1. What is the work done by a person in carrying a suitcase weighing 10 kg f on his head when he travels a distance of 5 m in the (*i*) vertical direction and (*ii*) horizontal direction ? Take $g = 9.8\ ms^{-2}$.

[Ans. (*i*) 490 J (*ii*) Zero]

2. Calculate the amount of work done by a labourer who carries n bricks, each of mass m, to the roof of a house of height h by climbing up a ladder. (Ans. $n\ mgh$)

3. A man moves on a straight horizontal road with a block of mass 2 kg in his hand. If he covers a distance of 40 m with an acceleration of $0.5\ ms^{-2}$, find the work done by the man on the block during the motion. (Ans. 40 J)

4. A force $\vec{F} = (2\hat{i} - 6\hat{j})$ N is applied on a body, which is sliding over a floor. If the body is displaced through $(-3\hat{j})$ m, how much work is done by the force ? **[Himachal 09]** (Ans. 18 J)

5. Find the work done by force $\vec{F} = 2\hat{i} - 3\hat{j} + \hat{k}$ when its point of application moves from the point $A(1, 2, -3)$ to the point $B(2, 0, -5)$. (Ans. 6 units)

6. A particle is acted upon by constant forces $\vec{F_1} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ and $\vec{F_2} = -\hat{i} + 2\hat{j} - 3\hat{k}$, is displaced from the point $A(2, 1, 0)$ to the point $B(-3, -4, 2)$. Find the total work done by these forces. (Ans. 2 units)

7. A man weighing 50 kg f supports a body of 25 kg f on his head. What is the work done when he moves a distance of 20 m up an incline of 1 in 10 ? Take $g = 9.8\ ms^{-2}$. (Ans. 1470 J)

Problems For Practice

1. A force $F = (15 + 0.50x)$ acts on a particle in the X-direction, where F is in newton and x in metre. Find the work done by this force during a displacement from $x = 0$ to $x = 2.0$ m. (Ans. 31 J)

2. A force $F = a + bx$ acts on a particle in the X-direction, where a and b are constants. Find the work done by this force during a displacement from $x = 0$ to $x = d$.
(Ans. $\left(a + \frac{bd}{2}\right)d$)

3. A body moves from a point A to B under the action of a force shown in Fig. 6.10. Force F is in newton and distance x in metre. What is the amount of work done ? (Ans. 11.5 J)

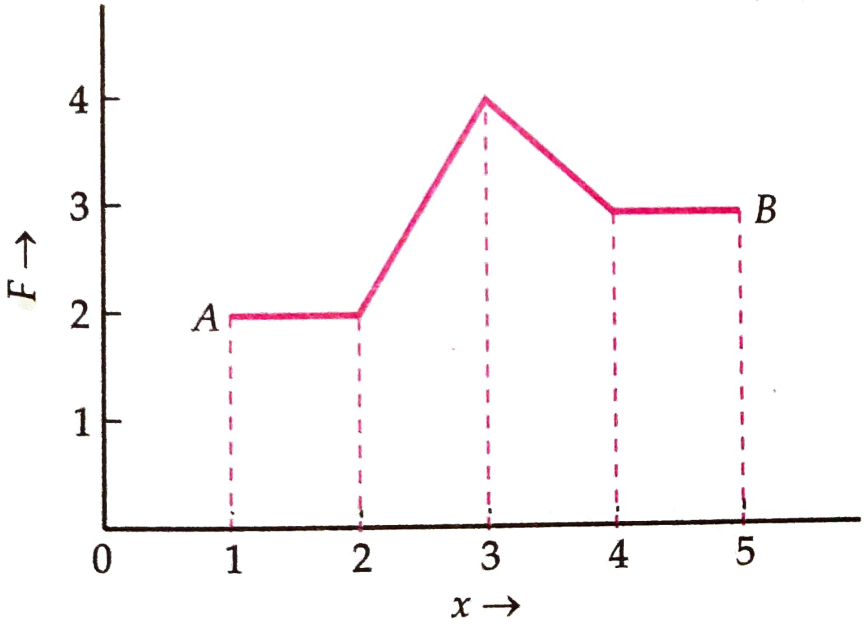
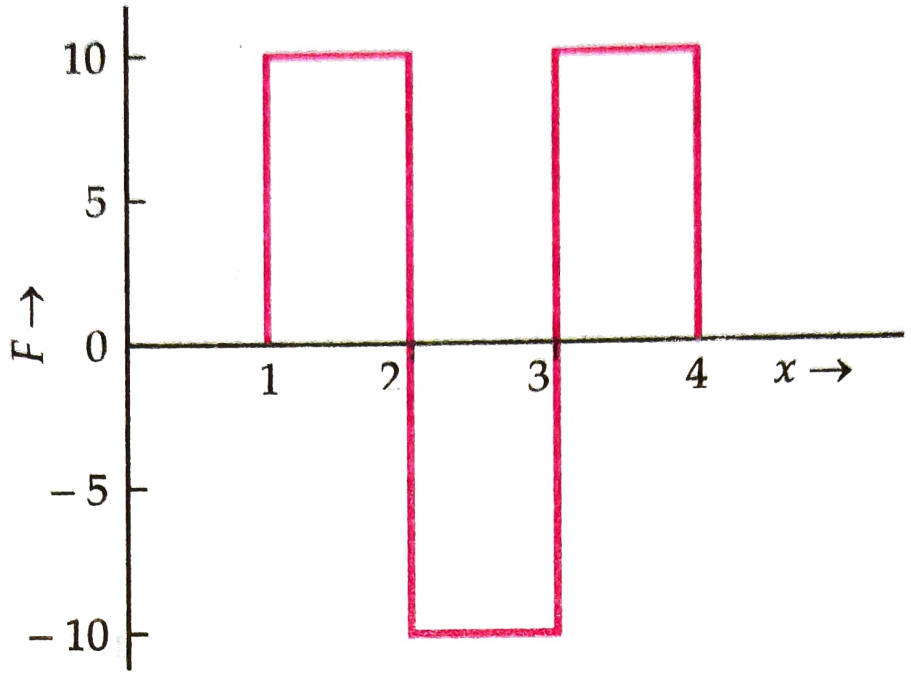


Fig. 6.10

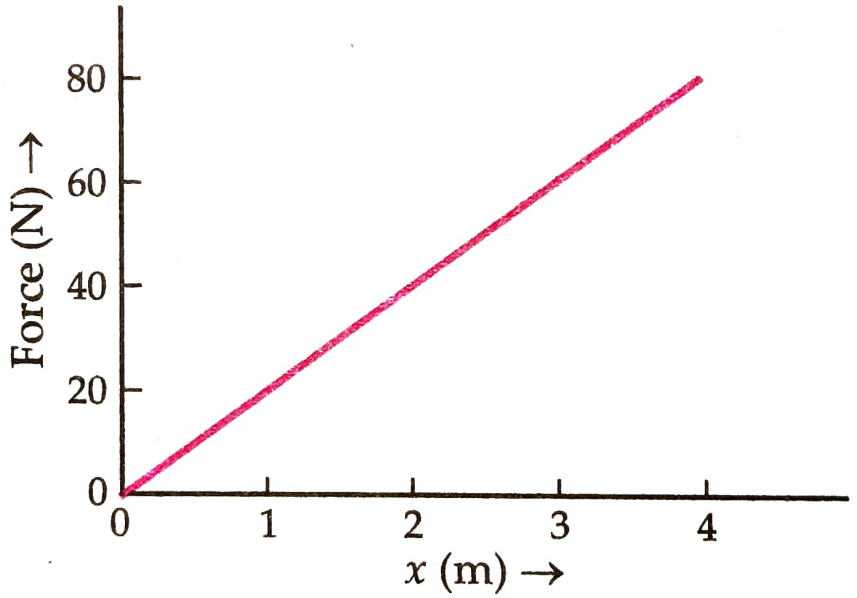
4. The relation between the displacement x and the time t for a body of mass 2 kg moving under the action of a force is given by $x = t^3 / 3$, where x is in metre and t in second, calculate the work done by the body in first 2 seconds. (Ans. 16 J)

5. Fig. 6.11 shows the F-x graph. Here the force F is in newton and distance x in metre. What is the work done ? (Ans. 10 J)



ig. 6.11

6. Calculate work done in moving the object from $x = 2$ m to $x = 3$ m from the following graph :



ig. 6.12

Problems For Practice

1. The momentum of a body of mass 5 kg is 500 kg ms^{-1}. Find its K.E. (Ans. 2.5×10^4 J)

2. A bullet of mass 20 g is found to pass two points 30 m apart in a time interval of 4 s. Calculate the kinetic energy of the bullet if it moves with constant speed. (Ans. 0.5625 J)

3. A body of mass 2 kg is resting on a rough horizontal surface. A force of 20 N is now applied to it for 10 s, parallel to the surface. If the coefficient of kinetic friction between the surfaces in contact is 0.2, calculate : (*a*) Work done by the applied force in 10 s. (*b*) Change in kinetic energy of the object in 10 s. Take $g = 10\ ms^{-2}$. **[Delhi 04]** (Ans. 8000 J, 6400 J)

4. An electron and a proton are detected in a cosmic ray experiment, the electron with K.E. of 5 keV and the proton with K.E. of 50 keV. Find the ratio of their speeds. Given $m_e = 9.11 \times 10^{-31}$ kg and $m_p = 1.67 \times 10^{-27}$ kg. $\left(\text{Ans. } \frac{v_e}{v_p} = 4.28\right)$

5. A neutron of mass 1.67×10^{-27} kg is moving with a speed of 7×10^5 ms^{-1}. Calculate (*i*) its kinetic energy and (*ii*) the average force it will exert in entering a body to a depth of 0.01 cm.

[Ans. (*i*) 40.915×10^{-17} J (*ii*) 40.915×10^{-13} N]

6. A body of mass 1 kg is allowed to fall freely under gravity. Find the momentum and kinetic energy of the body 5 seconds after it starts falling. Take $g = 10\ ms^{-2}$. (Ans. 50 kg ms^{-1}, 1250 J)

7. Two bodies of masses 1 g and 16 g are moving with equal kinetic energies. Find the ratio of the magnitudes of their linear momenta. (Ans. 1 : 4)

8. If the momentum of a body is increased by 50%, then what will be the percentage increase in the kinetic energy of the body ? **[Central Schools 10]**

(Ans. 125%)

9. The kinetic energy of a body decreases by 19%. What is the percentage decrease in its linear momentum ? (Ans. 10%)

10. A running man has half the kinetic energy that a boy of half his mass has. The man speeds up by 1.0 ms^{-1} and then has the same energy as the boy. What were the original speeds of the man and the boy ? (Ans. 2.414 ms^{-1}, 4.828 ms^{-1})

11. While catching a cricket ball of mass 200 g moving with a velocity of 20 ms^{-1}, the player draws his hands backwards through 20 cm. Find the work done in catching the ball and the average force exerted by the ball on the hand. (Ans. 40 J, 200 N)

1. A stone of mass 0.4 kg is thrown vertically up with a speed of 9.8 ms^{-1}. Find the potential and kinetic energies after half second. (Ans. 14.386 J, 4.802 J)

2. A ball is thrown vertically up with a velocity of 20 ms^{-1}. At what height, will its K.E. be half its original value ? (Ans. 10.20 m)

3. 230 joules were spent in lifting a 10 kg weight to a height of 2 m. Calculate the acceleration with which it was raised. Take $g = 10\ ms^{-2}$. (Ans. 1.5 ms^{-2})

4. Calculate the work done in lifting a 300 N weight to a height of 10 m with an acceleration 0.5 ms^{-2}. Take $g = 10\ ms^{-2}$. (Ans. 3150 J)

5. A bullet of mass 10 g travels horizontally with speed of 100 ms^{-1} and is absorbed by a wooden block of mass 990 g suspended by a string. Find the vertical height through which the block rises. Take$g = 10\ ms^{-2}$. (Ans. 5 cm)

6. A simple pendulum of length 1 m has a wooden bob of mass 1 kg. It is struck by a bullet of mass 10^{-2} kg moving with a speed of 2×10^2 ms^{-1}. The bullet gets embedded into the bob. Obtain the height to which the bob rises before swinging back.

Take $g = 10\ ms^{-2}$ **[Chandigarh 04]** (Ans. 0.2 m)

7. A 3.0 kg block, as shown in Fig. 6.25, has a speed of $2\ ms^{-1}$ at A and $6\ ms^{-1}$ at B. If the distance from A to B along the curve is 12 m, how large a frictional force acts on it ? Assuming the same friction, how far from B will it stop ? (Ans. 3.35 N, 24.5 m)

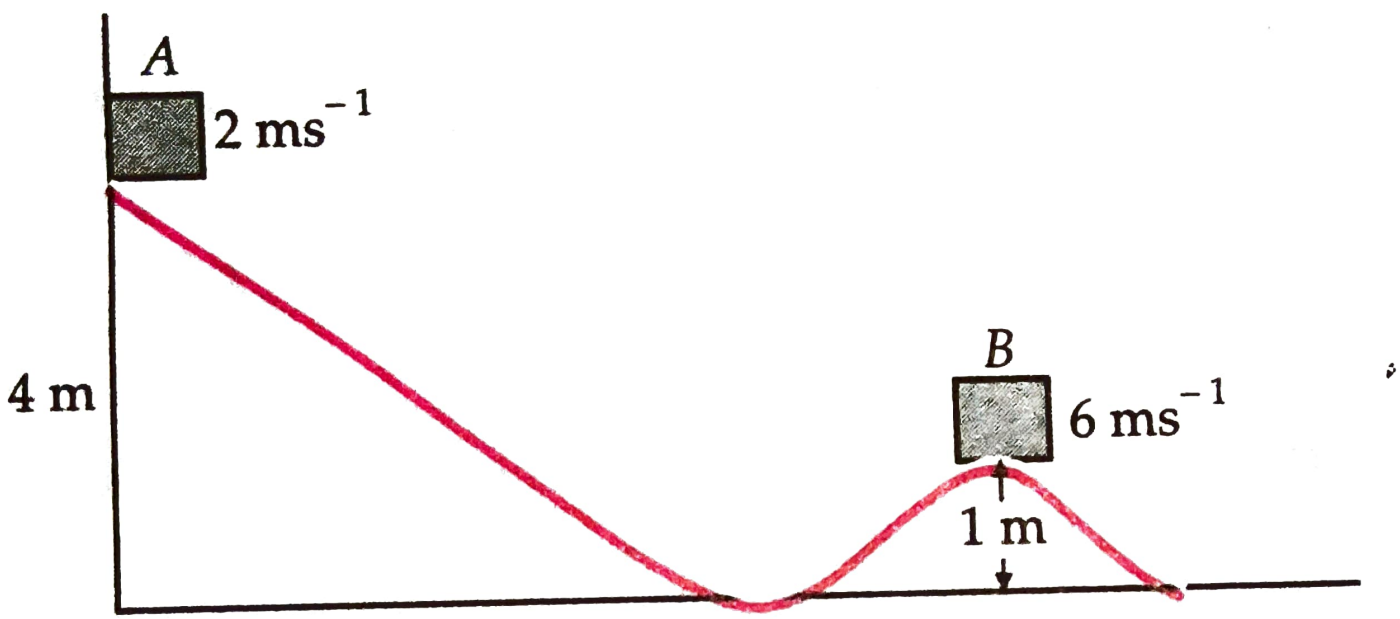


Fig. 6.25

1. A spring gun has a spring constant of 18 N cm^{-1}. The spring is compressed 12 cm by a ball of mass 15 g. How much is the potential energy of the spring ? If the trigger is pulled, what will the velocity of the ball be ? (Ans. 57.6 J, 87.6 ms^{-1})

2. A solid of mass 2 kg moving with a velocity of 10 ms^{-1} strikes an ideal weightless spring and produces a compression of 25 cm in it. Calculate the force constant of the spring. (Ans. 3200 Nm^{-1})

3. A 16 kg block moving on a frictionless horizontal surface with a velocity of 5 ms^{-1} compresses an ideal spring and comes to rest. If the force constant of the spring be 100 Nm^{-1}, then how much is the spring compressed ? (Ans. 2.0 m)

4. A block of mass 2 kg is dropped from a height of 40 cm on a spring whose force-constant is 1960 Nm^{-1}. What will be the maximum distance x through which the spring is compressed ? (Ans. 10 cm)

5. A block of mass m, initially at rest, is dropped from a height h onto a spring whose force constant is k. Find the maximum distance x through which the spring will be compressed.

$$\left[\text{Ans. } x = \frac{1}{2}\left(\frac{2mg}{k} \pm \sqrt{\left(\frac{2mg}{k}\right)^2 + \frac{8mgh}{k}}\right)\right]$$

6. An object is attached to a vertical spring and slowly lowered to its equilibrium position. This stretches the spring by a distance d. If the same object is attached to the same vertical spring but permitted to fall freely, through what distance does it stretch the spring ? (Ans. 2 d)

7. A massless platform is kept on a light elastic spring. When a sand particle of mass 0.1 kg is dropped on the pan from a height of 0.24 m, the particle strikes the pan, and the spring compresses by 0.01 m. From what height should the particle be dropped to cause a compression of 0.04 m ? (Ans. 3.96 m)

1. About 4×10^9 kg of matter is converted into energy in the sun each second. What is the power output of the sun ?

(Ans. 3.6×10^{27} W)

2. Show that energy equivalent to atomic mass unit equals nearly 933 MeV of energy. Given 1 atomic mass unit = 1.66×10^{-27} kg.

3. 500 kg of water is heated from 20° to 100°C. Calculate the increase in the mass of water. Given specific heat of water = 4.2×10^3 J kg^{-1} $°C^{-1}$.

(Ans. 1.87×10^{-9} kg)

4. 1 mg of uranium is completely destroyed in an atomic bomb. How much energy is liberated ?

[Himachal 03] (Ans. 9×10^{10} J)

5. An electron-positron pair annihilates at rest to produce γ-rays. Calculate the energy produced in MeV if the rest mass of electron is 9.1×10^{-31} kg.

(Ans. 1.02 MeV)

6. If 10 g of mass is completely converted into energy, then find the corresponding energy produced.

[Central Schools 14] (Ans. 9×10^{14} J)

4. An engine of 4.9 kW power is used to pump water from a well 50 m deep. Calculate the quantity of water in kilolitres which it can pump out in one hour. (Ans. 36.0 kilo litre)

5. Water is pumped out of a well 10 m deep by means of a pump rated at 10 kW. Find the efficiency of the motor if 4200 kg of water is pumped out every minute. Take $g = 10\ ms^{-2}$. (Ans. 70%)

6. A 30 m deep well is having water upto 15 m. An engine evacuates it in one hour. Calculate the power of the engine if the diameter of the well is 4 m. (Ans. 11.55 kW)

7. The human heart forces 4000 cm^3 of blood per minute through the arteries under pressure of 130 mm. The density of blood is 1.03 g cm^{-3}. What is the horse power of the heart ?

(Ans. 1.17×10^{-4} hp)

8. A car of mass 1000 kg accelerates uniformly from rest to a velocity of 54 kh h^{-1} in 5 seconds. Calculate (*i*) its acceleration (*ii*) its gain in K.E. (*iii*) average power of the engine during this period, neglect friction. **[Chandigarh 03]**

[Ans. (*i*) 3 ms^{-2} (*ii*) 1.125×10^5 J (*iii*) 22500 W]

1. A vehicle of mass 30 quintals moving with a speed of 18 km h^{-1} collides with another vehicle of mass 90 quintals moving with a speed of 14.4 km h^{-1} in the opposite direction. What will be the velocity of each after the collision ?

(Ans. 30.6 km h^{-1}, 1.8 km h^{-1})

2. A ball of 0.1 kg makes an elastic head on collision with a ball of unknown mass that is initially at rest. If the 0.1 kg ball rebounds at one-third of its original speed, what is the mass of the other ball ?

(Ans. 0.2 kg)

3. A body of mass m strikes a stationary body of mass M and undergoes an elastic collision. After collision m has a speed one-third of its initial speed. What is the ratio M/m ? (Ans. 1 : 2)

4. Two particles of masses 0.5 kg and 0.25 kg moving with velocities 4.0 ms^{-1} and – 3.0 ms^{-1} collide head on in a perfectly inelastic collision. Find (*i*) the velocity of the composite particle after the collision and (*ii*) the kinetic energy lost in the collision.

[Ans. (*i*) 1.7 ms^{-1} (*ii*) 4.1 J]

5. What percentage of the K.E. of a moving particle is transferred to a stationary particle when it strikes the stationary particle of four times its mass ?

(Ans. 64%)

6. A neutron moving with a speed of 10^6 ms^{-1} suffers a head-on collision with a nucleus of mass number 80. What is the fraction of energy retained by the nucleus ? (Ans. 79/81)

7. What percentage of kinetic energy of a moving particle is transferred to a stationary particle, when moving particle strikes with a stationary particle of mass (*i*) 19 times its mass (*ii*) equal in mass and (*iii*) 1/9th of its mass ? [Ans. (*i*) 19% (*ii*) 100% (*ii*) 36%]

8. Show that when a moving body collides with stationary body of mass m or $1/m$ times its mass, then the moving body transfers $\frac{4m}{(1+m)^2}$ part of its kinetic energy to the stationary body.

9. A ball is dropped from a height of 3 m. What is the height upto which the ball will rebound ? The coefficient of restitution is 0.5. (Ans. 0.75 m)

10. A ball is dropped from a height h on to a floor. If the coefficient of restitution is e, calculate the height to which the ball first rebounds ? (Ans. $h\,e^2$)