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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'.

- Suma is swimming in a pond.
- A donkey is carrying a load on its back.
- A wind mill is lifting water from a well.
- A green plant is carrying out photosynthesis.
- An engine is pulling a train.
- Food grains are getting dried in the sun.
- A sailboat is moving due to wind energy.

Answer:
Work is done whenever the given two conditions are satisfied:

- A force acts on the body.
- There is a displacement of the body by the application of force in or opposite to the direction of force.

(a) While swimming, Suma applies a force to push the water backwards. Therefore, Suma swims in the forward direction caused by the forward reaction of water. Here, the force causes a displacement. Hence, work is done by Seema while swimming.
(b) While carrying a load, the donkey has to apply a force in the upward direction. But, displacement of the load is in the forward direction. Since, displacement is perpendicular to force, the work done is zero.
(c) A wind mill works against the gravitational force to lift water. Hence, work is done by the wind mill in lifting water from the well.
(d) In this case, there is no displacement of the leaves of the plant. Therefore, the work done is zero.
(e) An engine applies force to pull the train. This allows the train to move in the direction of force. Therefore, there is a displacement in the train in the same direction. Hence, work is done by the engine on the train.
(f) Food grains do not move in the presence of solar energy. Hence, the work done is zero during the process of food grains getting dried in the Sun.
(g)Wind energy applies a force on the sailboat to push it in the forward direction. Therefore, there is a displacement in the boat in the direction of force. Hence, work is done 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?
Answer:
Work done by the force of gravity on an object depends only on vertical displacement.
Vertical displacement is given by the difference in the initial and final positions/heights of the object, which is zero.
Work done by gravity is given by the expression,
$W = mgh$
Where,
h = Vertical displacement = 0

W = mg x 0 = 0 J
Therefore, the work done by gravity on the given object is zero joule.

3. A battery lights a bulb. Describe the energy changes involved in the process.
Answer:
When a bulb is connected to a battery, then the chemical energy of the battery is transferred into electrical energy.
When the bulb receives this electrical energy, then it converts it into light and heat energy.
Hence, the transformation of energy in the given situation can be shown as:
Chemical Energy → Electrical Energy → Light Energy + Heat Energy

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.
Answer:
Kinetic energy is given by the expression,$(E_k)_v = 1/2\ mv^2$
Where,
E_k= Kinetic energy of the object moving with a velocity, v
(i) Kinetic energy when the object was moving with a velocity 5 m s^{-1}
$(E_k)_5 = 1/2 \times 20 \times (5)^2 = 250$ J
Kinetic energy when the object was moving with a velocity 2 m s^{-1}
$(E_k)_2 = 1/2 \times 20 \times (2)^2 = 40$ J.

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, what is the work done on the object by the gravitational force? Explain your answer.
Answer:
Work done by gravity depends only on thevertical displacement of the body.
It does not depend upon the path of the body.
Therefore, work done by gravity is given by the expression,
W = mgh
Where,
Vertical displacement, h = 0
∴ W= mg x 0 = 0
Hence, the work done by gravity on the body is zero.

6. The potential energy of a freely falling object decreases progressively. Does this violate the law of conservation of energy? Why?
Answer: No. The process does not violate the law of conservation of energy. This is because when the body falls from a height, then its potential energy changes into kinetic energy progressively. A decrease in the potential energy is equal to an increase in the kinetic energy of the body. During the process, total mechanical energy of the body remains conserved. Therefore, the law of conservation of energy is not violated.

7. What are the various energy transformations that occur when you are riding a bicycle?
Answer: While riding a bicycle, the muscular energy of the rider gets transferred into heat energy and kinetic energy of the bicycle. Heat energy heats the rider's body. Kinetic energy provides a velocity to the bicycle. The transformation can be shown as:
Muscular Energy → Kinetic Energy + Heat Energy
During the transformation, the total energy remains conserved.

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?
Answer: When we push a huge rock, there is no transfer of muscular energy to the stationary rock. Also, there is no loss of energy because muscular energy is transferred into heat 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?
Answer:
1 unit of energy is equal to 1 kilowatt hour (kWh).
1 unit = 1 kWh
1 kWh = 3.6×10^6 J
Therefore, 250 units of energy = $250 \times 3.6 \times 10^6 = 9 \times 10^8$ 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 half-way down.
Answer:
Gravitational potential energy is given by the expression,
W = mgh
Where,
h = Vertical displacement = 5 m
m = Mass of the object = 40 kg
g = Acceleration due to gravity = 9.8 m s^{-2}
$\therefore W = 40 \times 5 \times 9.8 = 1960$ J.
At half-way down, the potential energy of the object will be 1960 / 2 = 980 J.
At this point, the object has an equal amount of potential and kinetic energy. This is due to the law of conservation of energy.
Hence, half-way down, the kinetic energy of the object will be 980 J.

11. What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer.
Answer: Work is done whenever the given two conditions are satisfied:

- A force acts on the body.
- There is a displacement of the body by the application of force in or opposite to the direction of force.

If the direction of force is perpendicular to displacement, then the work done is zero.
When a satellite moves around 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 Earth 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.
Answer:
Yes. For a uniformly moving object.
Suppose 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 a displacement without a force.

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