NCERT Solutions for Class 9 Science - Chapter 11 Work and Energy

Exercise-11.1 Page: 148

1. A force of 7 N acts on an object. The displacement is, say 8 m, in the direction of the force. Let us take it that the force acts on the object through the displacement. What is the work done in this case?

Solution:

When a force F acts on an object to move it in its direction through a distance S, the work is done

The work on the body is done by force

Work done = Force × Displacement W

= F × S

Where,

F = 7 N S = 8 m

So, work done, W

= 7 × 8

W = 56 Nm

W = 56 J

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Exercise-11.2

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1. When do we say that work is done?

Solution:

Work is completed whenever the given conditions are satisfied:

(i) A force acts on the body.

(ii) There's a displacement of the body caused by the applied force on the direction of the applied force.

2. Write an expression for the work done when a force is acting on an object in the direction of its displacement.

Solution:

When a force F displaces a body through a distance S within the direction of the applied force, then the work done W on the body is given by the expression: $W = F \times S$

3. Define 1 J of work.

Solution:

1 J is that the quantity of labor done by a force of one N on associate degree object that displaces it through a distance of one m within the direction of the applied force.

4. A pair of bullocks exerts a force of 140 N on a plough. The field being ploughed is 15 m long.

How much work is done in ploughing the length of the field?

Solution:

Work done by the bullocks is given by the expression:

$W = F \times d$

Where,

Applied force, F = 140 N

Displacement, d = 15 m

W= a hundred and forty × fifteen = 2100 J

Hence, 2100 J of labor is finished in tilling the length of the sector.

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Exercise-11.3

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1. What is the kinetic energy of an object?
Solution:
The energy possessed by a body by the virtue of its motion is termed mechanical energy or kinetic energy. Every moving object possesses mechanical energy. A body uses mechanical energy to try to work. Kinetic energy of hammer is employed in driving a nail into a log of wood, mechanical energy of air is employed to run wind mills, etc.

3. Write an expression for the kinetic energy of an object.
Solution:
If a body of mass m is moving with a speed v, then its K.E. E k is given by the expression,
E k = 2mv
Its SI unit is Joule (J).

4. The kinetic energy of an object of mass, m moving with a velocity of 5 ms^{-1} is 25 J. What will be its kinetic energy when its velocity is doubled? What will be its kinetic energy when its velocity is increased three times? Solution:
The kinetic energy of the object = 25J
The formula for kinetic energy is

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

m = 2 kg
Therefore increased velocity = {3×5} $\frac{m}{s}$ = 15 m/s
Kinetic energy increase = $\frac{1}{2} \times 2 \times (15)^2$ = 225J

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Exercise-11.4

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1. What is power?

Solution:

Power is that the rate of doing work or the speed of transfer of energy. If W is that the quantity of work wiped out time t, then power is given by the expression,

$$Power = \frac{Work}{Time}$$

P = W/T

It is expressed in watt (W).

2. Define 1 watt of power.

Solution:

A body is claimed to possess power of one watt if it will work on the speed of 1 joule in 1 s.

That is,

One W = 1 J/1 S

3. A lamp consumes 1000 J of electrical energy in 10 s. What is its power? Solution:

Power = Work/Time

P = W/T

Time = 10 s

Work done = Energy consumed by the lamp = 1000 J

Power = 1000/10 = 100 Js^{-1} =100 W

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Exercise-11.5

4. Define average power Solution:

The average Power of an agent could also be outlined because the total work done by it within the total time taken.

$$\text{Average Power} = \frac{\text{Total Work Done}}{\text{Total Time Taken}}$$

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Exercises - 11.5 Page: 158

1. Look at the activities listed below. Reason out whether or not work is done in the light of your understanding of the term 'work'.

(a) Suma is swimming in a pond.

(b) A donkey is carrying a load on its back.

(c) A wind-mill is lifting water from a well.

(d) A green plant is carrying out photosynthesis.

(e) An engine is pulling a train.

(f) Food grains are getting dried in the sun.

(g) A sailboat is moving due to wind energy.

Solution:

Work is finished whenever the given 2 conditions are satisfied:

(i) A force acts on the body.

(ii) There's a displacement of the body by the applying of force in or opposite to the direction of force.

(a) Whereas swimming, Suma applies a force to push the water backwards. Therefore, Suma swims within the forward direction caused by the forward reaction of water. Here, the force causes a displacement. Hence, work is finished by Seema whereas swimming.

(b) Whereas carrying a load, the donkey should apply a force within the upward direction. But, displacement of the load is within the forward direction. Since, displacement is perpendicular to force, the work done is zero.

(c) A wind mill works against the gravity to elevate water. Hence, work is finished by the wind mill in lifting water from the well.

(d) During this case, there's no displacement of the leaves of the plant. Therefore, the work done is zero.

(e) An engine applies force to tug the train. This permits the train to maneuver within the direction of force. Therefore, there's a displacement within the train in the same direction. Hence, work is finished by the engine on the train.

(f) Food grains don't move within the presence of alternative energy. Hence, the work done is zero during the method of food grains obtaining dried within the Sun.

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(g)Wind energy applies a force on the sailing ship to push it within the forward direction. Therefore, there is a displacement within the boat in the direction of force. Hence, work is finished by wind on the boat.

2. An object thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and the final points of the path of the object lie on the same horizontal line. What is the work done by the force of gravity on the object?

Solution:

Work done by the force of gravity on an object depends solely on vertical displacement. Vertical displacement is given by the distinction within the initial and final positions/heights of the thing that is zero.

Gravity-related work is expressed as, W=

m g h

Where, h= Vertical displacement =

zero W = m g × zero = 0 J

Consequently, the work done on the given object by gravity is zero joule.

3. A battery lights a bulb. Describe the energy changes involved in the process.

Solution:

When a bulb is connected to a battery, then the energy of the battery is transferred into voltage. Once the bulb receives this voltage, then it converts it into light-weight and warmth energy. Hence, the transformation of energy within the given situation may be shown as:

Chemical Energy → Electrical Energy → Light Energy + Heat Energy.

E k = K.E. of the thing moving with a rate, v

K.E. once the thing was moving with a rate five m s^{-1}

1 (E k) 5 = two × twenty × (5)

= 250 J

Kinetic energy once the thing was moving with a rate two m s^{-1} one (E k) 2 = two x twenty × (2)

= 40 J

4. Certain force acting on a 20 kg mass changes its velocity from 5 m s^{-1} to 2 m s^{-1}. Calculate the work done by the force.

Solution:

Given data:

Initial velocity $u=5\ ms^{-1}$

Mass of the body = 20kg

Final velocity $v = 2\ ms^{-1}$

The initial kinetic energy

$E_i = (1/2)\ mu^2 = (1/2) \times 20 \times (5\ ms^{-1})^2 = 250 kgms^{-2}$

$= 250Nm = 250J$

Final kinetic energy $E_f = (1/2)\ mv^2 = (1/2) \times 20 \times (2\ ms^{-1})^2 = 40kgms^{-2} = 40\ Nm = 40J$

Therefore,

Work done = Change in kinetic energy

Work done = $E_f - E_i$

Work done =40J – 250J

Work done = -210J

Where negative sign indicates that force acts contrary to motion direction.

5. A mass of 10 kg is at a point A on a table. It is moved to a point B. If the line joining A and B is horizontal, hat is the work done on the object by the gravitational force? Explain your answer.

Solution:

Work done by gravity depends solely on the vertical displacement of the body. It doesn't rely on the trail of the body. Therefore, work done by gravity is given by the expression,

W= m g h

Where,

Vertical displacement, h = 0

$\therefore$ W= mg × zero = 0

Therefore the work done on the body by gravity is therefore zero.

6. The potential energy of a freely falling object decreases progressively. Does this violate the law of conservation of energy? Why?

Solution:

No, the method doesn't violate the law of conservation of energy. This is because once the body falls from a height, then its mechanical energy changes into kinetic energy increasingly. A decrease within the mechanical energy is capable a rise in the kinetic energy of the body. Throughout the method, total energy of the body remains conserved. Therefore, the law of conservation of energy isn't desecrated.

7. What are the various energy transformations that occur when you are riding a bicycle? Solution:

During riding a bicycle, the muscular energy of the rider is regenerate into heat and mechanical energy.

Kinetic energy provides rate to the bicycle and warmth energy heats our body.

Muscular energy ➐ mechanical energy + heat

8. Does the transfer of energy take place when you push a huge rock with all your might and fail to move it? Where is the energy you spend going?

Solution:

When we push a large rock, there's no transfer of muscular energy to the stationary rock. Also, there's no loss of energy as a result of muscular energy is transferred into energy, which causes our body to become hot.

9. A certain household has consumed 250 units of energy during a month. How much energy is this in joules?

Solution:

1 unit of energy is up to one B.T.U. (kWh).

1 unit = one kWh

1 kWh = 3.6×10^6 J

Therefore, 250 units of energy = $250 \times 3.6 \times 10^6$

= 9×10^8 J.

10. An object of mass 40 kg is raised to a height of 5 m above the ground. What is its potential energy? If the object is allowed to fall, find its kinetic energy when it is halfway down.

Solution:

Gravitational mechanical energy is given by the expression, W = mgh

Where, h = Vertical displacement = 5 m, m = Mass of the item = 40 kg

g = Acceleration because of gravity = 9.8 m s^{-2} ∴
W = 40 × 5 × 9.8 = 1960 J.

At half-way down, the mechanical energy of the item are going to be 1960/2 At this time, the item has an equal quantity of potential and K.E.

This can be due to law of conservation of energy. Hence, half-way down, the K.E. of the item can be 980 J.

11. What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer.

Solution:

Work is completed whenever the given 2 conditions are satisfied:

→ a force acts on the body.

→ there's a displacement of the body by the appliance of force in or opposite to the direction of force.

If the force direction is perpendicular to the displacement, the work performed is zero. When a satellite moves round the Earth, then the direction of force of gravity on the satellite is perpendicular to its displacement. Hence, the work done on the satellite by the planet is zero.

12. Can there be displacement of an object in the absence of any force acting on it? Think. Discuss this question with your friends and teacher Solution:

Yes, consider a uniformly moving object,

Suppose an object is moving with constant rate. The web force performing on its zero. But, there is a displacement on the motion of the article. Hence, there will be a displacement while not a force.

13. A person holds a bundle of hay over his head for 30 minutes and gets tired. Has he done some work or not? Justify your answer.

Solution:

Work is completed whenever the given 2 conditions are satisfied.

(i) A force acts on the body.

(ii) There's a displacement of the body by the applying of force in or opposite to the direction of force.

When an individual holds a bundle of fodder over his head, then there's no displacement within the bundle of fodder. Although, force of gravity is functioning on the bundle, the person isn't applying any force thereon. Hence, within the absence of force, work done by the person on the bundle is zero.

14. An electric heater is rated 1500 W. How much energy does it use in 10 hours?

Solution:

With the help of the expression, energy consumed by an electric heater will be obtained, P = T

Where,

Power rating of the heater,

P = 500 W = 1.5 power unit Time that the heater has operated,

T = ten h Work done = Energy consumed by the heater

Therefore, energy consumed = Power × Time

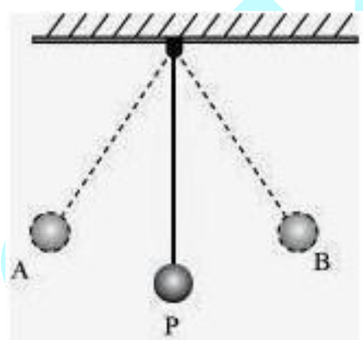
= 1.5 × 10 = 15 kWh

Hence, the energy consumed by the heater in 10h is 15 kWh.

15. Illustrate the law of conservation of energy by discussing the energy changes which occur when we draw a pendulum bob to one side and allow it to oscillate. Why does the bob eventually come to rest? What happens to its energy eventually? Is it a violation of the law of conservation of energy?

Solution:

Consider the case of oscillation pendulum.



When an apparatus moves from its mean position P to either of its extreme positions A or B, it rises through a height h on top of the mean level P. At this time, the K.E. of the bob changes fully into P.E. The K.E. becomes zero, and also the bob possesses solely P.E. Because it moves towards purpose P, its P.E. decreases increasingly. Consequently, the

K.E. will increase. Because the bob reaches purpose P, its P.E. becomes zero and also the bob possesses solely K.E. This method is perennial as long because the apparatus oscillates.
The bob doesn't oscillate forever. It involves rest as a result of air resistance resists its motion. The apparatus loses its K.E. to beat this friction and stops once a while. The law of conservation of energy isn't desecrated as a result of the energy lost by the apparatus to beat friction is gained by its surroundings. Hence, the overall energy of the apparatus and also the encompassing system stay preserved.

16. An object of mass, m is moving with a constant velocity, v. How much work should be done on the object in order to bring the object to rest? Solution:

The formula for kinetic energy = $\frac{1}{2}mv^2$

The kinetic energy of the object at rest = 0

Change in kinetic energy = Work done on an object

$$= \frac{1}{2}mv^2 - 0$$

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

17. Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 km/h?

Solution:

Given data:

The mass of the body = 1500kg

Velocity v = 60km/hr

$$= \frac{60 \times 1000m}{3600s}$$

$$= \frac{50}{3}m/s$$

The work required to stop the car = kinetic energy change of the car

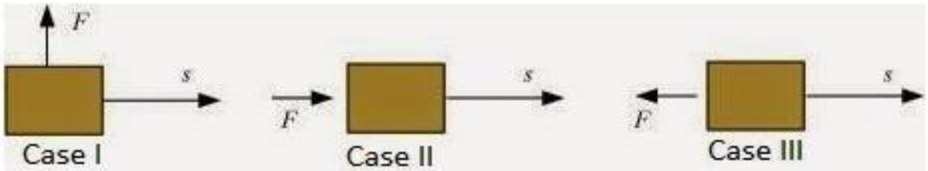
$$= \frac{1}{2}mv^2 - \frac{1}{2}m(0)^2$$

$$= \frac{1}{2} \times (1500) \times (\frac{50}{3})^2$$

= 208333.3 J

18. In each of the following a force, F is acting on an object of mass, m. The direction of displacement is from west to east shown by the longer arrow. Observe

the diagrams carefully and state whether the work done by the force is negative, positive or zero.



Solution:

Case I

In this case, the direction of force functioning on the block is perpendicular to the displacement. Therefore, work done by force on the block are going to be zero.

Case II

In this case, the direction of force functioning on the block is within the direction of displacement. Therefore, work done by force on the block are going to be positive.

Case III

In this case, the direction of force on the block is contrary to the direction of displacement. Therefore, work done by force on the block are going to be negative.

19. Soni says that the acceleration in an object could be zero even when several forces are acting on it. Do you agree with her? Why?

Solution:

Acceleration in associate object might be zero even once many forces are working on it. This happens once all the forces get rid of one another i.e., the online force working on the thing is zero. For a uniformly moving object, the online force working on the thing is zero. Hence, the acceleration of the thing is zero. Hence, Soni is correct.

20. Find the energy in kW h consumed in 10 hours by four devices of power 500 W each. Solution:

Energy consumed by an electrical device will be obtained with the assistance of the expression for power,

P = T

Where,

Power rating of the device,

P = five hundred W = 0.50 power unit Time that the device runs,

T= ten h Work d consumed by the device thus, energy c × Time

= 0.50 × 10 = 5 kWh

Hence, the energy consumed by four equal rating devices in 10 h = 4 × 5 kWh = 20 kWh = 20 Units.

21. A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy?

Solution:

When the object falls freely towards the bottom, its mechanical energy decreases and K.E. will increase, because the object touches the bottom, all its mechanical energy gets reborn into K.E. Because the object hits the laborious ground, all its K.E. gets reborn into heat and sound energy. It may also deform the bottom relying upon the character of the ground and therefore the quantity of K.E. possessed by the thing.