EXERCISES

Sol's 1. (a) While swimming, Suma applies a force to push the water backward. Suma swims in the forward direction caused by the forward reaction of water. Here, the force causes a displacement. Hence, work is done.

(b) While carrying a load, the force of gravity is acting vertically downward direction. But, the displacement is in the forward direction. Since, displacement is perpendicular to force, the work done is zero.

(c) Work is done because displacement of water takes place and a force is applied by the wind mill. Wind mill does work against gravity.

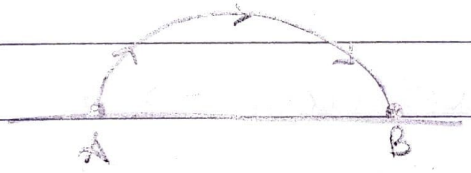
(d) In this case, there is no displacement of the leaves of plant. Therefore, the work done is zero.

(e) Work is done because the displacement of train takes place and a force is applied by the engine.

(f) No work is done, because displacement does not take place.

(g) Work is done because the displacement of sailboat takes place and a force is applied by the wind.

Sol. 2.



The object returns to its level of projection, therefore displacement is in horizontal direction, while force of gravity acts in vertically downward direction. Thus, force and displacement are in perpendicular directions. Hence, work done by the force of gravity on the object is zero.

Sol:3. 1. A battery contains chemicals and supplies electrical energy. So, a battery converts chemical energy into electrical energy.

2. In a electric bulb, the electrical energy is first converted into heat energy.

3. This heat energy causes the filament of bulb to become white-hot and produce light energy.

4. So, the energy changes involved when a battery lights up a bulb are:

Chemical energy → Electrical energy → Heat energy → Light energy

Sol:4. Mass of object, $m = 20\ kg$

Initial velocity of object, $u = 5\ m/s$

Final velocity of object, $v = 2\ m/s$

Work done by the force = change in kinetic energy

~~⇒ work done~~

$\Rightarrow W = \frac{1}{2} m (v^2 - u^2)$

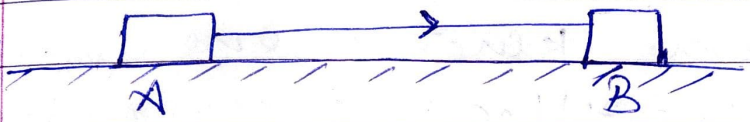
$\Rightarrow W = \frac{1}{2} \times 20 \times (2^2 - 5^2)$

$\Rightarrow W = 10 \times (4 - 25)$

$\Rightarrow W = 10 \times (-21) = -210\ J$

$\therefore$ Work done by the force is -210 J.

Sol: 5



Work done on the object by the gravitational force is zero.

1. gravity always acts vertically downwards and depends only on the vertical displacement of the object. It does not depend upon the path of the object.
2. Here, the body undergoes horizontal displacement.
3. ~~Hence, the displacement and gravitational force are perpendicular to each other. So, work done by gravity is zero~~

$W = mgh$

Vertical displacement $= h = 0$

$\Rightarrow W = mg \times 0 = 0$

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Hence, work done by gravity is zero.

Q5. The potential ---------- Why?

Ans:- The law of conservation of energy states that energy can neither be created nor be destroyed, it can only be converted from one form to another.

The potential energy of a freely falling object decreases progressively. It does not violate the law of conservation of energy.

The decrease in potential energy due to loss of height, increases the kinetic energy due to gain in speed such that total energy remains constant.

Sol:7.1. While riding a bicycle the muscular energy of the rider gets transferred into heat energy and kinetic energy of the bicycle. 2. Heat energy heats the rider's body. ~~And~~ 3. The kinetic energy provides a velocity to the bicycle.

The transformation can be:
Muscular Energy ⟶ Heat Energy + Kinetic Energy

Sol:8. When we push a huge rock, energy transfer does not take place as no displacement takes place in the direction of applied force.

There is no loss of energy because muscular energy is transferred into heat energy which causes our body to ~~heat up~~ become hot.
Muscular Energy ⟶ Heat Energy

Q9. A certain ---------- joules?

Ans: Energy consumed in a month = 250 units

1 unit = 1 kWh

250 units = 250 kWh

1 kWh = 3.6×10^6 J

250 kWh = $250 \times 3.6 \times 10^6$ J

= 9×10^8 J

Q2. Can there ---------- teacher.

Ans: Yes, for a uniformly moving object.

When an object is moving with constant velocity, the net force acting on it is zero. But, there is a displacement along the motion of the object. Hence, there can be displacement without a force.

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Sol:- 10. Mass of object, $m = 40\ kg$
Height, $h = 5\ m$
Acc^{n} due to gravity, $g = 9.8\ ms^{-2}$

Potential energy $= mgh$
$\Rightarrow$ Potential energy $= 40 \times \frac{98}{10} \times 5$

$= 1960\ J$

$\therefore$ Initial Potential energy at height $5\ m = 1960\ J$
Initial Kinetic energy at height $5\ m = 0$

Height from ground, when the object is half-way down
$= \frac{5}{2} = 2.5\ m$

Final ~~P.E~~ Potential energy at height $2.5\ m = mgh$
$= 40 \times \frac{98}{10} \times \frac{5}{2} = 980\ J$

Final Kinetic energy, $E_{k_2} = ?$

According to law of conservation of energy
Initial Mechanical energy = Final Mechanical Energy

$$E_{P_1} + E_{K_1} = E_{P_2} + E_{K_2}$$

$$\Rightarrow 1960 + 0 = 980 + E_{K_2}$$

$$\Rightarrow E_{K_2} = 1960 - 980 = 980\,J$$

∴ Kinetic energy of object when it is half-way down is 980 J.

Sol°-11. The work done by the force of gravity on the satellite moving round the earth is zero because the force of gravity acts at right angles to the direction of motion of the satellite.
Therefore, displacement and force are in perpendicular directions.
Hence, work done is zero.

Sol°-13. Work is said to be done when:
1. A force acts on the body.
2. There is a displacement of the body due to the application of force.

When a person holds a bundle of hay ~~on~~ over his head for 30 minutes, no displacement takes place.

Hence, work done by the person is zero.

Q14. An electric ---------- 10 hours?

Ans:- $\text{Power} = \frac{\text{Work}}{\text{Time}}$

Work done = Energy consumed by the heater

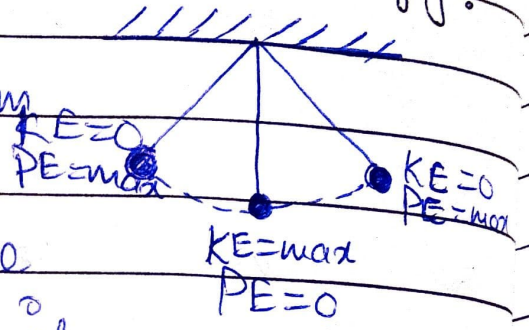
⇒ Energy = Power × Time

⇒ Energy = $\frac{1500}{1000} \times 10$

⇒ Energy = 15 kWh

Q15 Illustrate the ----- energy?

Sol:-



1. When the pendulum bob is pulled towards left, the energy supplied is stored in it in the form of PE due to its height.
2. When the pendulum is released so that it starts moving towards right, its PE changes into KE, such that at its mean position, it has maximum KE and zero PE
3. As the pendulum moves towards extreme right, its KE changes into PE, such that at the extreme position, it has maximum PE and zero KE.
4. When it moves from this

extreme position to mean position, its PE again changes to K.E.

5. This means total mechanical energy remains constant. This illustrates the law of conservation of energy.

Eventually, the bob comes to rest, because during each oscillation a part of the energy possessed by it is transferred to air and in overcoming friction.

The energy of the pendulum is dissipated in air.

The law of conservation of energy is not violated as the energy lost by the pendulum to overcome friction is gained by its surroundings. Hence, the total energy of the pendulum and the surrounding system is conserved.

Q16. An object ---------- rest?

Sol: Kinetic energy of an object of mass m moving with a ~~vel~~ velocity $v = \frac{1}{2}mv^2$

To bring the object to rest, an equal amount of work ~~is~~ is required to be done on the object.

∴ Work done to bring the object to rest $= \frac{1}{2}mv^2$

Q19. Soni says ---------- Why?

Ans- Yes, acceleration in an object could be zero even when several forces are acting on it.

When a number of forces act on a body, such that they constitute balanced forces, then net force acting on the body is zero. In such a situation no acceleration occurs in the object.

Sol: 17. Mass of car, $m = 1500\ kg$

Initial velocity of car, $u = 60\ km/h$

$$= \frac{60 \times 1000}{60 \times 60} = \frac{50}{3}\ m/s$$

Final velocity of car, $v = 0$

Work done = Δ Kinetic Energy

$$\Rightarrow W = \frac{1}{2} m(v^2 - u^2)$$

$$\Rightarrow W = \frac{1}{2} \times 1500 \left[0^2 - \left(\frac{50}{3}\right)^2\right]$$

$$\Rightarrow W = 750 \times \frac{50}{2} \times \frac{50}{3} = 208333.3\ J$$

$$= 2.083 \times 10^5\ J$$

$\therefore$ 208333.3 J of work is required to stop the car.

Sol: 18. (a) In this case, the force acts in the perpendicular direction of displacement. Therefore, work done is zero.

(b) In this case, the force acts in the direction of displacement. Therefore, work done by the force is positive.

(c) In this case, the force acts in the direction opposite to the displacement. ~~Thus~~ Therefore, work done by the force is negative.

Sol:-20. Total power of 4 devices = 4×500
= 2000 W = 2 KW

Time = 10 h

Power = $\frac{\text{Energy}}{\text{Time}}$

⇒ Energy = Power × Time

⇒ Energy = 2 × 10 = 20 KWh

Hence, the energy consumed is 20 KWh.

Q21. A freely ---------- energy?

Ans: As the object hits the ground, its kinetic energy gets converted into :-

1. heat energy (the object and the ground become slightly warm)
2. sound energy (sound is heard when the object hits the ground)
3. potential energy (due to momentarily change in shape of object)