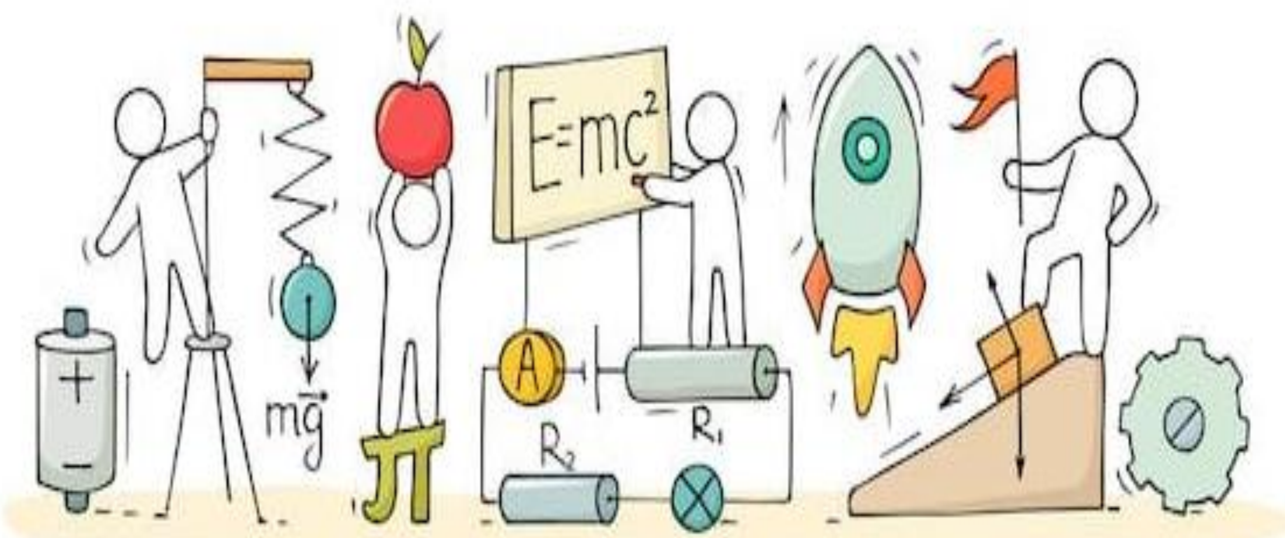
PHYSICS

Chapter 11: Work and Energy



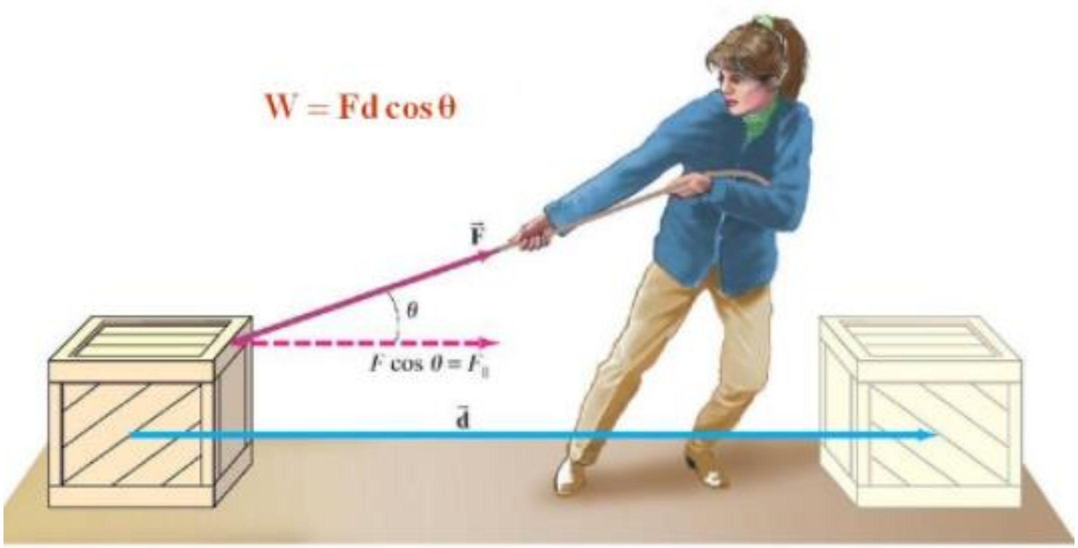
Work and Energy

- In our everyday life we use terms like work and energy.
- Term work is generally used in context to any kind of activity requiring physical or mental effort.
- When we push or pull a heavy load or lift it above the floor then we are doing work, but a man carrying heavy load and standing still is not doing any work according to scientific definition of work.
- Another term we often use is energy. Energy is usually associated with work done in the sense that a person feeling very energetic is capable of doing lot of work.
- This way energy is defined to be as capacity of doing work.
- There are many forms of energy like chemical energy, mechanical energy, electrical energy, heat energy etc. These forms of energies can be used in number of ways.
- One form of energy can be converted into another form of energy.
- In this chapter we will study about work, relation between work and energy, conservation of energy etc.

Work Done

Work done on an object is defined as the product of the magnitude of the force acting on the body and the displacement in the direction of the force. W = F.s

If a force acting on a body causes no displacement, the work done is 0. For example, pushing a wall.



Work: Factors On Which It Depends

We use terms such as overworked and hard workers to describe the effort put by a person. But what is the meaning of work and how do we quantify it? In this article, we will learn the definition of work in terms of physics and the factors on which work depends.

Defining Work

The scientific definition of work is different in many ways from its everyday meaning. The definition of work in physics reveals its relationship to energy – whenever work is done, energy is transferred.

For a work to be done, in a scientific sense, a force must be exerted and there must be displacement in the direction of the force. With this said, we can say that

Work is the product of the component of the force in the direction of the displacement and the magnitude of this displacement.

Mathematically, the above statement is expressed as follows:

$W = (F \cos \theta)\ d = F.\ d$

Where,

W is the work done by the force.

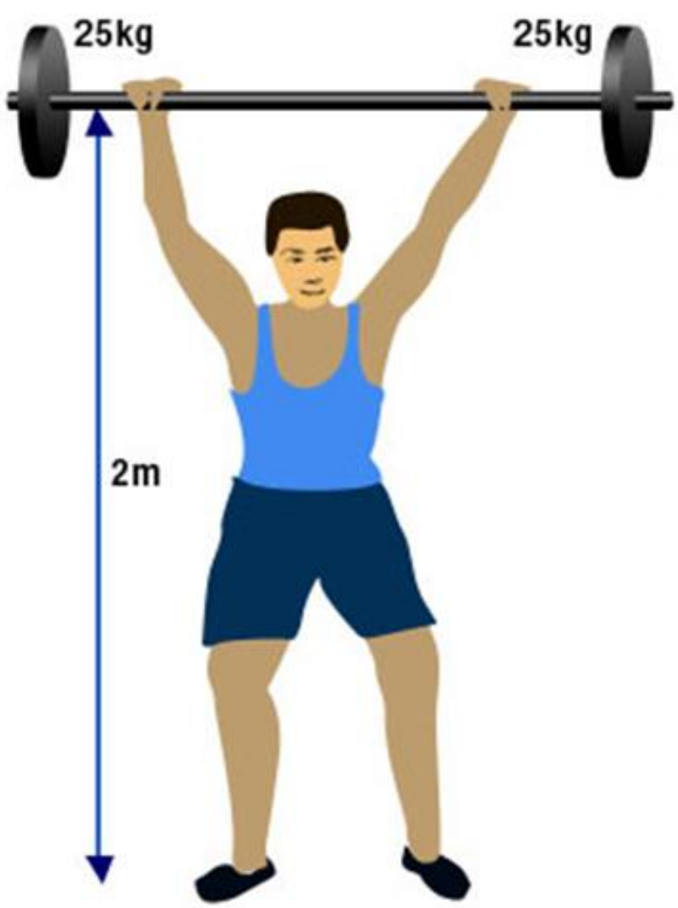
F is the force, d is the displacement caused by the force

θ is the angle between the force vector and the displacement vector

The dimension of work is the same as that of energy and is given as, $[ML^2T^{-2}]$.

Unit of Work

The SI unit of work is the joule (J), which is defined as the work done by a force of 1 Newton in moving an object through a distance of 1 meter in the direction of the force.



The work done upon the weight against gravity can be calculated as follows:

Work Done = (Mass × acceleration due to gravity) × Displacement

= (25 × 9.8) × 2 J

Factors Affecting Work

Let us now consider the factors on which work done on an object by a force depends.

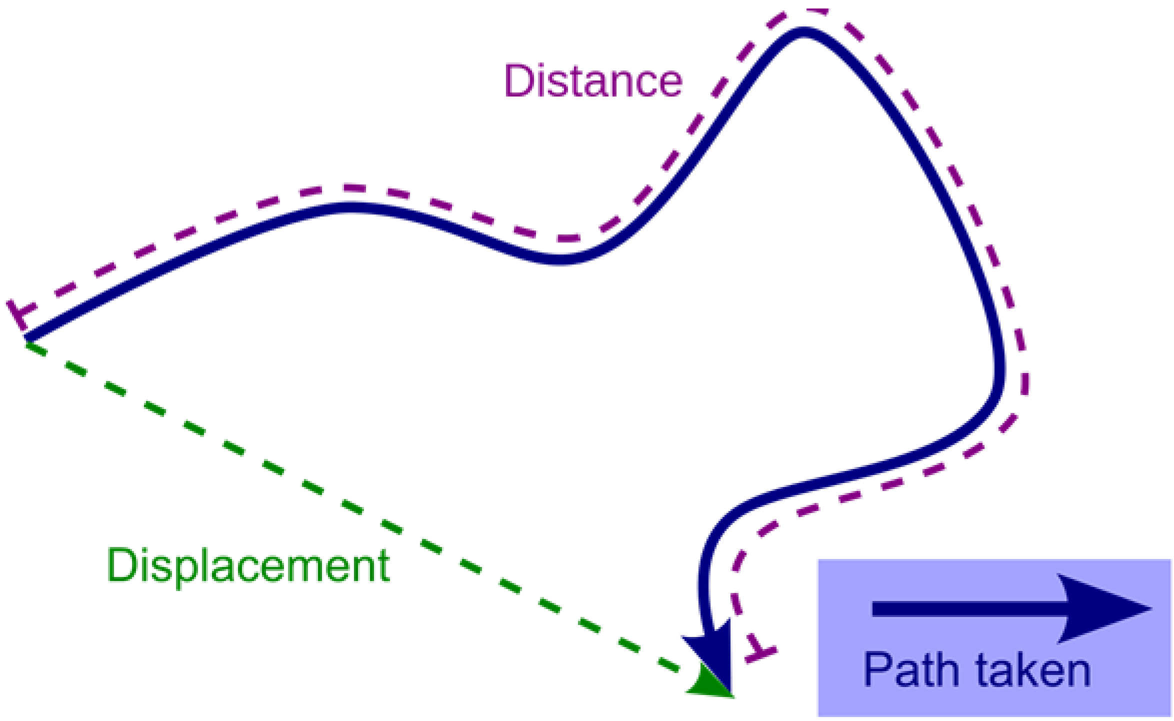
Force:

Force is defined as a push or a pull that can cause any object with a mass to change its velocity and acceleration. Force is a vector quantity and has both a magnitude and a direction. If the force acting on an object is zero irrespective of the state of the object (dynamic or static) that work done by the force is zero.

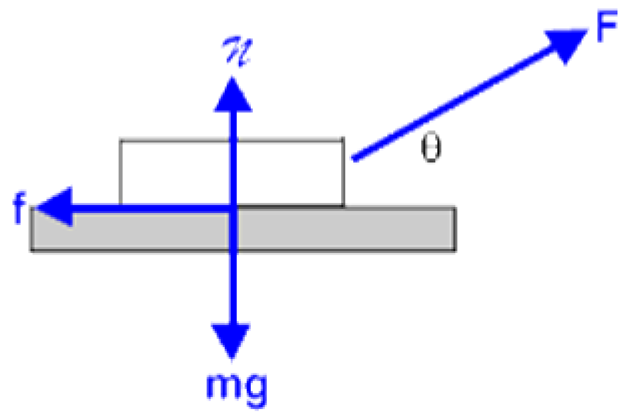
Displacement:

Displacement is a vector quantity that gives the shortest distance between the initial position and the final position of any object. If the resulting displacement in the direction of force, due to force acting on any object is zero, the net work done by that force on that object is zero. For e.g., if we push a rigid wall with all our might and still fail to displace it, then we can say no work has been performed by us on the wall.

The Angle between the Force Vector and the Displacement Vector



The work done by a force on an object can be positive, negative, or zero, depending upon the direction of displacement of the object with respect to the force. For an object moving in the opposite direction to the direction of force, such as friction acting on an object moving in the forward direction, the work is done due to the force of friction is negative.



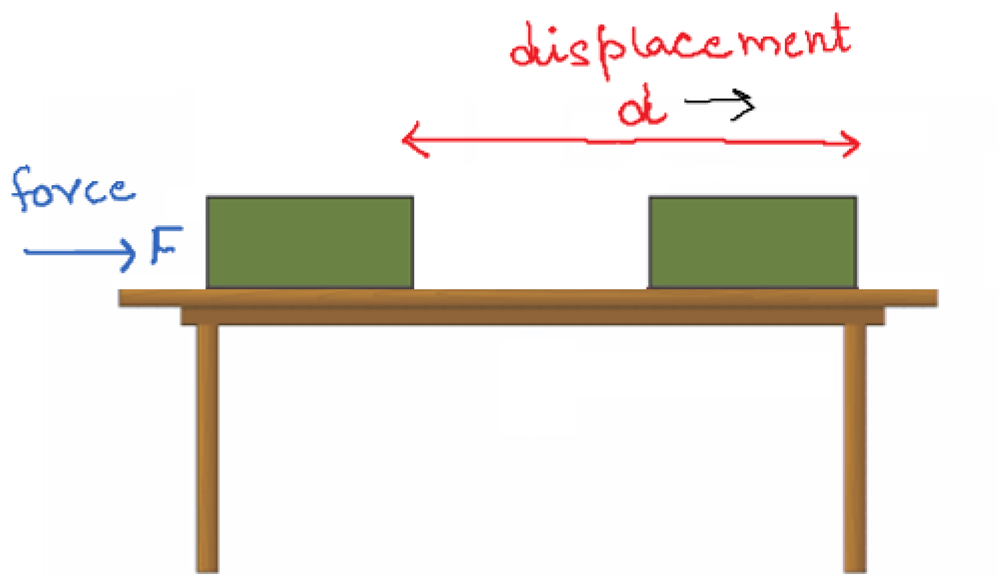
Similarly, an object experiences a zero force when the angle of displacement is perpendicular to the direction of the force. Consider an example of a coolie lifting a mass on his head moving at an angle of 90˚ with respect to the force of gravity. Here, the work done by gravity on the object is zero.

Work

- **Work** is done when a **force** produces **motion** in a body.
- Work done in moving a body is equal to the product of force exerted on the body and the distance moved by the body in the direction of force.

  Work = Force × Distance

  $W = F \times S$



Force **F** points in the same direction as displacement ***d***

- Work is a **scalar** quantity. It has only magnitude and no direction.
- Its SI unit is **joule** (J).
- **One joule of work** is said to be done on an object when a force of 1 N displaces the object

by 1 m along the line of action of force.

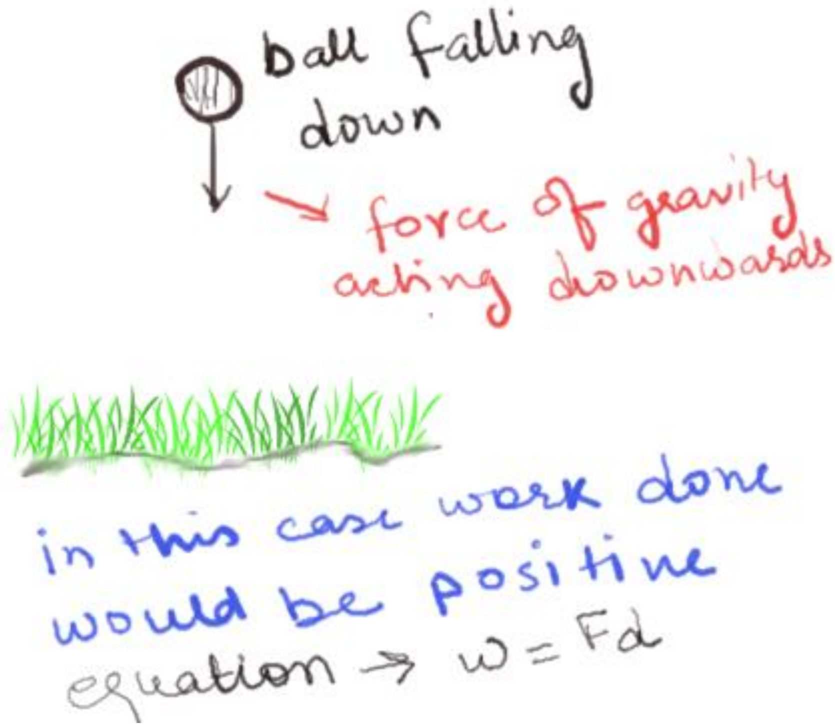
- Work done by a force can be positive, negative or zero.
- It is **positive** when a force acts in the direction of motion of the body.
- It is **negative** when a force acts opposite to the direction of motion of the body.
- It is **zero** when a force acts at right angles to the direction of motion of the body.

Positive Work

If a force displaces the object in its direction, then the work done is positive

So, W= Fd

The example of this kind of work done is motion of ball falling towards ground where displacement of ball is in the direction of force of gravity.



Negative work

If the force and the displacement are in opposite directions, then the work is said to be negative. For example if a ball is thrown in upwards direction, its displacement would be in upwards direction but the force due to earth's gravity is in the downward direction.

So here in this case gravity is doing negative work when you throw the ball upwards. Hence the work done by gravitational force is negative. Mathematically when displacement is opposite to the force work done is given by

Negative work just means that the force and the displacement act in opposite directions.

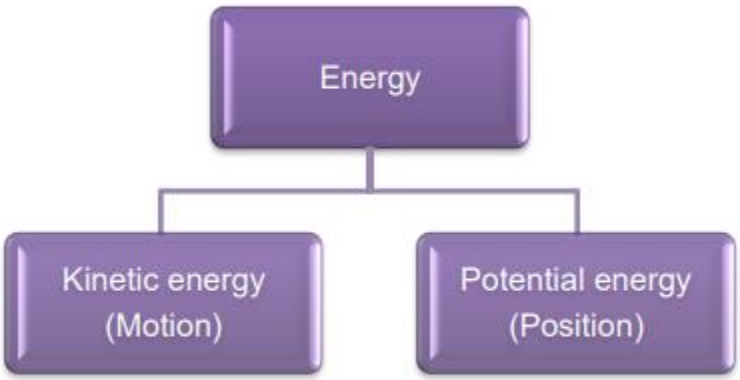
Case of zero work done

If the directions of force and the displacement are perpendicular to each other, the work done by the force on the object is zero.

For example, when we push hard against a wall, the force we are exerting on the wall does no work, because in this case the displacement of the wall is d = 0. However, in this process, our muscles are using our internal energy and as a result we get tired.

Energy

- We define energy as the ability to do work.
- The amount of energy possessed by a body is the amount of work it can do when that energy is released.
- Energy is a scalar quantity.
- Its SI unit is joule (J). 1 kJ = 1000 J
- The main forms of energy are kinetic energy, potential energy, chemical energy, heat energy, light energy, sound energy, electrical energy and nuclear energy.

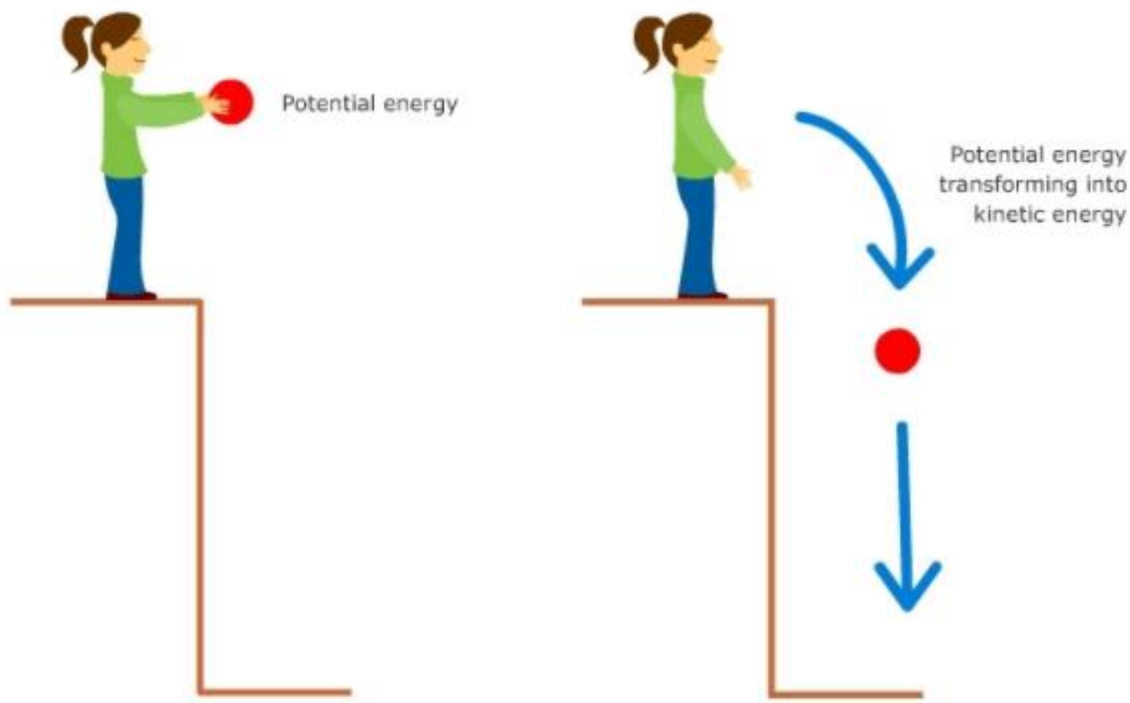


Kinetic Energy

- The energy possessed by a body on account of its motion is known as kinetic energy.
- Kinetic energy possessed by a body of mass ‘m’ moving with a velocity ‘v’ is given by the formula:

$$\text{Kinetic Energy} = \frac{1}{2}mv^2$$

- Kinetic energy of a body is directly proportional to
  - ✓ the mass of the body
  - ✓ the square of the velocity of the body



Potential Energy

- The energy possessed by a body because of its **position** or **configuration** is known as **potential energy**.
- The work done in raising an object from the ground to a point against gravity is called gravitational potential energy.
- Potential energy of a body of mass 'm' raised to a height 'h' above the surface of the Earth is given by the formula:

  Potential Energy = m g h

  where 'g' is the acceleration due to gravity.

Law of conservation of energy:

> Energy can neither be created nor destroyed; it can only be converted from one form to the other.

Sum of kinetic energy and potential energy of an object is its total mechanical energy.

Power

Power is defined as the rate of doing work or the rate of transfer of energy.

$$\text{Power} = \frac{\text{Work done}}{\text{Time taken}}$$

$$\text{or Power} = \frac{\text{Energy consumed}}{\text{Time taken}}$$

- Power is a scalar quantity. Its SI unit is watt (W).
- It is said to be one watt when the rate of consumption of energy is 1 Js^{-1}.
- Larger units of power are kilowatt (kW), megawatt (MW) and horsepower (hp). 1 kW = 1000 W
- 1 MW = 10^6 W
- 1 hp = 746 W

Commercial Unit of Energy

- The commercial unit of energy is kilowatt hour (kWh).
- One kilowatt hour is the amount of electrical energy consumed when an electrical appliance with a power rating of 1 kilowatt is used for 1 hour.
- 1 kWh is equal to 3.6×10^6 J of energy.
- 1 kilowatt hour of electrical energy is commonly known as 1 unit.

Work-energy theorem

The work-energy theorem states that the net work done by a moving body can be calculated by finding the change in KE.

$\Rightarrow W_{net} = KE_{final} - KE_{initial}$

$\Rightarrow W_{net} = \frac{1}{2} m[v^2 - u^2]$

Factors affecting kinetic energy

Mass

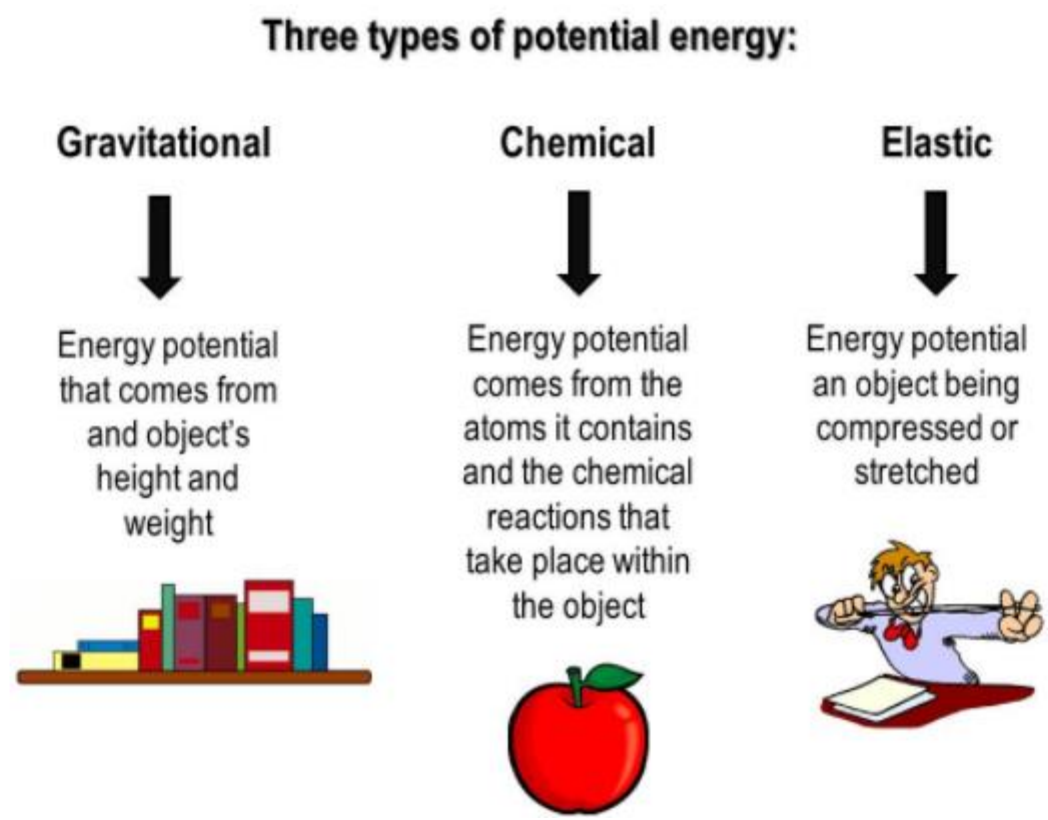
Velocity

Momentum

Potential Energy

Energy can get stored in an object when work is done on it.

For example, stretching a rubber string. The energy that is possessed by a body by virtue of its configuration or change in position is known as Potential Energy.



The potential energy of an object at a height.

When an object is raised to a certain height, work is done against gravity to change its position. This energy is stored as Potential Energy.

⇒W = F.s

⇒F = ma

In the case of increasing the height, F = mg

Therefore, W (P.E) = mgh

⇒ $\Delta PE = mg\,(h_{final} - h_{initial})$

Law of Conservation of Energy

Law of conservation of energy states that energy can neither be created nor destroyed, but can be transferred from one form to another. The total energy before and after the transformation remains constant.

Total energy = KE + PE

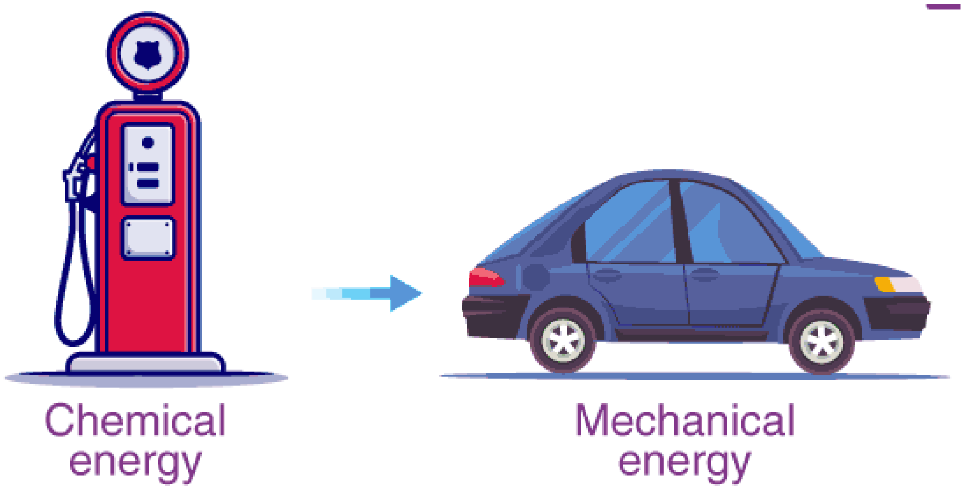
For example: consider a ball falling freely from a height. At height h, it has only PE = mgh.

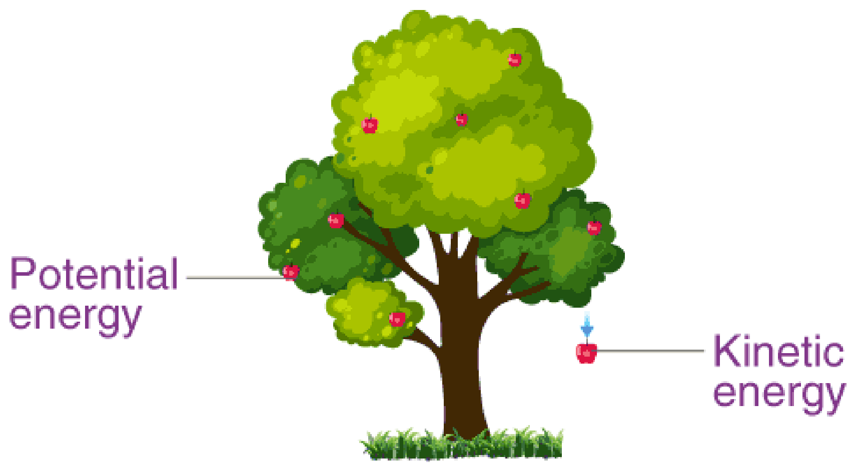
By the time it is about to hit the ground, it has a velocity and therefore has KE = $\frac{1}{2}mv^2$. Therefore, energy gets transferred from PE to KE, while the total energy remains the same.

Energy is required for the evolution of life forms on earth. In physics, it is defined as the capacity to do work. We know that energy exists in different forms in nature. You have learned about various forms of energy – heat, electrical, chemical, nuclear, etc. In this article, we will learn about the laws and principles that govern energy. This law is known as the law of conservation of energy.

The law of conservation of energy states that energy can neither be created nor be destroyed. Although, it may be transformed from one form to another. If you take all forms of energy into account, the total energy of an isolated system always remains constant. All the forms of energy follow the law of conservation of energy. In brief, the law of conservation of energy states that

In a closed system, i.e., a system that is isolated from its surroundings, the total energy of the system is conserved.





So in an isolated system such as the universe, if there is a loss of energy in some part of it, there must be a gain of an equal amount of energy in some other part of the universe. Although this principle cannot be proved, there is no known example of a violation of the principle of conservation of energy.

The amount of energy in any system is determined by the following equation:

$$U_T = U_i + W + Q$$

U_T is the total energy of a system

U_i is the initial energy of a system

Q is the heat added or removed from the system

W is the work done by or on the system

The change in the internal energy of the system is determined using the equation

$$\Delta U = W + Q$$

Law of Conservation of Energy Derivation

Considering the potential energy at the surface of the earth to be zero. Let us see an example of a fruit falling from a tree.

Consider a point A, which is at height ‘H’ from the ground on the tree, the velocity of the fruit is zero hence potential energy is maximum there.

E = mgH ———- (1)

When the fruit is falling, its potential energy is decreasing and kinetic energy is increasing.

At point B, which is near the bottom of the tree, the fruit is falling freely under gravity and is at a height X from the ground, and it has speed as it reaches point B. So, at this point, it will have both kinetic and potential energy.

E = K.E + P.E

P.E = mgX ——— (2)

According to third equation of motion

$$v^2 = 2g(H - X)$$

$$\Rightarrow \frac{1}{2}mv^2 = \frac{1}{2}m.2g(H - X)$$

$$\Rightarrow K.E = \frac{1}{2}m.2g(H - X)$$

$$\Rightarrow K.E = mg(H - X)$$

K.E = mg (H-X)——– (3)

Using (1), (2) and (3)

E = mg (H – X) + mgX

E = mg (H – X + X)

E = mgH

Similarly, if we see the energy at point C, which is at the bottom of the tree, it will come out to be mgH. We can see as the fruit is falling to the bottom and here, potential energy is getting converted into kinetic energy. So there must be a point where kinetic energy becomes equal to potential energy. Suppose we need to find that height ‘x’ from the ground. We know at that point,

K.E = P.E

P.E = K.E = $\frac{E}{2}$ ——– (4)

E2 is the new energy

Where, E = mgH2

H2 is the new height.

As the body is at height X from the ground,

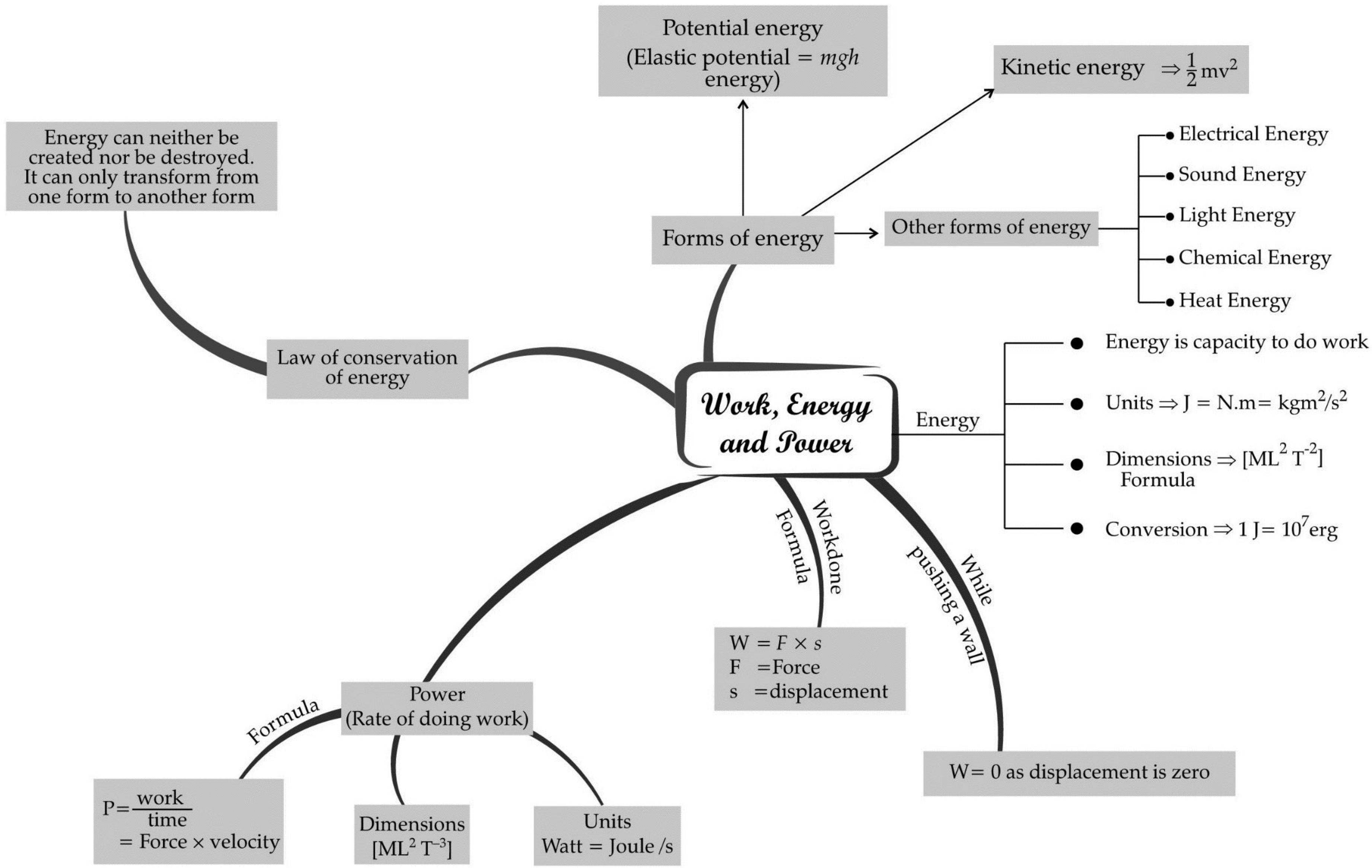
P.E = mgX ——— (5)

Using (4) and (5) we get,

$$mgX = \frac{mgH}{2}$$

$$\Rightarrow X = \frac{H}{2}$$

H2 is referred to the new height


Work, Energy and Power
Forms of energy
Potential energy (Elastic potential = mgh energy)
Kinetic energy ⇒ 1/2 mv²
Other forms of energy
Electrical Energy
Sound Energy
Light Energy
Chemical Energy
Heat Energy
Energy
Energy is capacity to do work
Units ⇒ J = N.m= kgm²/s²
Dimensions ⇒ [ML² T⁻²] Formula
Conversion ⇒ 1 J= 10⁷erg
Workdone Formula
W = F × s
F =Force
s =displacement
While pushing a wall
W= 0 as displacement is zero
Law of conservation of energy
Energy can neither be created nor be destroyed. It can only transform from one form to another form
Power (Rate of doing work)
Formula
P= work/time = Force × velocity
Dimensions [ML² T⁻³]
Units Watt = Joule /s

Important Question

➢ Multiple Choice Questions:

1. When a body falls freely towards the earth, then its total energy

(a) increases

(b) decreases

(c) remains constant

(d) first increases and then decreases

2. A car is accelerated on a levelled road and attains a velocity 4 times of its initial velocity. In this process the potential energy of the car

(a) does not change

(b) becomes twice to that of initial

(c) becomes 4 times that of initial

(d) becomes 16 times that of initial

3. In case of negative work the angle between the force and displacement is:

(a) 0°

(b) 45°

(c) 90°

(d) 180°

4. An iron sphere of mass 10 kg has the same diameter as an aluminium sphere of mass is 3.5 kg. Both spheres are dropped simultaneously from a tower. When they are lo m above the ground, they have the same.

(a) acceleration

(b) momenta

(c) potential energy

(d) kinetic energy

5. A girl is carrying a school bag of 3 kg mass on her back and moves 200 m on a levelled road. The work done against the gravitational force will be ($g = 10\ ms^2$)

(a) 6×10^3 J

(b) 6 J

(c) 0.6 J

(d) zero

6. Which one of the following is not the unit of energy?

(a) joule

(b) newton meter

(c) kilowatt

(d) kilowatt hour

7. The work done on an object does not depend upon the

(a) displacement

(b) force applied

(c) angle between force and displacement

(d) initial velocity of the object

8. Water stored in a dam possesses

(a) no energy

(b) electrical energy

(c) kinetic energy

(d) potential energy

9. A body is falling from a height h. After it has fallen a height $\frac{h}{2}$, it will possess

(a) only potential energy

(b) only kinetic energy

(c) half potential and half kinetic energy

(d) more kinetic and less potential energy

10. The number of joules contained in 1 kWh is

(a) 36×10^5 J

(b) 3.6×10^7 J

(c) 36×10^8 J

(d) 3.7×10^7 J

➢ Very Short Question:

1. Define the following terms.

(a) Work was done

(b) Energy

(c) Mechanical energy

(d) Kinetic energy

(e) Potential energy

(f) Power

(g) Commercial unit of energy.

2. Write down the type of energy stored in

(a) spring of a watch

(b) flowing water

(c) rolling stone

(d) raised hammer

(e) running athlete

3. What will be the kinetic energy of a body when its mass is made four-time and the velocity is doubled?

4. If we lift a body of 7 kg vertically upwards to a height of 10 m, calculate the work done in lifting the body.

5. State the transformation of energy that takes place when

Green plants prepare their food.

Head of a nail hammered hard and it becomes hot.

6. How much work is done by a man who tries to push the wall of a house but fails to do so?

7. Establish a relationship between SI unit and commercial unit of energy.

8. Write down the energy transformation taking place

(a) In electric bulb

(b) In torch

(c) In the thermal power station

(d) In solar cell

(e) Electric heater

9. A body of mass m is moving in a circular path of radius r. How much work is done on the body?

10. A horse of mass 200 kg and a dog of mass 20 kg are running at the same speed. Which of the two possesses more kinetic energy? How?

➢ Short Questions:

1. State law of conservation of energy and law of conservation of mechanical energy.

2. Define (a) 1 joule (b) 1 watt.

3. Write down SI unit of the following quantities.

(a) work

(b) kinetic energy

(c) potential energy

(d) power

4. What is the sequence of energy change that takes place in the production of electricity from adam?

5. A light and a heavy object have the same momentum. Find out the ratio of their kinetic energies. Which one has larger kinetic energy?

6. Why a man does not do work when he moves on a level road while carrying a box on his head?

7. If an electric iron of 1200 W is used for 30 minutes every day, find electric energy consumed in the month of April.

8. What is work done by a force of gravity in the following cases?

(a) Satellite moving around the Earth in a circular orbit of radius 35000 km.

(b) A stone of mass 250 g is thrown up through a height of 2.5 m.

➢ Long Questions:

1. State the conditions for positive, negative, and zero work. Give at least one example of each.

2. Give a reason for the following:

(a) A bullet is released on firing the pistol.

(b) An arrow moves forward when released from the stretched bow.

(c) Winding the spring of a toy car makes it to run on the ground.

(d) Falling water from a dam generates electricity.

(e) Winding the spring of our watch, the hands of the watch movement.

3. State the law of conservation of energy. Show that the energy of a freely falling body is conserved.

➢ Assertion Reason Questions:

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
    a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.
    b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

c. Assertion is true but Reason is false.

d. Assertion is false but Reason is true.

Assertion: Work done by or against gravitational force in moving a body from one point to another is independent of the actual path followed between the two points.

Reason: Gravitational forces are conservative forces.

2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

a. Both Assertion and Reason are correct, and reason is the correct explanation for assertion.

b. Both Assertion and Reason are correct, and Reason is not the correct explanation for Assertion.

c. Assertion is true but Reason is false.

d. Assertion is false but Reason is true.

Assertion: The work done during a round trip is not zero.

Reason: No force is required to move a body in its round trip.

➢ Case Study Questions:

1. Work done by force acting on an object is equal to the magnitude of the force multiplied by the distance moved in the direction of the force. Work has only magnitude and no direction. Work done is negative when the force acts opposite to the direction of displacement. Work done is positive when the force is in the direction of displacement. The unit of work is newton-metre (N m)or joule (J).

(i) Work done is:

(a) Scalar quantity

(b) Vector quantity

(c) Tensor quantity

(d) None of these

(ii) When force acts against the direction of displacement then work done will be:

(a) positive

(b) negative

(c) both a and b can possible

(d) None of these

(iii) SI unit of work is:

(a) Joule(J)

(b) Newton meter(N-m)

(c) both a and b

(d) None of these

(iv) You are lifting stone from floor. Work is done by the force exerted by you on the stone. The object moves upwards. The force you exerted is in the direction of displacement. However, there is the force of gravity acting on the object. Which one of these forces is doing positive work?

Which one is doing negative work?

(v) Define 1J of work.

2. A moving object can do work. An object moving faster can do more work than an identical object moving relatively slow. A moving bullet, blowing wind, a rotating wheel, a speeding stone can do work. How does a bullet pierce the target? How does the wind move the blades of a windmill? Objects in motion possess energy. We call this energy kinetic energy.

Thus, the kinetic energy possessed by an object of mass, m and moving with a uniform velocity, v is:

$KE = ½ * mv^2$

The energy possessed by an object is thus measured in terms of its capacity of doing work. The unit of energy is, therefore, the same as that of work, that is, joule (J).

(i) Energy possessed by body which is in motion is called:

(a) Potential energy

(b) Kinetic energy

(c) Nuclear energy

(d) None of these

(ii) Which of the following has same unit?

(a) Potential energy and Force

(b) Kinetic energy and work

(c) Both a and b

(d) None of these

(iii) Kinetic energy depends:

(a) Inversely on velocity of body

(b) Directly on square of velocity of body

(c) Directly on velocity of body

(d) None of these

(iv) Define kinetic energy of body. Give its SI unit

(v) Is kinetic energy scalar or vector? Justify your answer

✓ Answer Key-

➢ Multiple Choice Answers:

1. (c) remains constant
2. (a) does not change
3. (d) 180°
4. (a) acceleration
5. (d) zero
6. (c) kilowatt
7. (d) initial velocity of the object
8. (d) potential energy
9. (c) half potential and half kinetic energy
10. (a) 36×10^5 J

➢ Very Short Answers:

1. Answer:

   (a) Work done: Work done by a force acting on an object is equal to the magnitude of the force multiplied by the distance moved in the direction of the force.

   (b) Energy: Energy of a body is defined as the capacity or ability of the body to do work.

   (c) Mechanical energy: Mechanical energy includes kinetic energy and potential energy.

   (d) Kinetic energy: The energy possessed by a body by virtue of its motion.

   (e) Potential energy: The energy possessed by a body due to its position or configuration.

   (f) Power: Power is defined as the rate of doing work or the rate of transfer of energy.

   (g) Commercial unit of energy: The energy used in households, industries, and commercial establishment are usually expressed in kilowatt-hour.

   1 kWh 1 unit = 3.6×10^6J

2. Answer:

   (a) potential energy

   (b) kinetic energy

   (c) kinetic energy

(d) potential energy

(e) kinetic energy.

3. Answer:

Initial kinetic energy,

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

Final kinetic energy,

$$E_{K_f} = \frac{1}{2}(4m) \times (2v)^2$$

$= 16 \times \frac{1}{2}mv^2$

$$E_{K_f} = 16E_{K_i}$$

4. Answer:

Given, m = 7 kg

s = 10m

Workdone, W = F x s

E = mg x s

W = 7 x 10 x 10 J

w = 7000 J

5. Answer:

- Solar energy of sun into chemical energy.
- The kinetic energy of the hammer into heat energy.

6. Answer:

W = Fs = 0

As there is no displacement.

7. Answer:

SI unit of energy is joule and the commercial unit of energy is the joule.

1kWh = 1000 W x 3600 s = 3.6×10^6J

8. Answer:

(a) Electricity into light energy

(b) The chemical energy of the cell into light and heat energy

(c) The chemical energy of fuel into electricity

(d) Solar energy into electricity

(e) Electricity into heat energy.

9. Answer: Zero. This is because the centripetal force acting on the body is perpendicular to the displacement of the body.
10. Answer: The kinetic energy of the horse is more as kinetic energy is directly proportional to mass.

➢ Short Answers:

1. Answer: Law of conservation of energy: Energy can neither be created nor be destroyed, it can only be transformed from one form to another.

   Conservation of mechanical energy: If there is no energy, then the mechanical energy of a system is always constant.

2. Answer:

   (a) 1 joule is the amount of work done on an object when a force of 1 N displaces it by 1 m along the line of action of the force.

   (b) 1 watt is the power of an agent, which does work at the rate of 1 joule per second.

3. Answer:

   (a) joule (J)

   (b) joule (J)

   (c) joule (J)

   (d) watt (W).

4. Answer: The potential energy of stored water is converted into the rotational kinetic energy of turbine blades. The rotational kinetic energy of turbine blades is finally converted into electric energy by the generator.

5. Answer: The relation between kinetic energy and momentum

   Given,

$$E_K = \frac{p^2}{2m}$$

Given, $p_1 = p_2$

Take $m_1 > m_2$,

$$E_{K_1} = \frac{P_1^2}{2m_1}$$

and $$\boxed{E_{K_2} = \frac{p_2^2}{2m_2}}$$

$$\therefore \quad \frac{E_{K_1}}{E_{K_2}} = \frac{m_2}{m_1}$$

$$E_{K_2} > E_{K_1} \quad \text{as} \quad m_1 > m_2$$

6. Answer: When a man carries a load on his head, the angle between displacement (s) and force (F) is 900. Therefore, work done is zero.
7. Answer:

   Given,

   Power, P = 1200 W

   time, t = 30 minutes

   Power, p = $\frac{W}{t} = \frac{E}{T}$

   E = P x t

   Energy consumed, E = 1200 x 30 x 60

   = 2.16 x 10^6J = 2.16MJ
8. Answer:

   (a) Zero

   (b) Given,

   mass (m) = 250 g = 0.25 kg

   height (h) = 2.5 m

   Workdone, W = Fs = mgh

   = 0.25 x 10 x 2.5

   = 6.25 J

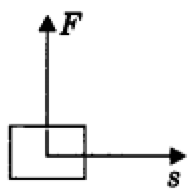
   W = 625 J

➢ Long Answers:

1. Answer:

   1. Zero work: If the angle between force and displacement is 90°, then work done is said to be zero work.

   Example: When a man carries a load on his head and moves on a level road. Work done by the man on the load is zero.



   2. Positive work: Work done is said to be positive if the force applied on an object and displacement are in the same direction.

   W = Fs

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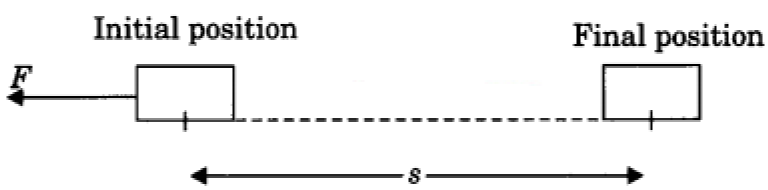
Example: Work done by the force of gravity on a falling body is positive.

3. Negative work: Work done is said to be negative if the applied force on an object and displacement is in opposite direction.

W = -Fs

Her displacement is taken to be negative (- s).



Example: Work done by friction force applied is negative on a moving body.

2. Answer:

(a) The chemical energy of gun powder is converted into kinetic energy of the bullet.

(b) The elastic potential energy in a stretched bow is converted into kinetic energy of the arrow.

(c) The potential energy of a spring is converted into kinetic energy of the toy.

(d) The kinetic energy of water is converted into electric energy.

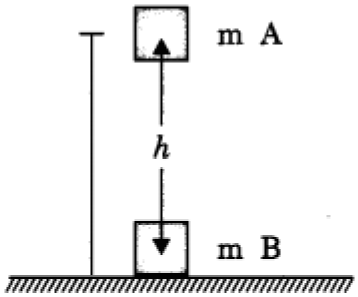
(e) The potential energy of spring due to its windings is converted into mechanical energy of the watch.

3. Answer:

Energy can neither be created nor be destroyed, it can only be transformed ‘ m A from one form to another. The total energy before and after the transformation always remains constant.

Let us consider an object of mass ‘m’ dropped from a height h.

Total energy at point A



$E_{T_A} = E_K + E_P$

or, $E_{T_A} = 0 + mgh$

$\therefore E_{T_A} = mgh$

Total energy at point B,

$E_{T_B} = E_T + E_p$

For finding out velocity at point B

apply $\upsilon^2 - u^2 = 2as$

$v_B^2 = 2gh$ = 2gh

Hence, $E_{T_B} = \frac{1}{2}mV_B^2 + mg$

$E_{T_B} = \frac{1}{2}m(2gh) = mgh$

Here, $E_{T_A} = E_{T_B}$

Hence if there is no energy loss, total energy is conserved.

➢ Assertion Reason Answer:

1. (c) Assertion is true but Reason is false.
2. (d) Assertion is false but Reason is true.

➢ Case Study Answers:

1.

(i) (a) Scalar quantity

(ii) (b) negative

(iii) (c) both a and b

(iv) Here work done by you is positive work as work is being done in the direction of displacement unlike in case of gravitational force which acts in downward direction against the direction of displacement which is in upward direction.

(v) When 1 Newton of force acts on body and body displaces from its position by 1 meter then the work done is said to be 1 joule (J).

2.

(i) (b) Kinetic energy

(ii) (b) Kinetic energy and work

(iii) (b) Directly on square of velocity of body

(iv) Energy possessed by object due to its motion is called as kinetic energy. Its SI unit is N-m or Joule(J).

(v) kinetic energy is scalar quantity as it is a work done and work done is scalar quantity hence kinetic energy is also scalar quantity and doesn’t have any direction.