Assignments in Science Class IX (Term II)

11 Work and Energy

IMPORTANT NOTES

1. **Work :** Work is said to be done, when a force causes displacement in its own direction.
2. No work is done, if the displacement is not in the direction of applied force or its rectangular component.
3. **Factors which determine work :**
   (i) Work done is directly proportional to the magnitude of applied force.
   (ii) Work done is directly proportional to the displacement in the direction of applied force.
4. **Mathematical expression for work :**
   If F is the force, which causes a displacement S, in its own direction, such that W is the work done, then
   $$W = F \times S$$
5. **SI unit of work :** SI unit of work is Joule (J).
6. **Bigger units of work :**
   (a) kilojoule = 10^3 J = 1000 J
   (b) Megajoule = 10^6 J = 1000,000 J
   (c) Gigajoule = 10^9 J = 1000,000,000 J
7. **Definition of Joule :** When a force of 1 N, causes a displacement of 1 m in its own direction, the work done is said to be one joule.
   So, 1 J = 1 N × 1 m = 1 $kgms^{-2}$ × 1 m = 1 kgm^2s^{-2}.
8. **Energy :** Capacity of doing work is called energy.
9. **Units of energy :** Same as units of work, i.e., Joule.
10. **Potential energy :** The energy possessed by a body on account of its position or configuration is called potential energy.
11. **Mathematical expression for potential energy :**
    $$\text{P.E.} = mgh$$
    where 'm' is the mass, 'g' is the acceleration due to gravity and 'h' is the height.
12. **Characteristics of potential energy :**
    (a) Potential energy of a body at the surface of earth is taken as zero.
    (b) When a body is raised above the ground level, its potential energy increases.
    (c) When a body is brought from a height towards the ground, its potential energy decreases.
    (d) At any point above the surface of the earth, potential energy is numerically equal to the work done in raising the body.
13. **Kinetic energy :** The energy possessed by a body by virtue of its motion is called kinetic energy.
14. **Mathematical expression for kinetic energy :**
    $$\text{K.E.} = \frac{1}{2}mv^2$$
    where 'm' is the mass of the body and 'v' is the uniform velocity.
15. **Power :** Rate of doing work is called power.
16. **SI unit of power :** SI unit of power is watt (W), where 1 W = 1 Js^{-1}
17. **Mathematical expression for power :**
    $$P = \frac{W}{t}$$
    where 'P' is the power, 'W' is the work done (or energy used) and t is the time in seconds.
18. **Bigger units of power :**
    (a) kilowatt (kW) = 10^3 W = 1000 W
    (b) Megawatt (MW) = 10^6 W = 1000,000 W
    (c) Gigawatt (GW) = 10^9 W = 1000,000,000 W
19. **Definition of watt :** When a work of 1 J is done in 1 s, then the power is said to be 1 watt.
    $$1\ \text{W} = \frac{1\text{J}}{1\text{s}} = 1\text{kg}\frac{\text{m}^2}{\text{s}^2} \times \frac{1}{\text{s}} = 1\ \text{kgm}^2\text{s}^{-3}.$$

20. Law of conservation of energy : Energy in a system cannot be created, nor can it be destroyed. It may be transformed from one form to another form, but the total energy of the system remains constant.

ASSIGNMENTS FOR SUMMATIVE ASSESSMENT

I. VERY SHORT ANSWER QUESTIONS (1 Mark)

PREVIOUS YEARS' QUESTIONS

1. Seema tried to push a heavy rock of 100 kg for 200s but could not move it. Find the work done by Seema at the end of 200 s. **[2011 (T-II)]**

2. At what speed a body of mass 1 kg will have a kinetic energy of 1 J? **[2011 (T-II)]**

3. Define 1 Joule of work. **[2011 (T-II)]**

4. Identify the energy possessed by a rolling stone. **[2011 (T-II)]**

5. Identify the kind of energy possessed by a running athlete. **[2011 (T-II)]**

6. What would be the amount of work done on an object by a force, if the displacement of the object is zero? **[2011 (T-II)]**

7. How much work is done by a weight lifter when he holds a weight of 80 kgs on his shoulders for two minutes? **[2011 (T-II)]**

8. A car and a truck are moving with the same velocity of 60 km/hr. Which one has more kinetic energy? (Mass of truck > Mass of car). **[2011 (T-II)]**

9. A body is thrown vertically upwards. Its velocity goes on decreasing. Write the change in kinetic energy when its velocity becomes zero. **[2011 (T-II)]**

10. A force of 10 N moves a body with a constant speed of 2 m/s. Calculate the power of the body. **[2011 (T-II)]**

11. What will be the kinetic energy of a body when its mass is made four times and the velocity is doubled? **[2011 (T-II)]**

12. A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy on reaching the ground? **[2011 (T-II)]**

13. State the energy conversions in a dry cell. **[2011 (T-II)]**

14. What is the work done by the Earth in moving around the Sun? **[2011 (T-II)]**

15. A coolie is walking on a railway platform with a load of 30 kg on his head. How much work is done by coolie? **[2011 (T-II)]**

16. How many times does the kinetic energy of a body become when its speed is doubled? **[2011 (T-II)]**

17. In an oscillating pendulum, at what positions the potential and kinetic energy are maximum? **[2011 (T-II)]**

18. Define S.I. unit of work? **[2011 (T-II)]**

19. Name the type of energy possessed by a raised hammer? **[2011 (T-II)]**

20. What is the form of energy possessed by a running car? **[2011 (T-II)]**

21. State the value of commercial unit of electrical energy in joules? **[2011 (T-II)]**

22. A 2 m high person is holding a 25 kg trunk on his head and is standing at a roadways bus-terminus. How much work is done by the person? **[2011 (T-II)]**

23. A horse of mass 210 kg and a dog of mass 25 kg are running at the same speed. Which of the two possesses more kinetic energy? How? **[2011 (T-II)]**

24. If the speed of the body is halved, what is the change in its kinetic energy? **[2011 (T-II)]**

25. Moon is experiencing a gravitational force due to Earth and is revolving around the Earth in a circular orbit. How much work is done by moon? **[2011 (T-II)]**

26. Give the formula for calculating work done. What is the SI unit of work? **[2011 (T-II)]**

27. Define 1 watt of power. **[2011 (T-II)]**

28. A man holding a bucket of water on his head stands stationary. Is he doing any work? Give reason. **[2011 (T-II)]**

29. Name the type of energy possessed by the following? **[2011 (T-II)]**

(i) Stretched slinky (ii) Speeding car

30. Write the formula to measure the work done, if the displacement of the object is at an angle of 90° to the direction of force. **[2011 (T-II)]**

31. If we lift a body of mass 70 g vertically upwards

10 m then calculate the force required to lift the body (g = 10 ms^{-2}). **[2011 (T-II)]**

32. At what rate is electrical energy consumed by a bulb of 60 watt? **[2011 (T-II)]**

33. Give an example of a body having potential energy due to change of shape. **[2011 (T-II)]**

34. When is work done by a force zero? **[2011 (T-II)]**

35. If the heart works 60 joules in one minute, what is its power? **[2011 (T-II)]**

36. Name the term used for the sum of kinetic energy and potential energy of a body. **[2011 (T-II)]**

37. Write the observed energy transformation that takes place at thermal power station. **[2011 (T-II)]**

38. A 40 kg girl is running along a circular path of radius 1 m with a uniform speed. How much work is done by the girl in completing one circle? **[2011 (T-II)]**

39. Calculate the work done when a force of 15 N moves a body by 5 m in its direction. **[2011 (T-II)]**

40. Write the S.I. unit of power. **[2011 (T-II)]**

41. A student is writing a three hours science paper. How much work is done by student? Give reasons to your answer. **[2011 (T-II)]**

42. When displacement is in a direction opposite to the direction of force applied, what is the type of work done? **[2011 (T-II)]**

43. What is the work done against gravity when a body is moved horizontally along a frictionless surface? **[2011 (T-II)]**

OTHER IMPORTANT QUESTIONS

1. When does a force do work? How is this work measured?

2. State the mathematical expression for work.

3. What are the conditions for doing work?

4. Is work a scalar or a vector quantity?

5. Give one example of a moving body, where no work is done.

6. Explain, why no work is done when a man pushes a wall.

7. Define the term 'power'.

8. A boy climbs 100 stairs to reach at the top of a building. What happens to the potential energy of the boy?

9. Water flows down the mountains to the plains. What happens to the potential energy of water?

10. Give two examples in which a body possesses potential energy.

11. What do you understand by the term kinetic energy?

12. What determines the kinetic energy of a body of a given mass?

13. What is the biggest source of energy?

14. How is power related to work and time?

15. What do you understand by the term mechanical energy?

16. What do you understand by the term potential energy?

17. State the law of conservation of energy.

18. What do you understand by the term energy transformation?

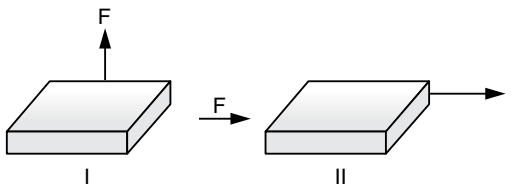
19. What kind of energy transformation takes place when the hands are rubbed?

II. SHORT ANSWER QUESTIONS - I (2 Marks)

PREVIOUS YEARS' QUESTIONS

1. The velocity of a body moving in a straight line is increased by applying a constant force F, for some distance in the direction of the motion. Prove that the increase in the kinetic energy of the body is equal to the work done by the force on the body. **[2011 (T-II)]**

2. 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 longer arrow. Observe the diagrams carefully and state whether work done by force is –ve, +ve or 0. **[2011 (T-II)]**



3. (a) Define 1 watt. **[2011 (T-II)]**

(b) An electric bulb of 60 W (sixty watt) is used for 6 (six) hours per day. Calculate the units of energy consumed in one day by the bulb.

4. (a) Is it possible that a force is acting on a body but still work done is zero? Explain giving one example. **[2011 (T-II)]**

(b) Two bodies of equal masses move with uniform velocities of v and $3v$ respectively. Find the ratio of their kinetic energies.

5. (a) How much work is done when a force of 1 N moves a body through a distance of 1 m in its direction?

(b) Is it possible that a force is acting on a body but still the work done is zero? Explain giving one example. **[2011 (T-II)]**

6. (a) What is meant by potential energy? Is potential energy a vector or scalar quantity?

(b) Given one example of a body having potential energy. **[2011 (T-II)]**

OTHER IMPORTANT QUESTIONS

1. A sparrow and a crow are having the same kinetic energy during a flight. Which of the two is moving fast and why?

2. Why does a satellite going around the Earth in a circular path does not work?

3. A locomotive exerts a force of 7500 N and pulls a train by 1.5 km. How much work is done by the locomotive in megajoules?

4. Why is no work done, when a force acts at right angles to the direction of displacement?

5. The energy of a torch cell is converted into two other forms of energy in a flashlight bulb. Name the energy conversions.

6. A man climbs a slope and another walks the same distance on a level road. Which of the two expends more energy and why?

7. A nail becomes hot when hammered into a plank. Explain, why?

8. If you apply 1 J of energy to lift a book of. 0.5 kg, how high will it rise? [Take g = 10 ms^{-2}]

9. What force will cause a displacement of 2 m, while doing a work of 60 J?

10. Calculate the work done by a machine of 50 W power rating in 30 s.

III. SHORT ANSWER QUESTIONS - II (3 Marks)

PREVIOUS YEARS' QUESTIONS

1. A mass of 10 kg is dropped from a height of 50 cm. Find its :

(a) potential energy just before dropping

(b) kinetic energy just on touching the ground

(c) velocity with which it hits the ground [Given g = 10 ms^{-2}] **[2011 (T-II)]**

2. (i) Define the term potential energy. Write the S.I. unit of potential energy.

(ii) A body of mass 50 kg is situated at a height of 10 m. What is its potential energy (Given g = 10 ms^{-2}) **[2011 (T-II)]**

3. (i) Define power. Mention its S.I. unit.

(ii) A body of mass 50 kg runs up a staircase of 40 steps in 8 s. If the height of each step is 15 cm, find his power. (Given, g = 10 ms^{-2}) **[2011 (T-II)]**

4. A light and heavy object have the same momentum, find out the ratio of their kinetic energies. Which one has a larger kinetic energy? **[2011 (T-II)]**

5. (a) Can any object have momentum even if its mechanical energy is zero? Explain why?

(b) A ball is dropped from a height of 10 m. If energy of the ball reduces by 40% after striking the ground, how high can the ball bounce back? (g = 10 m/s^2). **[2011 (T-II)]**

6. (a) Define potential energy. Write an expression for potential energy of an object of mass m raised through a height h.

(b) Find the energy possessed by an object of mass 10 kg when it is raised to a height of six metre above the ground given g = 9.8 ms^{-2}. **[2011 (T-II)]**

7. Define power. A boy of mass 45 kg climbs up 20 steps in 20 sec. If each step is 25 cm high, calculate the power of the boy used in climbing. (Take g = 10 m/s^2) **[2011 (T-II)]**

8. (a) Write the relation between commercial unit of electricity and the S.I. unit of energy. **[2011 (T-II)]**

(b) A boy of mass 45 kg climbs up 20 steps in 20 second. If each step is 25 cm high,

calculate the power used in climbing.

9. (a) When is work done by a force negative? **[2011 (T-II)]**

(b) Two bodies have their masses $m_1/m_2 = 3$ and their kinetic energies $E_1/E_2 = 1/3$. What will be the ratio of their velocities?

10. (a) Define one Watt.

(b) A lamp consumes 1000 J electrical energy in 10 s. What is its power? **[2011 (T-II)]**

11. The kinetic energy of an object of mass *m* moving with a velocity of 5 m/s is 25 J. Calculate its kinetic energy when its velocity is doubled? What will be its kinetic energy when its velocity is increased three times? **[2011 (T-II)]**

12. (a) If the speed of a particle is doubled, what will be the new kinetic energy?

(b) A spring is compressed, what change is expected in the potential energy of the spring? **[2011 (T-II)]**

13. Calculate the electricity bill amount for a month of April, if 4 bulbs of 40 W for 5 hrs, 4 tube lights of 60 W for 5 hrs, a T.V. of 100 W for 6 hrs, a washing machine of 400 W for 3 hrs are used per day. The cost per unit is Rs. 1.80. **[2011 (T-II)]**

14. A 5 kg ball is thrown upwards with a speed of 10 m/s. (take g = 10 m/s^2)

(a) Calculate the maximum height attained by it.

(b) Find the potential energy when it reaches the highest point. **[2011 (T-II)]**

15. Calculate the potential energy of an object of mass 50 kg raised to a height of 4 m above the ground. If the object falls down, what is the kinetic energy when it has fallen through 2 m? Take g = 9.8 m/s^2. **[2011 (T-II)]**

16. (a) Name the form of energy associate in each case. **[2011 (T-II)]**

(i) A flying bird.

(ii) A man climbing the stairs

(iii) A compressed watch spring

(iv) A fast moving object.

(b) What is the commerical unit of energy? And state its relation with S.I. unit of energy.

17. (a) Name the energy transformation taking place in the following devices : **[2011 (T-II)]**

(i) a motor

(ii) a car engine

(iii) a radio

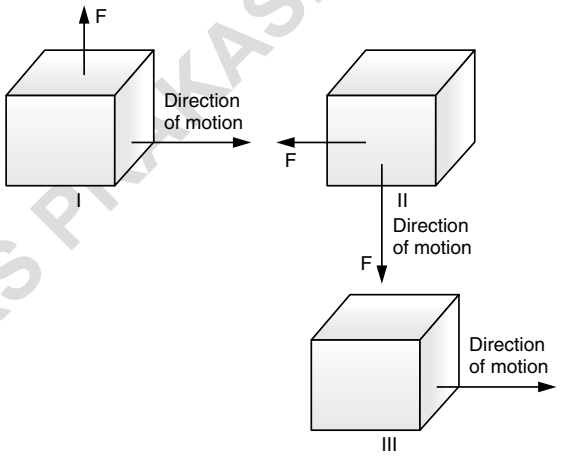
(iv) a nuclear reactor

(b) How much the work is done, when Earth moves around the Sun in its orbit?

18. (a) A truck and a car are running with same velocity. Which of the two has less kinetic energy?

(b) Give an example of electrical energy converted into light energy. **[2011 (T-II)]**

19. 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 arrows. Observe the diagram carefully and identify the case in which the work done by the force is (i) negative, (ii) positive (iii) zero. **[2011 (T-II)]**



20. Four persons jointly lift a 350 kg box to a height of 1 m and hold it.

(a) Calculate the work done by the persons in lifting the box.

(b) How much work do they do in just holding it?

(c) Why do they get tired while holding it? (g = 10 ms^{-2}) **[2011 (T-II)]**

21. State law of conservation of energy. Explain with the help of a simple pendulum. Illustrate if necessary. **[2011 (T-II)]**

22. A boy throws a rubber ball vertically upwards. What type of work is done; **[2011 (T-II)]**

(a) by the force applied by the boy?

(b) by the gravitational force?

Support your answer with reason.

23. (a) A ball of mass 0.5 kg slows down from a speed of 5 m/s to that of 3 m/s, calculate the change in kinetic energy of the ball.

(b) Which would have greater effect on the kinetic energy of an object-doubling the mass or doubling the velocity? **[2011 (T-II)]**

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

(b) An object is dropped from a height *h*. When is its

(i) potential energy maximum

(ii) kinetic energy maximum **[2011 (T-II)]**

OTHER IMPORTANT QUESTIONS

1. Derive an expression for kinetic energy of a body moving with a uniform velocity '*v*' and having a mass '*m*'.

2. Two bodies A and B of masses 4 kg and 16 kg respectively have the same kinetic energy. Calculate the ratio of their velocities.

3. A boy of mass of 50 kg runs up a flight of 120 stairs, each measuring 25 cm in one minute and 40 seconds. Calculate the power of the boy. [Take g = 10 ms^{-2}]

4. A motor pump of power 400 W operates for 2 minutes and 40 seconds and in doing so raises 200 kg of water to the top of a building. If g = 10 ms^{-2}, calculate the height of the building.

5. A truck and a car are running at the same speed. If the mass of the truck is 10 times that of the car, calculate the ratio of the kinetic energy of the truck with respect to the car.

6. A mass of 10 kg is dropped from a height of 50 cm. Find : (a) kinetic energy and (b) velocity, just as it reaches the ground. Does the velocity depend on the mass of the particle? Explain.

7. Write the energy change taking place when the heat of the Sun evaporates water, till it starts raining.

8. (i) A man whose mass is 50 kg, climbs up 30 steps of stairs in 30 seconds. If each step is 20 cm high, calculate the power used in climbing the stairs.

(ii) A boy pushes a box through 10 m across a floor, offering 50 N resistance. What is the work done by the resisting force?

IV. LONG ANSWER QUESTIONS (5 Marks)

PREVIOUS YEARS' QUESTIONS

1. Define work, energy and power. Give the SI units for each of the these quantities. A man whose mass is 80 kg climbs up 30 steps of the stairs in 30 s. If each step is 12.5 cm in height, calculate the power used in climbing the stairs, (g = 10 m/s^2). **[2011 (T-II)]**

2. Define kinetic energy and potential energy. Write an expression for K.E. of a body of mass *m* moving with a speed *v*. Find the kinetic energy of a stone of 10 kg moving with a velocity of 10 m/s. **[2011 (T-II)]**

3. (i) Derive an expression for the kinetic energy of an object. Write the S.I. unit of kinetic energy. **[2011 (T-II)]**

(ii) An object of mass 10 kg is moving with a uniform velocity of 5 ms^{-1}. Calculate the kinetic energy possessed by the object.

4. (i) Give the S.I. unit of power. **[2011 (T-II)]**

(ii) What is the commercial unit of energy?

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

5. (i) Define the potential energy.

(ii) Derive the expression for work done by an object with mass *m*, when it is to be raised to a height *h*, from the ground.

(iii) An object of mass 10 kg is at a certain height above the ground. If the potential energy of the object is 400 J, find the height at which the object is with respect to the ground. (Given, g = 10 ms^{-2}) **[2011 (T-II)]**

6. (i) State the law of conservation of energy.

(ii) Define mechanical energy.

(iii) Calculate the energy in kWh consumed in 10 hours by four devices of power 500 W each. **[2011 (T-II)]**

7. (a) State law of conservation of energy. Explain it with one example.

(b) Two girls each of weight 400 N (Four hundred N) climb up a rope through a height of 8 metres (eight metres). Girl A takes 20 (Twenty) seconds while Girl B takes fifty seconds to accomplish this task. What is the power expended by each girl?

(c) An electric heater is rated 1500 watt. How much energy does it used in 10 hours (ten hours)? **[2011 (T-II)]**

8. (a) Define work done by a constant force on an object. Write an expression also for the work done.

(b) How much work will be done on an object by a force if the displacement of the object is zero?

(c) What is the kinetic energy of an object? Write an expression for the kinetic energy of an object of mass m moving with a speed v. **[2011 (T-II)]**

9. Prove that the work done on a moving object is always equal to the change in its kinetic energy. Calculate the work done required to stop a car of mass 1500 kg moving with a velocity of 60 km/h. **[2011 (T-II)]**

10. (a) Define the term 'average power'. **[2011 (T-II)]**

(b) When a player hits a football it moves along the curved path and then falls to the ground. Calculate the work done by the force of gravity on the football.

(c) Two friends Ram and Shyam, each having weight of 40 kg, go for rock climbing. Ram climbs to a height of 3 m in 10 s and Shyam covers the same height in 12 s. Is the work done by Ram and Shyam equal? or not? Compare the power of Ram and Shyam.

11. (a) Give the mathematical relation between power, force and velocity.

(b) Can a body have energy, without having momentum? If yes, why?

(c) A car of mass 2000 kg is lifted up to a distance of 30 m by a crane in 1 minute. A second crane does the same job in a 2 minutes. What is the power applied by each crane? Do the cranes consume the same or different amount of fuel? **[2011 (T-II)]**

12. (a) Define work. State two factors on which the magnitude of work depends. **[2011 (T-II)]**

(b) A car and a truck have the same speed of 30 m/s. If their masses are in the ratio 1:3, find the ratio of kinetic energy?

13. What do you mean by work? Give an example of negative work done. What is the work to be done to increase the velocity of a car from 18 km/hr to 90 km/hr if the mass of the car is 2000 kg? **[2011 (T-II)]**

14. (a) How do we define power of a body. Also define 1 joule.

(b) State the transformation of energy taking place when :

(i) Green plants prepare their food.

(ii) Head of a nail is hammered hard and it becomes warm.

(c) With what velocity should a body of mass 4 kg be thrown so that it acquires 1.25 kJ of kinetic energy. **[2011 (T-II)]**

15. Derive an expression to calculate the energy for an object in motion and calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 km/h. **[2011 (T-II)]**

16. (a) A body of mass 15 kg possesses kinetic energy of 18.75 kJ. Find the velocity.

(b) An electric bulb of 100 W is used for 4 hrs a day. Calculate the energy consumed by it in a day in joules and kilowatt hour unit. **[2011 (T-II)]**

17. An object of mass 10 kg is made to fall freely from a height of 10 m. Complete the table :

Height of object (m)	PE (J)	KE (J)	Mechanical Energy (J)
10			
8			
5			
Just above ground			

Hence state the law of conservation of energy. **[2011 (T-II)]**

18. (a) A boy pushes a book by applying a force of 40 N. Find the work done by this force as the book is displaced through 25 cm along the path. **[2011 (T-II)]**

(b) A body of mass 'm' is raised to a vertical height h through two different paths X and Y. What will be the potential energy of the body in the two cases? Give reason for your answer.

(c) An electronic bulb of 60 W is used for 6 hours per day. Calculate the units of energy consumed in one day by the bulb.

19. (a) Define 'Power'. Differentiate between kilowatt and kilowatt hour.

(b) Two girls each of weight 400 N climb up a rope through a height of 8 m. Let the name of one of the girls is A and that of other is B. Girl A takes 20 s while B takes 50 s to accomplish this task. Calculate the power expended by each girl. **[2011 (T-II)]**

20. (a) List the factors on which the amount of work done depends.

(b) In a tug of war one team gives way to other. How much work is done by the wining team?

(c) Certain force acting on a 20 kg mass changes its velocity from 5m/sec to 2m/sec. Calculate the work done by the force. **[2011 (T-II)]**

21. (a) The K.E. of an object of mass m, moving with a velocity 5 m/s is 25 J. What will be its K.E. when its velocity is doubled and tripled? **[2011 (T-II)]**

(b) An object of mass 12 kg is at a certain height above the ground. If the P.E. of the object is 480 J, find the height at which the object is w.r.t. the ground. (Given g = 10 m/s^2)

22. (a) Define power. Give its S.I. unit.

(b) Two electric bulbs of 60 W each works for one hour a day. Calculate the units of energy consumed by these bulbs?

(c) If the rate per unit is Rs. 2.50, what will be the bill of the household using these bulbs for 10 days? **[2011 (T-II)]**

23. (a) What is the change seen when an object is pushed along an inclined plane to a height?

(b) A child pulls a toy attached to a string with a force of 5 N. If displacement of the toy along the floor is 10 m and angle formed between F and S is 30°, what is the work done on the object?

(c) Give any two examples where zero work is done. **[2011 (T-II)]**

24. (a) Define the S.I. unit of power.

(b) Establish a relationship between S.I. unit and commercial unit of energy.

(c) A car of weight 20000 N climbs up a hill at a steady speed of 8 m/s gaining a height of 120 m in 100 s.

Calculate;

(i) work done by the car.

(ii) power of engine of car. **[2011 (T-II)]**

OTHER IMPORTANT QUESTIONS

1. State the energy transformations taking place in the following cases :

(a) When brakes are applied to a speeding vehicle.

(b) When an arrow is released from a stretched bow.

(c) When someone speaks in front of a microphone.

(d) When a tuning fork is hit against a rubber pad.

(e) When the coil of a motor moves in a magnetic field.

2. State in each of the following cases, if work is done/not done and why?

(a) A girl climbing a staircase.

(b) A man standing and holding a briefcase in hand.

(c) A porter carrying a heavy load and going down the stairs.

(d) A boy preparing for examination.

(e) A planet going around the Sun.

3. (i) About how many kg of boiled potatoes would you have to eat to supply energy for half hour of swimming. Assume that your body utilises only 20% of the energy stored in potatoes. Energy content of potatoes is 3.7×10^6 J/kg and the energy used in swimming is 25.6 kJ/minute. (ii) A rocket of 3×10^6 kg mass takes off from a launching pad and acquires a vertical velocity of 1 kms^{-1} at an altitude of 25 km. Calculate (a) Potential energy (b) Kinetic energy.

[Take the value of g = 10 ms^{-2}]

4. (i) Distinguish between work, energy and power. State the S.I. units for each of these quantities.

(ii) A dog of mass 16 kg is running at a constant speed of 12 ms^{-1}. Calculate the kinetic energy of the dog.

5. (i) A body has a mass m and velocity *v*. If the mass is increased four times and velocity is decreased two times, calculate the ratio of the kinetic energies in the above cases.

(ii) Why does a truck moving at 18 kmh^{-1} cause far more serious accident than a cycle moving at the same speed?

(iii) What kind of energy transformation takes place when a sparkle is lighted?

ASSIGNMENTS FOR FORMATIVE ASSESSMENT

A. Group Activity

To find the average work done and power developed by a group of students.

Materials Required

50 bricks (used for building construction), a stop watch, a table, a measuring tape.

Procedure :

1. Place all the bricks close to the table, which is at least 70 cm in height or more.
2. Measure the height of the table with the help of a measuring tape and record it. Convert the height into metres from centimetres.
3. Ask one of the students to place bricks one by one on the table, as quickly as possible and start the stop watch.
4. When the stop watch records 100 s, ask the boy to stop placing the bricks.
5. Count the number of bricks. Assuming each brick is 5 kg, find the total mass of bricks raised in 100 s.
6. Calculate the work done by the boy from the expression :

   Work done = mass of brick × acceleration due to gravity × height of the table.

   For example, if the number of bricks raised is 23 and height of the table is 85 cm and 'g' is 10 ms^{-2}, then,

$$\text{Work done} = 23 \times 5\ (\text{kg}) \times 10(\text{ms}^{-2}) \times \frac{85}{100}(\text{m})$$

$$= 115(\text{kg}) \times 10(\text{ms}^{-2}) \times 0.85\ (\text{m})$$

$$= 977.5\ \text{J}$$

7. In order to calculate power, divide work done by time, which is 100 s in the present case.

$$\therefore\ \text{Power} = \frac{\text{Work done}}{\text{time}} = \frac{977.5\ \text{J}}{100\ \text{s}} = 9.77\ \text{W}$$

8. Repeat the activity with the other boys. There should be 10 or more boys in the group. In each case find the work done and power.
9. Add all the work done and divide it with the number of boys. You will get the average work done by the group.
10. Add all the powers and divide it with the number of boys. You will get the average power of the group.

B. Charts and Models

1. Prepare a pictoral chart showing five examples of a body having only

   (i) kinetic energy (ii) potential energy

   (iii) both kinetic and potential energy
2. Make a model of a windmill connected to a small dynamo and producing electric current. For strong wind you can use a blower.

C. Classroom Discussions

Discuss in class how and what type of energy conversions take place.

(i) A coin on rubbing on a wooden desk gets hot.

(ii) A microphone and a loudspeaker in unison produce loud sound.

(iii) Energy of coal produces electricity.

(iv) Fast running water can be used to produce electricity.

(v) Dry cells in a battery produce light energy.

(vi) The food which we consume helps us to do various activities.

D. Visits

Visit the nearest power generating station. It may be a hydropower station, a thermopower station or a wind supported power station. Make a detailed report on how electric energy is produced.

Class IX Chapter 11 – Work and Energy Science

Question 1:

A force of 7 N acts on an object. The displacement is, say 8 m, in the direction of the force (Fig. 11.3). Let us take it that the force acts on the object through the

displacement. What is the work done in this case?

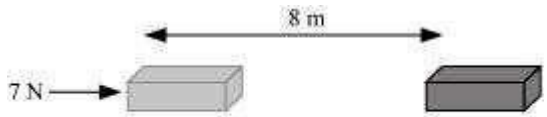


Fig 11.3

Answer:

When a force F acts on an object to displace it through a distance S in its direction, then the work done W on the body by the force is given by:

Work done = Force × Displacement

W = F × S

Where,

F = 7 N S

= 8 m

Therefore, work done, W = 7 × 8

= 56 Nm

= 56 J

When do we say that work is done?

Answer:

Work is done whenever the given conditions are satisfied:

(i) A force acts on the body.

(ii) There is a displacement of the body caused by the applied force along the direction of the applied force.

Question 2:

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

Answer:

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

Work done = Force × Displacement

$W = F \times s$

Question 3:

Define 1 J of work.

Answer:

1 J is the amount of work done by a force of 1 N on an object that displaces it through a distance of 1 m in the direction of the applied force.

Question 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?

Answer:

Work done by the bullocks is given by the expression:

Work done = Force × Displacement

$W = F \times d$

Where,

Applied force, F = 140 N

Displacement, d = 15 m W
= 140 × 15 = 2100 J

Hence, 2100 J of work is done in ploughing the length of the field.

What is the kinetic energy of an object?

Answer:

Kinetic energy is the energy possessed by a body by the virtue of its motion. Every moving object possesses kinetic energy. A body uses kinetic energy to do work. Kinetic energy of hammer is used in driving a nail into a log of wood, kinetic energy of air is used to run wind mills, etc.

Question 2:

Write an expression for the kinetic energy of an object.

Answer:

If a body of mass m is moving with a velocity v, then its kinetic energy E_K is given by the expression,

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

Its SI unit is Joule (J).

Question 3:

The kinetic energy of an object of mass, m moving with a velocity of 5 m s^{-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?

Answer:

Expression for kinetic energy is $E_k = \frac{1}{2}mv^2$

m = Mass of the object v = Velocity of the object

= 5 m s^{-1}

Given that kinetic energy, E_K = 25 J

(i) If the velocity of an object is doubled, then v = 5 × 2 = 10 m s^{-1}.

Therefore, its kinetic energy becomes 4 times its original value, because it is proportional to the square of the velocity. Hence, kinetic energy = 25 × 4 = 100 J. (ii) If velocity is increased three times, then its kinetic energy becomes 9 times its original value, because it is proportional to the square of the velocity. Hence, kinetic energy = 25 × 9 = 225 J.

What is power?

Answer:

Power is the rate of doing work or the rate of transfer of energy. If W is the amount of work done in time t, then power is given by the expression,

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

$$P = \frac{W}{T}$$

It is expressed in watt (W).

Question 2:

Define 1 watt of power:

Answer:

A body is said to have power of 1 watt if it does work at the rate of 1 joule in 1 s, i.e.,

$$1\ \text{W} = \frac{1\ \text{J}}{1\ \text{s}}$$

Question 3:

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

Answer:

Power is given by the expression,

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

Work done = Energy consumed by the lamp = 1000 J

Time = 10 s

$$\text{Power} = \frac{1000}{10} = 100\ \text{J s}^{-1}$$

= 100 W Question

4:

Define average power.

Answer:

A body can do different amount of work in different time intervals. Hence, it is better to define average power. Average power is obtained by dividing the total amount of work done in the total time taken to do this work.

$$\text{Average Power} = \frac{\text{Total work done}}{\text{Total time taken}}$$

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:

(i) A force acts on the body.

(ii) 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.

Question 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 × 0 = 0 J

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

Question 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:

$$\text{Chemical Energy} \rightarrow \text{Electrical Energy} \rightarrow \text{Light Energy} + \text{Heat energy}$$

Question 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,

$$(E_k)_v = \frac{1}{2}mv^2$$

Where,

E_k = Kinetic energy of the object moving with a velocity, v

m = Mass of the object

(i) Kinetic energy when the object was moving with a velocity 5 m s^{-1}

$$(E_k)_5 = \frac{1}{2} \times 20 \times (5)^2 = 250 \text{ J}$$

(ii) Kinetic energy when the object was moving with a velocity 2 m s^{-1}

$$(E_k)_2 = \frac{1}{2} \times 20 \times (5)^2 = 40 \text{ J}$$

Work done by force is equal to the change in kinetic energy.

Therefore, work done by force = $(E_k)_2 - (E_k)_5$

= 40 − 250 = −210 J

The negative sign indicates that the force is acting in the direction opposite to the motion of the object.

Question 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 the vertical 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, $h = 0$

$\therefore W = mg \times 0 = 0$

Hence, the work done by gravity on the body is zero.

Question 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.

Question 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:

$$\text{Muscular Energy} \rightarrow \text{Kinetic Energy} + \text{Heat Energy}$$

During the transformation, the total energy remains conserved.

Question 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.

Question 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 Question 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} ∴ W = 40 × 5 × 9.8 =

1960 J.

At half-way down, the potential energy of the object will be $\frac{1960}{2}$ = 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.

Question 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:

(i) A force acts on the body.

(ii) 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.

Question 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.

Question 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.

Answer:

Work is done whenever the given two conditions are satisfied:

(i) A force acts on the body.

(ii) There is a displacement of the body by the application of force in or opposite to the direction of force.

When a person holds a bundle of hay over his head, then there is no displacement in the bundle of hay. Although, force of gravity is acting on the bundle, the person is not applying any force on it. Hence, in the absence of force, work done by the person on the bundle is zero.

Question 14:

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

Answer:

Energy consumed by an electric heater can be obtained with the help of the expression,

$$P = \frac{W}{T}$$

Where,

Power rating of the heater, P = 1500 W = 1.5 kW Time for

which the heater has operated, T = 10 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 10 h is 15 kWh.

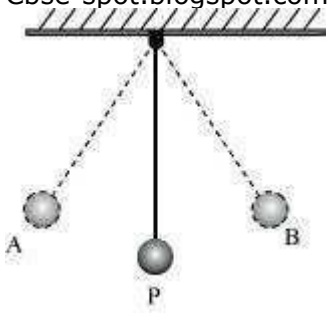
Question 15:

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?

Answer:

The law of conservation of energy states that energy can be neither created nor destroyed. It can only be converted from one form to another.

Consider the case of an oscillating pendulum.



When a pendulum moves from its mean position P to either of its extreme positions A or B, it rises through a height h above the mean level P. At this point, the kinetic energy of the bob changes completely into potential energy. The kinetic energy becomes zero, and the bob possesses only potential energy. As it moves towards point P, its potential energy decreases progressively. Accordingly, the kinetic energy increases. As the bob reaches point P, its potential energy becomes zero and the bob possesses only kinetic energy. This process is repeated as long as the pendulum oscillates.

The bob does not oscillate forever. It comes to rest because air resistance resists its motion. The pendulum loses its kinetic energy to overcome this friction and stops after some time.

The law of conservation of energy is not violated because 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 remain conserved.

Question 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?

Answer:

Kinetic energy of an object of mass, m moving with a velocity, v is given by the

expression,

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

To bring the object to rest, $\frac{1}{2}mv^2$ amount of work is required to be done on the object.

Question 17:

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

Answer:

Kinetic energy, $E_k = \frac{1}{2}mv^2$

Where,

Mass of car, m = 1500 kg

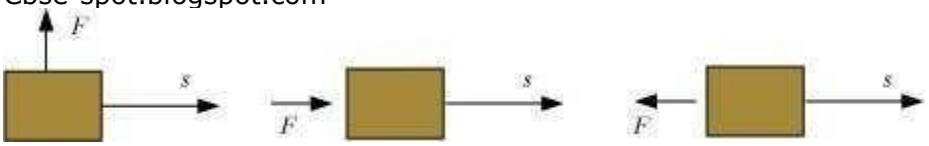
$$= 60 \times \frac{5}{18}\ \text{m s}^{-1}$$

Velocity of car, v = 60 km/h $\therefore E_k = \frac{1}{2} \times 1500 \times \left(60 \times \frac{5}{18}\right)^2 = 20.8 \times 10^4\ \text{J}$

Hence, 20.8×10^4 J of work is required to stop the car.

Question 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.



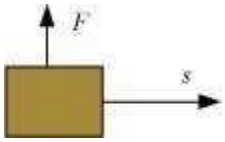
Answer:

Work is done whenever the given two conditions are satisfied:

(i) A force acts on the body.

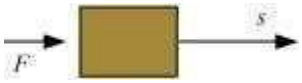
(ii) There is a displacement of the body by the application of force in or opposite to the direction of force.

Case I



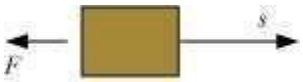
In this case, the direction of force acting on the block is perpendicular to the displacement. Therefore, work done by force on the block will be zero.

Case II



In this case, the direction of force acting on the block is in the direction of displacement. Therefore, work done by force on the block will be positive.

Case III



In this case, the direction of force acting on the block is opposite to the direction of displacement. Therefore, work done by force on the block will be negative.

Question 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?

Answer:

Acceleration in an object could be zero even when several forces are acting on it. This happens when all the forces cancel out each other i.e., the net force acting on the object is zero. For a uniformly moving object, the net force acting on the object is zero.

Hence, the acceleration of the object is zero. Hence, Soni is right.

Question 20:

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

Answer:

Energy consumed by an electric device can be obtained with the help of the expression for power,

$$P = \frac{W}{T}$$

Where,

Power rating of the device, P = 500 W = 0.50 kW

Time for which the device runs, T = 10 h

Work done = Energy consumed by the device

Therefore, energy consumed = Power × Time

= 0.50 × 10 = 5 kWh

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

Question 21:

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

Answer:

When an object falls freely towards the ground, its potential energy decreases and kinetic energy increases. As the object touches the ground, all its potential energy gets converted into kinetic energy. As the object hits the hard ground, all its kinetic energy gets converted into heat energy and sound energy. It can also deform the ground depending upon the nature of the ground and the amount of kinetic energy possessed by the object.