Chapter 12

Work and Energy

In the earlier chapters we have discussed about some main concepts of science like-motion of an object, motion due to force, laws of motion and gravitation. Work and energy are also important concepts of science which let us to understand several natural phenomenon and also helps us to describe them. In this chapter we will study about them.

In our daily life we use the words 'work' and 'energy' in several contexts. For example, he works in the fields, he is very energetic etc. Energy is needed to perform any kind of work. Humans and machines also use energy to do work. For example- a student uses energy to ride a bicycle from his house to his school. In the same way, electric bulb uses energy to produce light.

Think

- Where does the consumed energy go?
- Can we do a work without consuming energy?

We will try to understand such questions in this chapter.

12.1 Work

Generally any kind of useful physical or mental hardwork in our daily life is considered as work. For example- A student spends a lot of time in studying during exams. He reads books, solves question papers, discusses with classmates etc. In common language, he does a lot of hard work. Similarly singing a song, talking with friends, playing in school, having discussions etc, all are considered as work.

Fig. 1 : Thinking is not physical work

But the definition of work in terms of science is different.

In science, to do work, following two conditions are necessary

- a force must be applied on the object.
- The object must be displaced or its position must change.

Physical work takes place only when some displacement occurs in the presence of applied force. So all other types of work are not physical work. Similarly saying that a person is energetic, is a totally different concept from energies like electrical energy, heat energy or kinetic energy. In this chapter we will only study about physical work and physical energy.

Examples of physical work

Pick up a book. For this you need to apply some force and the position of the book gets changed. Therefore in the language of science, it can be called as work. The force applied to pick up the book acts against the gravitational force and thats why the motion of the book changes.

Now lets think about such daily life examples which are called as work in our common language. During exams, a student works very hard. But according to the scientific definition of work, here the condition of application of force and displacement are not fulfilled. Hence this hard work done by a student will not be considered as work done in terms of science.

Fig. 2

Similarly, singing a song, discussions etc. will also be not considered as work in terms of science. For example if you hold up a chair for 10 minutes, are you doing any work? From your tiredness you might say that you have worked a lot. But according to the definition of physical work you have not done any work on the chair while you keep holding it at one position. Offcourse you applied some force to keep the chair lifted up, but here did not occur any displacement in the position of that chair. And since no displacement of the chair took place so the force applied by you did not do any work on the chair.

When you picked up the chair, the position of chair did change, and so some physical work did take place at that time. But after that, no physical work took place to hold the chair in its position.

Following are some situations. In which of these work is taking place and in which it is not? Also state your reasons.

Fig. 3

Fig. 4

1. You pushed a very large stone, but it did not move.
2. You reached the second floor of a building by climbing stairs.
3. A traveller pulls his luggage to some distance on a platform.
4. Stopping a moving bicycle.

Activity-1

- You can see some chairs, tables, benches etc in your classroom. Pick up all these one by one, and raise them to a certain height. To raise which one of these you had to do the most work and why?

Work done by a constant force

If we know the amount of force applied and the displacement, we can calculate the work done.

Suppose that on applying a constant force F on a body it moves from its inital point to a distance S, as shown in the fig. 5.

According to the scientific definition of work, the magnitude of work is the product of applied force and the displacement of object in the direction of applied force.

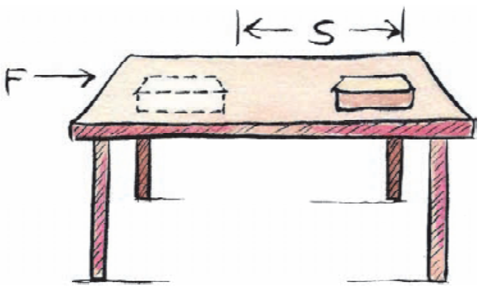


Fig. 5

So, work done = force × displacement of object in the direction of force.

$W = FS$

Therefore work done is a scalar quantity.

We know that the SI unit of force is Newton (N) and that of displacement is metre (m). So, the unit of work done will be Newton × metre (Nm). It is also known as Joules (J).

If we put F = 1 Newton (N) and S = 1 metre (m)

in the equation $W = FS$

F = 1 Newton (N)

S = 1 metre (m)

$W = FS$

$W = 1N \times 1m$

= 1 Nm (Newton-metre)

or 1 Joule (J)

Hence, 1 joule is that quantity of work which is done when 1 Newton force is applied and 1 m displacement takes place in the direction of force.

Example 1 : A girl applies a force of 4.5 N on a book kept on a table. The book moves 30 cm in the direction of applied force. Calculate the work done on the book by the applied force.

Solution : Force applied on the book $F = 4.5\ N$

displacement in the direction of force $S = 30\ cm.$

$$S = \frac{30}{100}\ m$$

$$S = 0.3\ m$$

Work done $W = F \times S$

$$W = 4.5\ N \times 0.3\ m$$

$$W = 1.35\ J$$

Example 2 : A person picks up an object of mass 20 kg. to a height of 3 m. Calculate the work done by him on that object. ($g = 9.8\ m/sec^2$)

Solution : mass of object $m = 20\ kg.$

displacement $S = 3\ m.$

force $F = mg$

$$= 20kg \times 9.8\ m/sec^2$$

$$= 196\ N$$

Work done $W = F \times S$

$$= 196N \times 3\ m$$

$$= 588\ J$$

- A box filled with books is placed near a wall. even after several efforts by you the box does not move. (according to fig. 6). Calculate the work done according to the equation $W = FS$.
- Think about several other such situations where there is no displacement on application of force.
- Can you think of such a situation as well where there is displacement in the absence of any force? Discuss with your teachers.

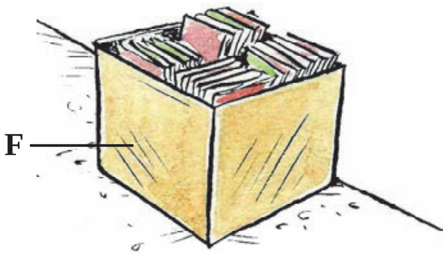


Fig. 6

Think about one another situation-

Suppose that you apply a force F on an object and it moves a distance S before it stops.

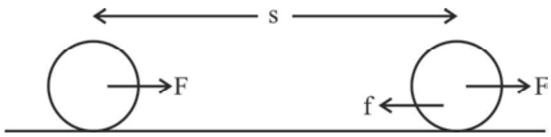


Fig. 7

1. When you exert a force (F) on the object, it displaces in the direction of force. Here the work done by the force is positive. Hence, W= FS.
2. A force of friction (f) acts on the object in a direction opposite to the direction of its motion. Due to this, the objects stops after a distance S. In this situation, the work done by frictional force on that object is negative. Here, the angle between both of them is 180°.

   Hence, W = –fS

Therefore, if the force applied and displacement are in same direction, the work done is positive while if the displacement is in opposite direction to the applied force, the work done is negative.

Example 3 : On rolling a spherical object, it displaces to a distance of 4 m. A frictional force of 15 Newton acts on it. Calculate the work done by the frictional force.

Solution : Frictional force applied on the object $f = 15$ N

Displacement of object $S = 4$ m

Since the direction of frictional force is opposite to the direction of displacement, therefore work done by the frictional force-

$$W = -(f \times S)$$

$$W = -(15 \times 4) \text{ Nm}$$

$$W = -60 \text{ J}$$

Example 4 : A woman of 60 kg. climbs 20 stairs to reach the first floor of a building. The height of each stair is 23 cm. Calculate the work done by the gravitational force on the woman.

Solution : mass of the woman = 60 kg.

gravitational force acting on her = 60 kg. × 9.8 Nm/s^2

height of each stair = $\frac{23}{100}$ m

Total height of 20 stairs $\quad h = 20 \times \frac{23}{100}$ m

Work done by gravitational force $\quad W = -mgh$

$$= -60 \times 9.8 \times 20 \times \frac{23}{100}$$

$$= -2704.8 \text{ Nm}$$

$$= -2.70 \text{ KJ}$$

Activity-2

Throw a ball upwards. For this, you will need to apply some force. A force of gravitation continuously acts on a ball moving upwards, and this force is opposite to the direction of motion. Think and tell-

1. Which force acting on the ball does positive work?
2. Which force on the ball does negative work?
3. Support your answer with reasons.

1. A student picks up an object of mass 'm' in vertical direction to a height h and moves a distance 'd' horizontally (as shown in fig. 8).

How much work will be done by the student in the given situation.

Come, lets try to understand this-

Work done by the student in picking the object of mass m to a height h

w = mgh ....(i) (here the directions of force and displacement are same)

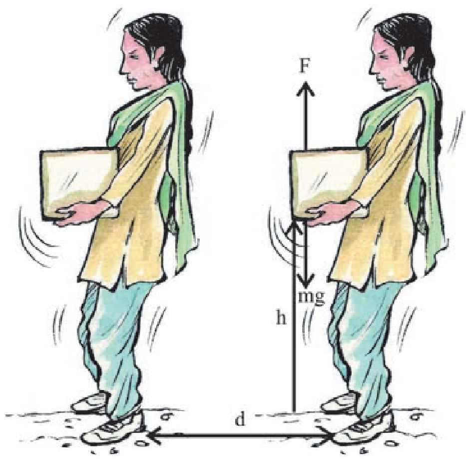


Fig. 8 : Student picks up an object

When the student walks in horizontal direction while holding the box, and his motion is uniform, then, the acceleration of box is zero. So the force acting on the box in this direction will be zero and work done on the box will be W = 0 .... (ii)

12.2 Energy

You must have seen that working of electric bulb, tubelight, television, electric fans etc. requires electricity. To run a train, bus, car, motorbike etc. we need to use petrol, diesel etc. Have you ever thought-

- Why do electrical equipments stop working when the flow of electricity stops.
- Why do vehicles not move without petrol, diesel etc.
- Why can't plants cook their food in the absence of sunlight.
- What is the relationship between energy and work?

You have read about 'energy' in your previous classes. We find energy in several forms-like electrical energy, light energy, sound energy, mechanical energy, chemical energy, nuclear energy etc. Electrical equipments gain energy from electricity. Similarly vehicles gain energy from petrol and diesel. Plants get energy from the light coming from the sun and so make their food.

In this chapter, we will study only about mechanical energy. Mechanical energy are of two types.

(i) Kinetic energy (ii) Potential energy

12.2.1 Kinetic energy

Activity-3

1. Take a heavy ball of metal.
2. Drop it from a height of 20 cm. on a tray filled with wet sand.
3. Measure the depth of the pit formed in the sand.
4. Now repeat this activity by dropping the ball from a height of 40 cm and 100 cm one by one.
5. Measure the depth of the pit formed in each case.

Fig. 9

Try answering the following questions based on this activity-

1. The ball forms a pit in the sand due to which reason?
2. Arrange your observations based on the depth of the pit formed by dropping the ball from different heights. Does the depth of pit increase on increasing the height from which ball is dropped?
3. On dropping the ball from which height is the pit formed deepest?

The energy of an object due to its motion is called kinetic energy. The kinetic energy of an object changes with its speed. An object moving at higher speed has more kinetic energy than the object of same mass moving at a lower speed. For this reason when a ball moving at a high speed strikes the wickets, the wickets are thrown away at a distance Whereas a ball coming slowly does not throw away the wickets.

Mathematical representation of kinetic energy

The kinetic energy of any object at rest is zero. Therefore kinetic energy of a moving object is due to its motion. We can see that the kinetic energy of a moving object is equal to the work done on the object to achieve its velocity.

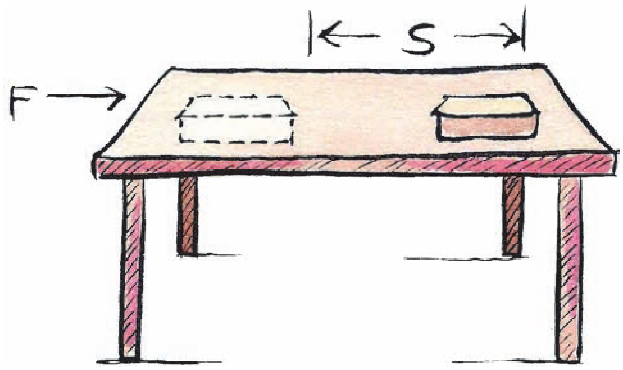


Fig. 10 : A moving object

Kinetic energy and work done

An object of mass 'm' is placed at a horizontal surface. On applying a constant force 'F', the object displaces a distance 'S'. Then, the work done on the object is

W = FS .... (i)

Let the acceleration created on the body be 'a' due so the applied force. We have studied the equations of motion in our previous lesson. Following is a relation between the constant acceleration 'a' of a moving object when its initial velocity is 'u', final velocity is 'v' and displacement is 's'.

$v^2 - u^2 = 2as$ .... (ii)

$$s = \frac{v^2 - u^2}{2a}$$ .... (iii)

We know from the second law of motion,

F = ma .... (iv)

Putting the value of S and F from eq. (iii) and (iv) into eq. (i),

We can write the work done as :-

$$w = ma \times \frac{v^2 - u^2}{2a}$$

$$w = \frac{1}{2}m\left(v^2 - u^2\right)$$

If the body starts from rest then u = 0,

So, $w = \frac{1}{2}mv^2$

Suppose the work done is equivalent to the change in kinetic energy. If the object starts from rest then the work done is equal to the kinetic energy.

We can say that the kinetic energy of a body of mass 'm' moving at a velocity 'v' is-

$$E_k = \frac{1}{2}mv^2$$

SI unit of energy is Joules.

Discuss

1. Can the kinetic energy of an object be negative?
2. Which of the two is easier to stop; a truck loaded with more goods or a truck loaded with lesser goods?
3. When will the kinetic energy of a car change more: When the velocity of car changer from 10 m/s to 20 m/s or when it changes from 20 m/s to 30 m/s.

Examples 5 : A body of mass 20 kg. is at a constant motion with a velocity of 5 m/s. What will be its kinetic energy?

Solution : mass of object = 20 kg.

Velocity of object = 5 m/s

Kinetic energy $= \frac{1}{2}mv^2$

$= \frac{1}{2} \times 20 \times 5^2$

= 250 J

So the kinetic energy of object is 250 J.

Example 6 : If the mass of car is 200 kg. then how much work will be done to increase its velocity from 36 km/h to 72 km/h.

Solution : mass of car m = 200 kg.

initial velocity of car u = 40 km/hr.

(convert all the values in SI units)

$$u = \frac{(36 \times 1000)\,m}{(60 \times 60)\,s}$$

$$u = \frac{360}{36} = 10 \text{ m/sec}$$

similarly, final velocity of car

$$v = \frac{(72 \times 1000)\,m}{(60 \times 60)\,s}$$

$$v = \frac{720}{36} \text{ m/sec}$$

$$= 20 \text{ m/s}$$

initial kinetic energy of car

$$E_{k1} = \frac{1}{2}mu^2$$

$$= \frac{1}{2} \times 200 \times (10)^2$$

$$= \frac{1}{2} \times 200 \times 100$$

$$= 10000 \text{ J}$$

final kinetic energy of car

$$E_{k2} = \frac{1}{2}mv^2$$

$$E_{k2} = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 200 \times (20)^2$$

$$= \frac{1}{2} \times 200 \times 400$$

$$= 40000 \text{ J}$$

So, the work done = change in kinetic energy

$$= E_{k2} - E_{k1}$$

$$= 40000 - 10000$$

$$= 30000 \text{ J}$$

$$= 30 \text{ KJ}$$

Discuss

1. What do you mean by kinetic energy of an object?

2. The kinetic energy of a body of mass 'm' moving at a velocity 'v' is $\frac{1}{2}mv^2$. If its velocity is doubled, then how much will be its kinetic energy?

3. If the velocity and mass of an object is twice the velocity and mass of another object, then how much will be the ratio of their kinetic energies?

12.2.2 Potential energy

Activity-4

1. Take a toy car.
2. Rotate its key for once or twice.
3. Now place it on the floor,
   - Does it start moving? If yes then why?
   - What happens if we rotate the key 4-5 times?

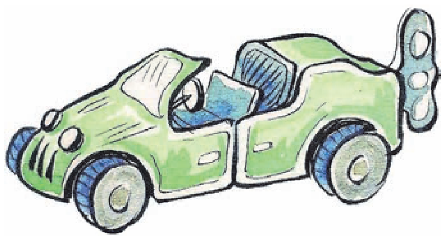
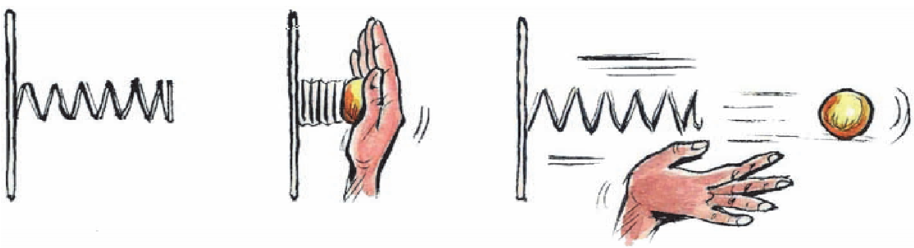


Fig. 11

According to the figure shown, when we place a ball on a spring attached to a wall horizontally (Fig. 12 a) and press the spring, it contracts (Fig. 12 b). Now when you remove your hand from the spring, the ball is thrown off (Fig. 12 c).



(a) (b) (c)

Fig. 12

Fig. 13

Something similar happens in a spring balance. on attaching a weight, the spring is pulled and on leaving it, it gets back to original shape.

See fig. 13. On pulling a catapull, the rubber of the catapult also gets back to a no pull position just like a pressed spring. For this it throws a stone to a very far off distance.

A body stores energy due to work done. This stored energy is called potential energy of the object. Therefore, the energy stored in an object due to its position is called its potential energy. This energy converts into other forms of energy and enables the body to do its work. When you press a ball against a spring, you are bringing a change in the position of the spring. This energy gets stored in the spring, in the form of potential energy. This gets converted into kinetic energy and allows the spring to throw away the ball.

- Can you explain the process of throwing a stone using a catapult?

Gravitational potential energy

When we place an object above the surface of earth, then the potential energy of that object increases. To raise the object upwards, work is done against the gravitational force of earth. The work done to raise the object to a certain height is stored as its potential energy. The energy stored due to work done against gravitational force is called as gravitational potential energy.

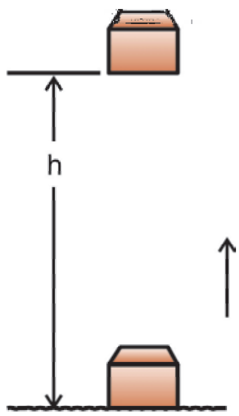


Fig. 14

If some force is needed so raise an object of mass m upwards, the minimum required force will be equal to the weight mg of the object. The energy stored in the object increases according to the work done in raising it. Suppose that the work done against gravitational force to raise the object to a height h is 'w'.

Then, work done $w = \text{Force} \times \text{displacement}$

$= mgh$

Since the work done on the object is mgh, so the potential energy of the object is also mgh. We will call this potential energy E_p.

$$E_p = mgh$$

Example 7 : A body of mass 50 kg. is raised to a height of 8 m. above the earth's surface. Calculate the energy stored in this object. Here $g = 9.8\ m/s^2$

Solution : mass of an object $m = 50$ kg.

Height of displacement $h = 8$ m

gravitational acceleration $g = 9.8\ m/s^2$

equation : potential energy $E_p = mgh$

$= 50 \times 9.8 \times 8$

$= 3920$ Joules

So, the potential energy is 3920 Joules.

Also know this

Potential energy of an object depends on the earth's surface or the zero-level chosen by you. The potential energy of an object w.r.t. one surface will be different than the potential energy of the same object w.r.t. some other surface.

Example 8 : A body of mass 5 kg. is placed at a certain height from the surface of earth. If the potential energy of the body is 400 J, then find out the height of the body w.r.t. earth $g = 9.8\ m/s^2$.

Solution : mass of object $m = 5kg$

height of displacement $h = ?$

Potential energy of object $= mgh = 400\ J$

gravitational acceleration $g = 9.8\ m/s^2$

potential energy of object $E_p = mgh = 400\ J$

$$5 \times 9.8 \times h = 400$$

$$h = \frac{400}{49}$$

$$h = 8.16\ m$$

Object is placed at a height of 8.16 m.

Question

1. Find out the potential energy of a book placed at there positions A, B and C as shown in the fig. 15.

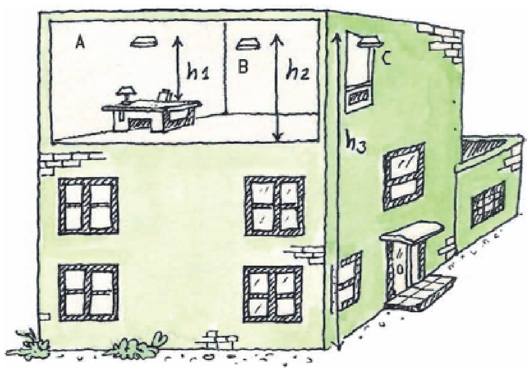
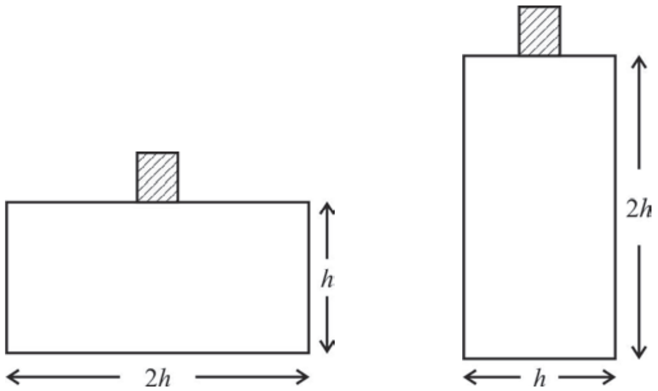


Fig. 15

2. A cuboidal box is shown in the figure 16. Its width and height are 2 h and h respectively. What will be the potential energy of an object of mass m placed on the box in the following two situations?



(a) (b)

Fig. 16

Disscus

1. In the process of using a bow and arrow, why do we have to pull the arrow backwards by using a thread or rubber?
2. Can the gravitational potential energy of an object be negative?

12.3 Law of conservation of mechanical energy

Suppose an object of mass m is made to fall fully from a height of h. Initial potential energy of the object is mgh and kinetic energy is zero as its initial velocity is zero.

In this way, the total energy of the object is mgh.

When this body falls, its potential energy changes into kinetic energy. If the velocity of an object at a given time is v, then kinetic energy will be $\frac{1}{2}mv^2$. As the object starts falling, its potential energy drops down and kinetic energy increases. When the object is about to reach the earth's surface its final velocity is v and this is its maximum velocity. So, now the kinetic energy is maximum and potential energy becomes minimum. We know that the sum of kinetic energy and the potential energy on all points is same. That means,

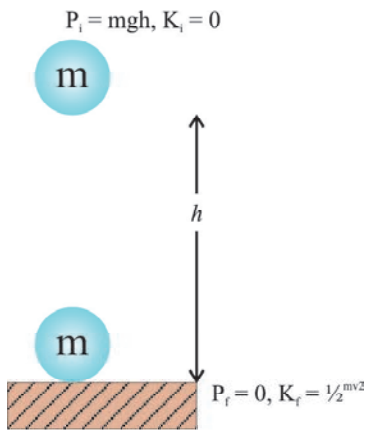


Fig. 16

potential energy + kinetic energy = constant or, $mgh + \frac{1}{2}mv^2 = \text{constant}$

The sum of kinetic energy and potential energy of an object is its mechanical energy. We can see that in a freely falling body, the decrease in potential energy at a point is equivalent to the increase in kinetic energy of that object.

Through several such examples, observations and arguments we can state that energy can neither be created nor destroyed. It can only be converted from one form to another. Thus, the total energy of universe remains constant. This is the law of conservation of energy.

Come, lets try to understand it through an activity.

Activity-5

A body of 30 kg. falls freely from a height of 5 m. Calculate the value of potential energy and kinetic energy at all the points and fill the following table.

$g = 9.8\ m/s^2$

(Calculate velocity at different heights using the equations of motion.)

Height of body (metre)	**Velocity of body (at different heights)**	**Potential energy $E_p = mgh$**	**Kinetic energy $E_k = \frac{1}{2}mv^2$**	**Total energy $E_p + E_k$**
5	0			
4	2			
3	4			
2	5			

If we see the results of above activity, we see that the total mechanical energy of the body remains constant in all the situations.

Discuss

What would have happened if the conversion of energy was impossible? According to one belief, life on earth could have been impossible without energy conversion. What do you think? Do you agree with this?

Do in a group

A person of mass m jumps in a swimming pool from a height of 10 m. (fig.18) Using the law of conservation of mechanical energy, calculate the velocity of the man when he is at a height of 5 m. from the surface of water.

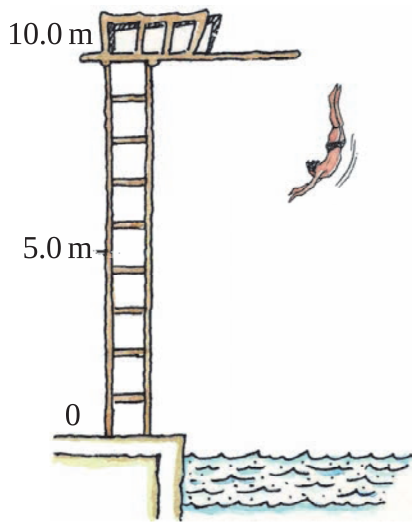


Fig. 18

12.4 Power

The water tank at Ramesh's and Rakhi's house are of same shape and height. Both of them make use of electric motor to fill water in their tanks. The tank at Rakhi's house fills quicklier than Ramesh's tank. What could be the reason behind this?

Sometimes we see that it takes more time to grind pulses in the grinder at our house, as compared to our neighbour's grinder. Why is it so?

Is the total work done in both the cases different? Or are the abilities of both the grinders to grind is different?

It is possible that different machines take different amount of time to do some work. This means that their rate of doing work is different. This rate of doing work is called power. We talk about the power of machines like motorbike, motorcar, electric pump, electric bulbs, tube light, electric saw, fodder cutter, tractors etc. Their power show that how quickly they convert their energies and do work.

The rate of doing work or rate of energy conversion is called power. We will write it in mathematical form as follows.

Power = work/time

P = w/t

The unit of power is watt (w). If a person does 1 Jouls work in 1 second then the rate of energy consumption is 1 J/s and power is 1 watt. So, 1 watt = 1 J/s

Or 1 watt = 1 J/s

If the power is large, we measure it in kilowatts.

1 kilowatt = 1000 watt

1 kw = 1000 watt or 1000 J/s

If we want to find out how much energy is consumed by a machine then we will have to see what is its power and for how long is it working.

Energy consumed $p = w/t$

i.e., $w = p \times t$

If p = 1 kw and t = 1 h then energy consumed is 1 kwh.

That means 1 kwh (kilowatt hour) is that quantity of energy which is consumed to use a source of 1 kw for 1 hour. The energy consumed in houses, workshops, industries etc. is generally expressed in kilowatt hour (kwh). For example, the electric energy consumed in one month is expressed in units. Here, 1 unit means 1 kwh.

1 kwh = 1 kw × 1 h = 1000 w × 3600 sec.

= 3600000 J

$= 3.6 \times 10^6$ J

Example 9 : A woman completes a work of 300 J in 5 sec. How much energy did she spend?

Solution : Work done by woman 300 J

Time taken to do work 5 sec.

Therefore, power spent by woman p = w/t

= 300/5

= 60 W

Example 10 : A boy of 50 kg. mass climbs 30 stairs in 10 sec. If the height of each stair is 15 cm. Then calculate his power. $g = 10\ m/s^2$

Solution : mass of boy = 50 kg

mg = 50 × 50 × 10

$= 500\ kg.\ m/s^2$

Total height of 30 stairs

h = (30 × 15)/100

= 4.50 m

Time taken to climb stairs = 10s

$$\text{Power} \quad p = \text{work done/time}$$
$$= mgh / t$$
$$p = (500 \times 4.50) / 10$$
$$= 225 \text{ W}$$

Power is 225 W.

Question

- What do you mean by power?
- Define 1 watt power.
- If a bulb consumes 990 Joules electric energy in 10 sec, how much will be its power?

Example 11 : A bulb of 60 watt is used daily for 10 hours. Calculate the units of energy used by bulb in a day.

Solution : Power of electric bulb = 60 watt 0.06 kW

Usage time = 10 hours

Thus, energy spent by bulb = power × time of usage

= 0.06 kw × 10h

= 0.60 kWh

= 0.60 units

So, bulb will consume 0.60 units of energy daily.

Activity-6

- Observe carefully the electric meter used in the electric circuits at your home. Note the reading on your metre everyday at 7 a.m.
- How many units are consumed each day?
- Tabulate your observations each day for a month.
- Compare your observations with your monthly bill.

What we have learnt

1. Work done on an object is equal to the product of measure of the force applied on it and the displacement caused in the direction of applied force. Unit of work done is Joule (J).
2. If the direction of applied force and the direction of displacement are same, then the work done will be positive and if the direction of applied force and direction of displacement are opposite, then the work done will be negative.
3. Energy gives the object, the ability to do work. Unit of energy is Joule (J).
4. The energy contained in an object due to its motion, is called kinetic energy. The kinetic energy of an object of mass m, moving with a velocity v will be $\frac{1}{2}mv^2$
5. The energy contained in an object due to the change in its shape or position is called its potential energy. The potential energy of an object of mass m, raised to a height h is called gravitational potential energy 'mgh'.
6. According to the law of conservation of energy, energy can neither be created nor it can be destroyed. It can only be converted from one form to another. The total energy before the conversion and after the conversion remains constant.
7. The rate of doing work or the rate of energy conversion is called power. The SI unit of power is watt (w).
8. 1 kwh is that quantity of energy which is spent in using a source of 1 kw for 1 hour.

Keywords

work,energy, kinetic energy, potential energy, energy conservation, power

Exercise

1. Pick an appropriate option

   (i) If an object displaces 2 m in the directin of 10 N applied force, the work done on the object by the force is,

   (a) 15 J (b) 20 J (c) .20 J (d) 5 J

(ii) A body of mass 5 kg. is in a constant motion at 2 m/s. What will be its kinetic energy?

(a) 10 Joule (b) 15 Joule (c) 5 Joule (d) 20 Joule

(iii) A body of 12 kg. mass is placed at a certain height from the surface of earth. If its potential energy is 480 J, then what will be its height w.r.t. to earth's surface?

(a) 6 meter (b) 9 meter (c) 5 meter (d) 4 meter

(iv) You burn a bulb of 100 w daily for 5 hours. What will be the energy spent in units by the bulb in one day?

(a) 0.4 unit (b) 0.5 unit (c) 0.05 unit (d) 0.01 unit

2. Fill in the blanks-

(i) SI unit of work is ....

(ii) 1 kwh is equivalent to .... joules.

(iii) The total energy of an object remains ....

(iv) If the direction of applied force of an object and its displacement are opposite then its work will be ....

3. What do you understand by kinetic energy? Establish the equation for kinetic energy for an object in motion.

4. The energy consumed at a house is 250 units in one month. How much will it be in Joules?

5. (a) What is energy conservation law? Explain.

(b) The potential energy of a freely falling body drops gradually. Does it contradict the law of energy conservation? Explain with reasons.

6. Explain potential energy and establish its equation.

7. (a) If the velocity of a particle is doubled, what will be its kinetic energy?

(b) If the work done on the particle is zero, then what will be its velocity?

8. On applying brakes of a car which is moving at a speed v, it stops after covering a distance d. Calculate, what will be the distance covered by the car after applying brakes if it was moving at a speed of 2 v.

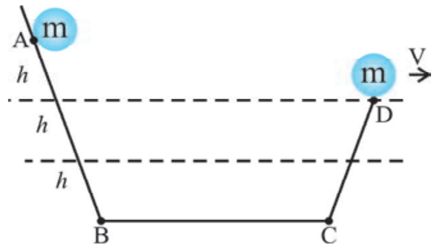
9. A man holds a sack of rice on his head for 30 minutes and gets tired. Has he done any work? Explain your answer with reasons.

10. On applying a force of 8 Newton on a body, it moves in the direction of motion and displaces for 4 m. Calculate the work done.

11. A body of 10 kg. mass is raised against the gravitational force of earth to a height of 10 m. How much work is done in this case?

12. Two body of masses 10 kg. and 15 kg. are raised to a height of 5 m. and 2 m. respectively above the surface of earth. Calculate the change in their potential energies.

13. By using the information given in the figure calculate the velocity of the ball at the position D. (use the law of conservation of mechanical energy).



14. On applying a force of 15 N for 6 sec. a man displaces a box by 8 m. Calculate his power.

15. To change the energy of a body of 0.5 kg. by 1 joule, we will have to raise it to what height? ($g = 10$ m/s^2).