 + at_1 \Rightarrow a = \frac{v_1}{t_1}$$

$$\therefore v = at \Rightarrow v = \frac{v_1 t}{t_1}$$

$$P_{inst} = \vec{F}.\vec{v} = (m\vec{a}).\vec{v}$$

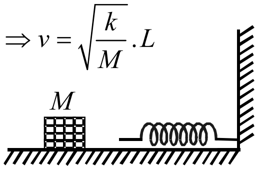
$$= \left(\frac{mv_1}{t_1}\right)\left(\frac{v_1 t}{t_1}\right) = m\left(\frac{v_1}{t_1}\right)^2 t$$

9. (a) Work done by such force is always zero since force is acting in a direction perpendicular to velocity.

$\therefore$ from work-energy theorem = $\Delta K = 0$
K remains constant.

10. (b) $\frac{1}{2}Mv^2 = \frac{1}{2}kL^2$

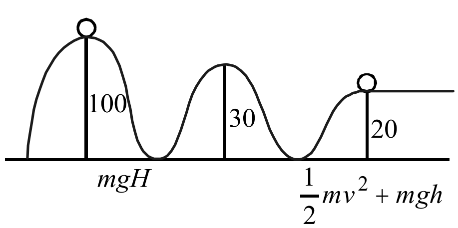
$$\Rightarrow v = \sqrt{\frac{k}{M}}.L$$



Momentum = $M \times v$

$$= M \times \sqrt{\frac{k}{M}}.L = \sqrt{kM}.L$$

11. (b)



Using conservation of energy,

$$m(10 \times 100) = m\left(\frac{1}{2}v^2 + 10 \times 20\right)$$

or $\frac{1}{2}v^2 = 800$ or $v = \sqrt{1600} = 40$ m/s

ALTERNATE SOLUTION

Loss in potential energy = gain in kinetic energy

$$m \times g \times 80 = \frac{1}{2}mv^2$$

$$10 \times 80 = \frac{1}{2}v^2$$

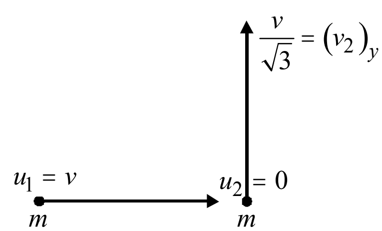
$v^2 = 1600$ or $v = 40$ m/s

12. (b) $u = 0;\ v = u + aT;\ v = aT$
Instantaneous power = $F \times v = m.\ a.$

$at = m.a^2.t$

$\therefore$ Instantaneous power = $m\frac{v^2}{T^2}t$

13. (d)



In x-direction : $mv + 0 = m(0) + m(v_2)_x$

In y-direction : $0 + 0 = m\left(\frac{v}{\sqrt{3}}\right) + m(v_2)_y$

is

$$\Rightarrow (v_2)_y = \frac{v}{\sqrt{3}} \text{ and } (v_2)_x = v$$

$$\therefore v_2 = \sqrt{\left(\frac{v}{\sqrt{3}}\right)^2 + v^2}$$

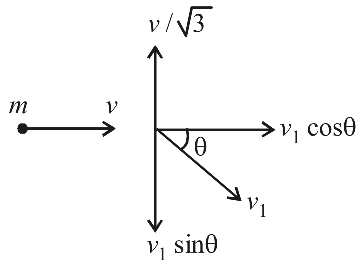
$$\Rightarrow v_2 = \sqrt{\frac{v^2}{3} + v^2} = v\sqrt{\frac{4}{3}} = \frac{2v}{\sqrt{3}}$$

ALTERNATE SOLUTION

In x-direction, $mv = mv_1 \cos\theta$ ...(1)
where v_1 is the velocity of second mass

In y-direction, $0 = \frac{mv}{\sqrt{3}} - mv_1 \sin\theta$

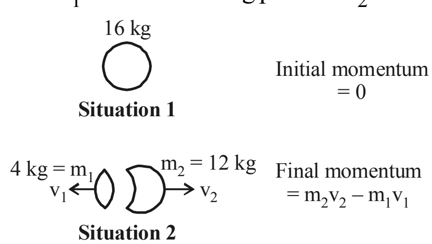
or $m_1 v_1 \sin\theta = \frac{mv}{\sqrt{3}}$ ...(2)



Squaring and adding eqns. (1) and (2)

$$v_1^2 = v^2 + \frac{v^2}{\sqrt{3}} \Rightarrow v_1 = \frac{2}{\sqrt{3}}v$$

14. (b) Let the velocity and mass of 4 kg piece be v_1 and m_1 and that of 12 kg piece be v_2 and m_2.



Applying conservation of linear momentum

$m_2 v_2 = m_1 v_1$

$$\Rightarrow v_1 = \frac{12 \times 4}{4} = 12\ ms^{-1}$$

$$\therefore K.E._1 = \frac{1}{2}m_1 v_1^2 = \frac{1}{2} \times 4 \times 144 = 288\ J$$

15. (b) $K.E = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.1 \times 25 = 1.25$ J

$$W = -mgh = -\left(\frac{1}{2}mv^2\right) = -1.25 \text{ J}$$

$$\left[\because mgh = \frac{1}{2}mv^2 \text{ by energy conservation}\right]$$

16. (a) Velocity is maximum when K.E. is maximum

For minimum. P.E.,

$$\frac{dV}{dx} = 0 \Rightarrow x^3 - x = 0 \Rightarrow x = \pm 1$$

$$\Rightarrow \text{Min. P.E.} = \frac{1}{4} - \frac{1}{2} = -\frac{1}{4}\text{ J}$$

$\text{K.E.}_{(max.)} + \text{P.E.}_{(min.)} = 2$ (Given)

$$\therefore \text{K.E.}_{(max.)} = 2 + \frac{1}{4} = \frac{9}{4}$$

$$\text{K.E.}_{max.} = \frac{1}{2}mv_{max.}^2$$

$$\Rightarrow \frac{1}{2} \times 1 \times v_{max.}^2 = \frac{9}{4} \Rightarrow v_{max.} = \frac{3}{\sqrt{2}}$$

17. (b) Let the block compress the spring by x before stopping.

kinetic energy of the block = (P.E of compressed spring) + work done against friction.

$$\frac{1}{2} \times 2 \times (4)^2 = \frac{1}{2} \times 10{,}000 \times x^2 + 15 \times x$$

$$10{,}000\,x^2 + 30x - 32 = 0$$

$$\Rightarrow 5000x^2 + 15x - 16 = 0$$

$$\therefore \quad x = \frac{-15 \pm \sqrt{(15)^2 - 4 \times (5000)(-16)}}{2 \times 5000}$$

$$= 0.055\text{m} = 5.5\text{cm}.$$

18. (d) The average speed of the athelete

$$v = \frac{100}{10} = 10\,\text{m/s}$$

$$\therefore \quad \text{K.E.} = \frac{1}{2}mv^2$$

If mass is 40 kg then,

$$\text{K.E.} = \frac{1}{2} \times 40 \times (10)^2 = 2000\,\text{J}$$

If mass is 100 kg then,

$$\text{K.E.} = \frac{1}{2} \times 100 \times (10)^2 = 5000\,\text{J}$$

19. (c) Initial kinetic energy of the system

$$\text{K.E}_i = \frac{1}{2}mu^2 + \frac{1}{2}M(0)^2$$

$$= \frac{1}{2} \times 0.5 \times 2 \times 2 + 0 = 1\text{J}$$

For collision, applying conservation of linear momentum

$$m \times u = (m + M) \times v$$

$$\therefore \quad 0.5 \times 2 = (0.5 + 1) \times v \Rightarrow v = \frac{2}{3}\,\text{m/s}$$

Final kinetic energy of the system is

$$\text{K.E}_f = \frac{1}{2}(m + M)v^2$$

$$= \frac{1}{2}(0.5+1) \times \frac{2}{3} \times \frac{2}{3} = \frac{1}{3}\text{J}$$

$\therefore$ Energy loss during collision

$$= \left(1 - \frac{1}{3}\right)\text{J} = 0.67\text{J}$$

20. (d) At equilibrium : $\frac{dU(x)}{dx} = 0$

$$\Rightarrow \frac{-12a}{x^{11}} = \frac{-6b}{x^5} \Rightarrow x = \left(\frac{2a}{b}\right)^{\frac{1}{6}}$$

$$\therefore U_{\text{at equilibrium}} = \frac{a}{\left(\frac{2a}{b}\right)^2} - \frac{b}{\left(\frac{2a}{b}\right)} = -\frac{b^2}{4a} \text{ and}$$

$$U_{(x=\infty)} = 0$$

$$\therefore D = 0 - \left(-\frac{b^2}{4a}\right) = \frac{b^2}{4a}$$

21. (a) In completely inelastic collision, all energy is not lost (so, statement -1 is true) and the principle of conservation of momentum holds good for all kinds of collisions (so, statement -2 is true) . Statement -2 explains statement -1 correctly because applying the principle of conservation of momentum, we can get the common velocity and hence the kinetic energy of the combined body.

22. (c) K.E. $\propto$ t or K. E. = ct

$$\Rightarrow \frac{1}{2}mv^2 = ct$$

$$\Rightarrow \frac{p^2}{2m} = ct \ (\because p = mv)$$

$$\Rightarrow p = \sqrt{2\text{ctm}}$$

$$\Rightarrow \text{F} = \sqrt{2\text{ cm}} \times \frac{1}{2\sqrt{t}}$$

$$\Rightarrow \text{F} \propto \frac{1}{\sqrt{t}}$$

23. (d) Maximum energy loss $= \frac{\text{P}^2}{2\text{m}} - \frac{\text{P}^2}{2(\text{m}+\text{M})}$

$$\left[\because \text{K.E.} = \frac{\text{P}^2}{2\text{m}} = \frac{1}{2}\text{mv}^2\right]$$

$$= \frac{\text{P}^2}{2\text{m}}\left[\frac{\text{M}}{(\text{m}+\text{M})}\right] = \frac{1}{2}\text{mv}^2\left\{\frac{\text{M}}{\text{m}+\text{M}}\right\}$$

Statement II is a case of perfectly inelastic collision.

By comparing the equation given in statement I with above equation, we get

$$\text{f} = \left(\frac{\text{M}}{\text{m}+\text{M}}\right) \text{ instead of } \left(\frac{\text{m}}{\text{M}+\text{m}}\right)$$

Hence statement I is wrong and statement II is correct.

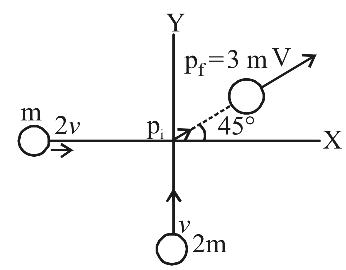
24. (c) Work done in stretching the rubber-band by a distance dx is

$$dW = F\,dx = (ax + bx^2)dx$$

Integrating both sides,

$$W = \int_0^L axdx + \int_0^L bx^2 dx = \frac{aL^2}{2} + \frac{bL^3}{3}$$

25. (a)



Initial momentum of the system

$$\text{p}_\text{i} = \sqrt{[\text{m}(2\text{V})^2 \times \text{m}(2\text{V})^2]}$$

$$= \sqrt{2}\text{m} \times 2\text{V}$$

Final momentum of the system = 3mV

By the law of conservation of momentum

$$2\sqrt{2}\text{m}v = 3\text{mV} \Rightarrow \frac{2\sqrt{2}v}{3} = \text{V}_{\text{combined}}$$

Loss in energy

$$\Delta\text{E} = \frac{1}{2}\text{m}_1\text{V}_1^2 + \frac{1}{2}\text{m}_2\text{V}_2^2 - \frac{1}{2}(\text{m}_1 + \text{m}_2)\text{V}_{\text{combined}}^2$$

$$\Delta\text{E} = 3\text{mv}^2 - \frac{4}{3}\text{mv}^2 = \frac{5}{3}\text{mv}^2 = 55.55\%$$

Percentage loss in energy during the collision $\simeq 56\%$

26. (b) $\text{n} = \frac{\text{W}}{\text{input}} = \frac{\text{mgh} \times 1000}{\text{input}} = \frac{10 \times 9.8 \times 1 \times 1000}{\text{input}}$

$$\text{Input} = \frac{98000}{0.2} = 49 \times 10^4\text{J}$$

Fat used $= \dfrac{49 \times 10^4}{3.8 \times 10^7} = 12.89 \times 10^{-3}$kg.

27. **(a)** Loss in P.E. = Work done against friction from p $\rightarrow$ Q
+ work done against friction from Q $\rightarrow$ R
mgh = μ(mgcosθ) PQ + μmg (QR)
h = $\mu \cos\theta \times$ PQ + μ(QR)
$2 = \mu \times \times + \mu x$
$2 = \mu + \mu x$ ..... (i) [sin 30° =]
Also work done P $\rightarrow$ Q = work done Q $\rightarrow$ R
$\therefore \mu = \mu x$

28. (a) Let V_f is the final speed of the body.

From questions,

$$\frac{1}{2} m V_f^2 = \frac{1}{8} m V_0^2 \quad \Rightarrow \quad V_f = \frac{V_0}{2} = 5\, m/s$$

$$F = m\left(\frac{dV}{dt}\right) = -kV^2 \quad \therefore \quad (10^{-2}) \frac{dV}{dt} = -kV^2$$

$$\int_{10}^{5} \frac{dV}{V^2} = -100K \int_0^{10} dt$$

$$\frac{1}{5} - \frac{1}{10} = 100K(10) \qquad \text{or,} \quad K = 10^{-4}\, kgm^{-1}$$

29. (c) Using, F = ma = $m\dfrac{dV}{dt}$

$$6t = 1.\frac{dV}{dt} \qquad [\because \quad m = 1 \text{ kg given}]$$

$$\int_0^v dV = \int 6t\, dt \quad V = 6\left[\frac{t^2}{2}\right]_0^1 = 3\,\text{ms}^{-1}$$

$[\because \quad t = 1$ sec given$]$

From work-energy theorem,

$$W = \Delta KE = \frac{1}{2} m\left(V^2 - u^2\right) = \frac{1}{2} \times 1 \times 9 = 4.5 \text{ J}$$