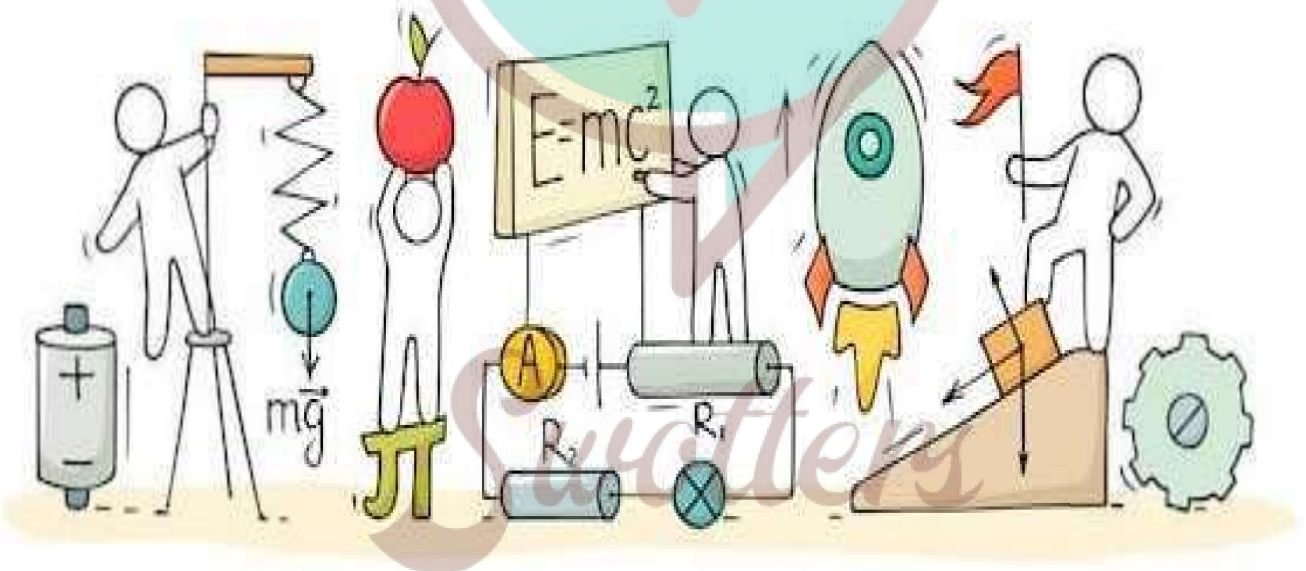
PHYSICS

Chapter 11: Work and Energy



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

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

$E_{K_2} > E_{K_1}$ as $m_1 > m_2$

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

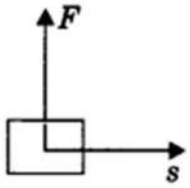
   W = 625 J

➢ Long Answers:

1. Answer:

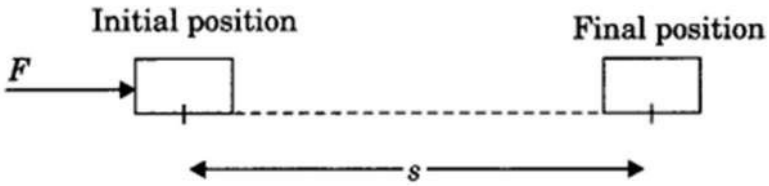
   1. Zero work: If the angle between force and displacement is 90°, then work done is said to be zero work.

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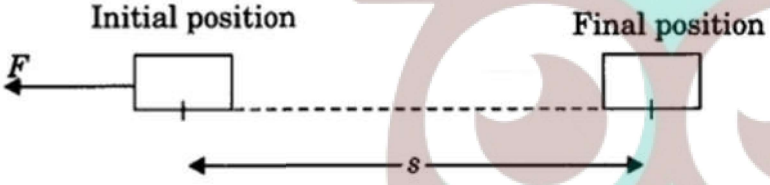
Example: Work done by the force of gravity on a falling body is positive.

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.

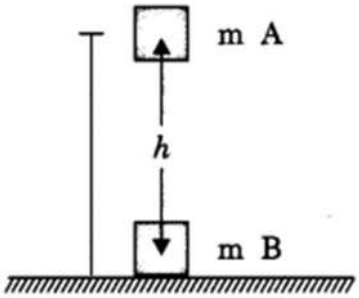
(e) The potential energy of spring due to its windings is converted into mechanical energy of the watch.

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 $v^2 - u^2 = 2as$

$v_B^2 = 2gh$ = 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.