Chapter 3

Work and Energy

- In physics work is defined if force applied on object displaces the object in direction of force. We define the work as : Product of the force and displacement in the direction of applied force or product of displacement and force in the direction of displacement.

  W = Force × displacement (force in direction of displacement)
- The SI unit of force is a newton and the unit of length is a metre (m). So the SI unit of work is newton-meter which is written as Nm. This unit (Nm) is also called joule (J), i.e.

  1 joule = 1 newton . 1 metre

  Abbreviated, this is 1 J = 1 Nm

  When a force of 1 newton moves a body through a distance of 1 metre in its own direction the work done is 1 Joule.
- If displacement is in the direction of the force

  W = F × S

  force ↑↑ Displacement
  W = + ve

  When a horse pulls a cart, the applied force and the displacement are in the same direction. So, work done by the horse is positive.
- If displacement is in the direction opposite to the force.

  W = – F × S

  (W = – ve) ↑ force
  ↓ displacement
- If displacement is perpendicular to the force work done is zero.

  force ↑ → displacement

Examples :

(i) A coolie with a luggage on his head, moving on a horizontal platform, does no work, since the direction of force is vertically up and displacement horizontal (even though he might feel physically tired).

(ii) If a boy tries to push a heavy boulder, by applying a force, but unable to displace it, then work done by the boy is zero.

- The energy may be defined as the capacity of a body to do work. The SI unit of energy is joule (J). Quite often, a bigger unit called kilo Joule (kJ) is used. Energy is a scalar quantity.

  1 kilo Joule = 1000 Joules

  or 1 kJ = 1000 J

Forms of energy : The various forms include potential energy, kinetic energy, heat energy, chemical energy, and light energy.

- Energy possessed by a body by virtue of its state of motion is called Kinetic energy. Kinetic energy is always positive and is a scalar. The fact, that moving bodies carry energy with them is proved by some of the several happenings in day to day life.

  Kinetic Energy, $K = \frac{1}{2}mv^2$, when m is the mass and v is the velocity of body.

Examples :

(i) A stone thrown with some velocity, breaks the window pane.

(ii) A moving vehicle, when accidently happens to collide with another vehicle at rest or motion, leads to destruction.

- Potential energy is energy due to position. If a body is in a position such that if it were released it would begin to move, it has potential energy. There are two common forms of potential energy, gravitational and elastic.

(i) Gravitational Potential Energy (GP_E) : When an object is raised through a height work is said to be done on it against gravity. The energy possessed by such an object is called the gravitational potential energy.

(ii) Elastic Potential energy : This is a kind of potential energy which is due to a change in the shape of a body. The change in shape of a body can be brought about by stretching, compressing, bending and twisting the body. Some work has to be done to change the shape of a body. This work gets stored in the deformed body in the form of elastic potential energy.

- **Law of Conservation of Energy :** According to this law, energy can only be converted from one form to another: it can neither be created or destroyed. The total energy before and after the transformation remains the same. The law of conservation of energy is valid in all situations and for all kinds of transformations.
- Let an object of mass, m be made to fall freely from a height, h. At the start, the potential energy is mgh and kinetic energy is zero because its velocity is zero. The total energy of the object is thus mgh. As it falls, its potential energy will change into kinetic energy. If v is the velocity of the object at a given instant, the kinetic energy would be $\frac{1}{2}mv^2$. As the fall of the object continues, the potential energy would decrease while the kinetic energy would increase. When the object is about to reach the ground, h = 0 and v will be the highest. Therefore, the kinetic energy would be the largest and potential energy

the least. However, the sum of the potential energy and kinetic energy of the object would be the same at all points. That is, potential energy + kinetic energy = constant

or $mgh + \frac{1}{2}mv^2 = \text{constant}$

The sum of kinetic energy and potential energy of an object is its total mechanical energy.

- The time rate of doing work is defined as power (P). If equal works are done in different times, power will be different. More quickly work is done, power will be more.

$$\text{Power} = \frac{\text{work}}{\text{time}}$$

- The unit of power is the joule per second and this is called the watt (W). When large amounts of power are involved, a more convenient unit is the kilowatt (kW) where 1 kW = 1000 W.

1 Megawatt = 10^6 watt

Power was also measured earlier in a unit called horse power. Even these days, the unit of horse power is in common use.

1 horse power = 746 watt

The unit kilowatt-hour means one kilowatt of power supplied for one hour. It is, therefore, the unit of energy.

1 KWh = (1000 J/s) × 60 × 60s = 3.6×10^6 J

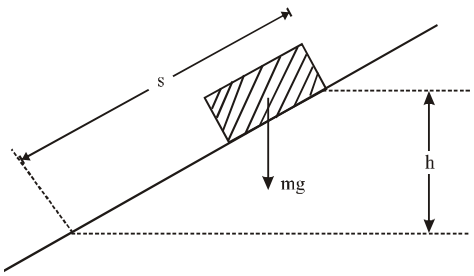
Exercise 1

DIRECTIONS : This section contains multiple choice questions. Each question has 4 choices (1), (2), (3) and (4) out of which only one is correct.

1. Which is not a unit of energy?
   (1) Watt second (2) Kilo watt hour
   (3) Watt (4) Joule
2. 1 kilowatt hour is equal to
   (1) 1 joule (2) 100 joule
   (3) 36 joule (4) 3.6×10^3 kilo joule
3. A stone of mass 1 kg is raised through 1m height
   (1) The loss of gravitational potential energy by the stone is 1 joule
   (2) The gain of gravitational potential energy by the stone is 1 joule
   (3) The loss of gravitational potential energy is 9.8 joule
   (4) The gain of gravitational potential energy is 9.8 joule
4. Scientific concept of work suggest that a work is said to be done if
   (1) a force acts on an object
   (2) the object must be displaced
   (3) energy must be consumed
   (4) Both (1) and (2)
5. A body of mass 1 kg has kinetic energy 1J when its speed is
   (1) 0.45 m/s (2) 1 m/s
   (3) 1.4 m/s (4) 4.4 m/s
6. The kinetic energy of a body will become eight times if –
   (1) its mass is made four times
   (2) its velocity is made four times
   (3) both the mass and velocity are doubled
   (4) both the mass and velocity are made four times
7. For a body falling freely under gravity from a height
   (1) only the potential energy goes on increasing
   (2) only the kinetic energy goes on increasing
   (3) both kinetic energy as well as potential energy go on increasing
   (4) the kinetic energy goes on increasing while potential energy goes on decreasing
8. Work done is defined as
   (1) product of force and displacement
   (2) distance through which the object is moved
   (3) mass of the object getting displaced
   (4) product of force and mass
9. The kinetic energy acquired by a body of mass 'm' after travelling a fixed distance from rest under the action of a constant force is
   (1) directly proportional to mass m
   (2) inversely proportional to mass m
   (3) inversely proportional to mass $m^{1/2}$
   (4) independent of mass m
10. If a force F is applied on a body and it moves with velocity v, the power will be –
    (1) Fv (2) F/v
    (3) Fv^2 (4) F/v^2
11. The kinetic energy of a body becomes twice its initial value. The new momentum of the body will be
    (1) 2 times (2) $\sqrt{2}$ times
    (3) 4 times (4) unchanged
12. Unit of work done is
    (1) Joule (2) Newton meter
    (3) Calorie (4) Both (1) and (2)
13. Kinetic energy of a body moving with speed 10 m/s is 30J. If its speed becomes 30 m/s, its kinetic energy will be
    (1) 10 J (2) 90 J
    (3) 180 J (4) 270 J
14. When you compress a coil spring you do work on it. The elastic potential energy
    (1) increases (2) decreases
    (3) disappears (4) remains the same
15. No work is done when
    (1) a nail is plugged into a wooden board
    (2) a box is pushed along a horizontal floor
    (3) there is no component of force parallel to the direction of motion
    (4) there is no component of force normal to the direction of force

16. Work done by a force can be
(1) only positive
(2) only negative
(3) both positive and negative
(4) None of these

17. The work done against gravity in moving the block a distance s up the slope is



(1) mh (2) mgs
(3) ms (4) mgh

18. Potential energy of your body is minimum when
(1) you are standing
(2) you are sitting on a chair
(3) you are sitting on the ground
(4) you lie down on the ground

19. A body of mass 2 kg is dropped from a height of 1 m. Its kinetic energy as it touches the ground is
(1) 19.6 N (2) 19.6 J
(3) 19.6 kg (4) 19.6 m

20. Negative value of work done indicates that
(1) force and displacement are in the same direction
(2) more than one force is acting on the object
(3) displacement and force are in opposite directions
(4) Both (2) and (3)

21. Work done is zero/when
(1) force and displacement of the body are in the same direction
(2) force and displacement of the body are in the opposite direction
(3) force acting on the body is perpendicular to the direction of the displacement of the body
(4) None of these

22. The energy of 4900 J was expanded in lifting a 50 kg mass. The mass was raised to a height of –
(1) 10 m (2) 98 m
(3) 960 m (4) 245000 m

23. When a stone is thrown upward to a certain height, it possesses
(1) potential energy (2) kinetic energy
(3) wind energy (4) sound energy

24. Capacity of doing work is termed as
(1) pressure (2) energy
(3) force (4) displacement

25. A fast wind can turn the blades of a windmill because it possesses –
(1) potential energy (2) kinetic energy
(3) chemical energy (4) heat energy

26. If a stone of mass m falls a vertical distance d, the decrease in gravitational potential energy is –
(1) mg/d (2) $md^2/2$
(3) mgd (4) md/g

27. A block of weight W is pulled a distance ℓ along a horizontal table. The work done by the weight is –
(1) $W\ell$ (2) 0
(3) $Wg\ell$ (4) $W\ell/g$

28. Unit of energy is
(1) same as the unit of work
(2) joule
(3) Both (1) and (2)
(4) Neither (1) nor (2)

29. The proper care and maintenance of machines require
(1) to make them good rooking
(2) for preserving them for future
(3) for their efficient and longer use
(4) None of these

30. Solar cookers are used
(1) to cook our food
(2) in artificial satellites
(3) converting into electrical energy
(4) in drying clothes and other materials

31. What is the sign of the work done by gravity on a man standing on a platform?
(1) Zero
(2) Positive
(3) Negative
(4) Depends on the particular situation

32. Kinetic energy of a moving object can represented mathematically as

(1) $E_k = \frac{1}{2} m v^2$ (2) $W = \frac{1}{2} m v^2$
(3) Both of these (4) None of these

33. A body at rest can have –
(1) speed (2) energy
(3) momentum (4) velocity

34. What is the sign of the work performed on an object in uniform circular motion?
(1) Zero
(2) Positive
(3) Negative
(4) Depends on the particular situation

35. A constant force of 10 N causes a box to move at a constant speed of 2 m/s. How much work is done in 10 seconds?
(1) 200 J (2) 50 J
(3) 10 J (4) 2 J

36. An object of 2 kg is moving with a velocity of 5 m/s. If its velocity is doubled, the kinetic energy will become
(1) 100 J (2) 25 J
(3) 200 J (4) 2.5 J

37. A mass is kept stationary by an external force. All of the following are true except –
(1) the point of application of the force does not move
(2) no work is done on the mass
(3) there is no net force on the mass
(4) the external force may perform work on the mass

38. A bird flying in the sky has –
(1) K.E. only
(2) P.E. only
(3) neither K.E. nor P.E.
(4) both K.E. and P.E.

39. The sum of the change in kinetic and potential energy is always
(1) zero (2) positive
(3) negative (4) None of the above

40. Potential energy of an object at a height is given as
(1) $E_p = \frac{1}{2}mv^2$ (2) $E_p = mgh$
(3) $E_p = w$ (4) All of these

41. A man of a mass 80 kg runs up a staircase in 12 seconds. Another man B of mass 60 kg runs up the same staircase in 11 seconds. The ratio of powers of A and B is –
(1) 11 : 12 (2) 11 : 9
(3) 12 : 11 (4) 9 : 11

42. A lorry and a car moving with the same K.E. are brought to rest by applying the same retarding force, then –
(1) lorry will come to rest in a shorter distance
(2) car will come to rest in a shorter distance
(3) both come to rest in a same distance
(4) None of the above

43. A weight-lifter lifts 200 kg from the ground to a height of 2 metre in 9 second. The average power generated by the man is
(1) 15680 W (2) 3920 W
(3) 1960 W (4) 980 W

44. Gravitational potential energy of an object will
(1) increase by increasing the path along which the object is moved
(2) decrease by increasing the path along which the object is moved
(3) not effected by changing the path, provided the overall height is same
(4) None of these

45. Total mechanical energy of an object is
(1) Potential energy + Kinetic energy = Constant
(2) $mgh + \frac{1}{2}mv^2$ = constant
(3) Both (a) and (b)
(4) None of these

46. Rate of doing work is termed as
(1) force (2) mechanical energy
(3) power (4) momentum

47. 1 kilowatt = -----
(1) 1000 W (2) 1000 J s^{-1}
(3) 1000 N m s^{-1} (4) All of these

48. Commercial unit of power is kilowatt-hour (kW h)
(1) 1 kWh = 3.6×10^6 J
(2) 1 kW h is the energy consumed in one hour at the rate of 1000 J s^{-1}
(3) 1 kW h = 1 unit of electrical energy
(4) All these statements are correct

49. An electrical appliance of 500 W is used for 5 hours per day. Energy consumed in 30 days will be
(1) 2.5 kW h (2) 25 kW h
(3) 75 kW h (4) None of these

50. Sun is said to be the ultimate source of energy. Solar energy gets transformed into
(1) chemical energy during photosynthesis
(2) heat energy in drying food grains
(3) electrical energy in solar cells
(4) All of these

51. The potential energy of a freely falling object decreases progressively.
(1) The law of conservation of energy is violated
(2) Potential energy gets converted into kinetic energy progressively
(3) Sum of Potential Energy and Kinetic Energy at any point during the free fall remains constant
(4) Both (2) and (3)

52. When a freely falling object hits the ground, its kinetic energy is
(1) Converted into heat energy
(2) Used to form a crater in the ground
(3) Collides and then rebounds
(4) Any of the three are possible

53. If velocity of a body is twice of previous velocity, then kinetic energy will become –
(1) 2 times (2) 1/2 times
(3) 4 times (4) 1 times

54. If the K.E. of a body is increased by 300%, its momentum will increase by –
(1) 100% (2) 150%
(3) $\sqrt{300}\%$ (4) 175%

55. A ball of mass 2 kg and another of mass 4 kg are dropped together from a 60 feet tall building. After a fall of 30 feet each towards earth, their respective kinetic energies will be in the ratio of –
(1) $\sqrt{2}:1$ (2) 1 : 4
(3) 1 : 2 (4) $1:\sqrt{2}$

56. A man of weight 60 kg wt. takes a body of mass 15 kg at a height 10m on a building in 3 minutes. The efficiency of mass is –
(1) 10% (2) 20%
(3) 30% (4) 40%

Exercise 2

Matching Based MCQ

DIRECTIONS (Qs. 1 to 5) : Match Column-I with Column-II and select the correct answer using the codes given below the columns.

1.

	Column-I		Column-II
(A)	Energy due to motion	(p)	Potential energy
(B)	Energy due to position	(q)	Kinetic energy
(C)	Energy stored in battery	(r)	Chemical energy
(D)	Energy between two charge particles at rest	(s)	Electrostatic energy

(1) (A) – (q); (B) – (p); (C) – (s); (D) – (r)
(2) (A) – (q); (B) – (p); (C) – (r); (D) – (s)
(3) (A) – (p); (B) – (q); (C) – (r); (D) – (s)
(4) (A) – (q); (B) – (r); (C) – (p); (D) – (s)

2.

	Column-I		Column-II
(A)	Electric motor	(p)	Electrical energy to sound energy
(B)	Electric bell	(q)	Electrical energy to mechanical energy
(C)	Electric bulb	(r)	Light energy to electrical energy
(D)	Photoelectric cell	(s)	Heat energy to mechanical energy
(E)	Steam engine	(t)	Electric energy to light energy

(1) (A) – (p); (B) – (q); (C) – (t); (D) – (r); (E) – (s)
(2) (A) – (q); (B) – (p); (C) – (r); (D) – (t); (E) – (s)
(3) (A) – (q); (B) – (p); (C) – (t); (D) – (s); (E) – (r)
(4) (A) – (q); (B) – (p); (C) – (t); (D) – (r); (E) – (s)

3.

Column-I	Column-II
(A) Chemical → Heat → K.E.	(p) Rubbing of hands
(B) K.E. → Heat energy	(q) A container filled with marbles is shaken
(C) Electrical energy → Kinetic energy	(r) A duster falling from a table
(D) Potential energy → Sound energy	(s) Launch of a rocket
(E) Chemical energy → Heat, light and sound energy	(t) A cracker bursts
(F) K.E. → Sound energy	(u) Starting of a washing machine

(1) (A) – s; (B) – p; (C) – u; (D) – r; (E) – t; (F) – q
(2) (A) – p; (B) – q; (C) – r; (D) – s; (E) – t; (F) – u
(3) (A) – u; (B) – t; (C) – s; (D) – r; (E) – q; (F) – p
(4) (A) – q; (B) – p; (C) – s; (D) – r; (E) – t; (F) – u

4.

Column-I	Column-II
(A) 1 unit	(p) Force against displacement
(B) Mean position	(q) Heat energy
(C) Work done is –ve	(r) Newton-metre
(D) Joule	(s) Maximum K.E.
(E) Hammering a nail	(t) 3.6×10^6 joule

(1) (A) → q, (B) → p, (C) → s, (D) → t, (E) → r
(2) (A) → p, (B) → r, (C) → t, (D) → s, (E) → q
(3) (A) → t, (B) → s, (C) → p, (D) → r, (E) → q
(4) (A) → p, (B) → t, (C) → q, (D) → s, (E) → r

5.

Column-I	Column-II
(A) Electrical to mechanical	(p) A.C. generator
(B) Mechanical to electrical	(q) 4.186 joule
(C) 60 kg man climbing 75 steps of 0.25 m each	(r) Electric motor
(D) 1 calorie	(s) 11, 250 joule

(1) (A) → r, (B) → p, (C) → s, (D) → q
(2) (A) → p, (B) → s, (C) → q, (D) → r
(3) (A) → q, (B) → r, (C) → p, (D) → s
(4) (A) → s, (B) → q, (C) → r, (D) → p

Statement Based MCQ

6. Consider the following statements :
(a) Work is always done on a body when it experiences an increase in energy through a mechanical influence.
(b) Work done by the resultant force is always equal to change in kinetic energy.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

7. Consider the following statements :
(a) Work done in the motion of a body over a closed loop is zero for every force in nature.
(b) No work is done on a particle which remains at rest.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

8. Consider the following statements :
(a) A light and a heavy body, having equal momenta, have equal kinetic energies.
(b) The total energy of a body in motion is equal to the work it can do in being brought to rest.
(c) A body cannot have momentum when its energy is zero.
Which of these statement(s) is/are correct ?
(1) (a) and (b) (2) (b) and (c)
(3) Only (b) (4) Only (c)

9. Consider the following statements :
(a) Kinetic energy of a body depends upon the direction of motion.
(b) When a body falls freely, its P.E. is converted into K.E.
(c) A body at rest may possess P.E.
Which of these statement(s) is/are correct ?
(1) (a) and (b) (2) (b) and (c)
(3) Only (b) (4) Only (c)

10. Consider the following statements :
(a) The unit of power is joule/sec.
(b) In a toy car greater the number of turns of the winding key smaller is the distance travelled.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

11. Consider the following statements :
(a) A person standing for a long time with a suitcase on his head does no work in terms of physics.
(b) There cannot be any displacement of an object in the absence of any force acting on it.
(c) The law of conservation of energy is valid in all situations and for all kinds of transformations.
Which of these statement(s) is/are correct ?
(1) (a) and (b) (2) (a) and (c)
(3) (b) and (c) (4) All are correct

12. Consider the following statements :
(a) More work is done in compressing a litre of air than a litre of water from a pressure of one atmosphere to three atmospheres.
(b) A man rowing a boat up stream is at rest with respect to the shore, is doing no work.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

13. Consider the following statements :
(a) A man carrying a bucket of water, walking on a level road with a uniform velocity does no work.
(b) Work done by friction can-never be positive.
Which of these statement(s) is/are correct ?
(1) (a) only (2) (b) only
(3) Both (a) and (b) (4) Neither (a) nor (b)

Passage Based MCQ

DIRECTIONS (Qs. 14 to 18) : Read the passage(s) given below and answer the questions that follow.

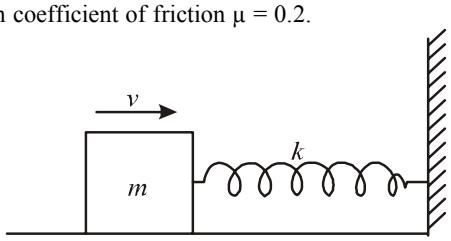
PASSAGE - 1

Centripetal force is a requirement for circular motion. No work is done on a body by centripetal force in a circular path.

14. The work done by a centripetal force –
    (1) increases by decreasing the radius of the circle
    (2) decreases by increasing the radius of the circle
    (3) increases by increasing the mass of the body
    (4) is always zero
15. The moon revolves around the earth because the earth exerts a radial force on the moon. Does the earth perform work on the moon ?
    (1) No (2) Yes, sometimes
    (3) Yes, always (4) Cannot be decided

PASSAGE - 2

A block of mass m = 2kg strikes an elastic spring of spring constant k = 100 Nm^{-1} with a speed 30 cms^{-1}. The surface is rough with coefficient of friction $\mu = 0.2$.



16. The maximum compression in the spring is
    (1) 5 cm (2) 10 cm
    (3) 20 cm (4) 25 cm
17. The velocity with which the block leaves the spring during return journey is
    (1) 10 cms^{-1} (2) 20 cms^{-1}
    (3) 30 cms^{-1} (4) zero
18. Work done by friction in the round trip is
    (1) 0.4 J (2) 0.8 J
    (3) 0.9 J (4) zero

Assertion Reason Based MCQ

DIRECTIONS (Qs. 19 to 25) : Following questions consist of two statements, one labelled as the 'Assertion' and the other as 'Reason'. You are to examine these two statements carefully and select the answer to these items using the code given below.

Code :

(1) Both A and R are individually true and R is the correct explanation of A:
(2) Both A and R are individually true but R is not the correct explanation of A.
(3) A is true but R is false
(4) A is false but R is true.

19. **Assertion :** A kinetic energy of a body is quadrupled, when its velocity is double.
    Reason : Kinetic energy is proportional to square of velocity.
20. **Assertion :** The change in kinetic energy of a particle is equal to the work done on it by the net force.
    Reason : Change in kinetic energy of particle is equal to the work done only in case of system of one particle.
21. **Assertion :** A moving hammer drives a nail into wood.
    Reason : A moving hammer has potential energy.
22. **Assertion :** A man gets completely exhausted in trying to push a stationary wall.
    Reason : Work done by the man on the wall is zero.
23. **Assertion :** The driver increases the speed of his car on approaching a hilly road.
    Reason : To give more kinetic energy to the car so that it may go up against gravity.
24. **Assertion :** Winding up the spring of a toy car gives it energy for moving.
    Reason : Work done in winding the spring get stored up as kinetic energy.
25. **Assertion :** A car engine convert heat energy into chemical energy.
    Reason : A car burns fuel to get energy.

Correct Definition Based MCQ

26. Power is defined as
    (1) work per unit length
    (2) force per unit length
    (3) work per time
    (4) work per unit time
27. Potential energy is defined as
    (1) energy of motion
    (2) energy of configuration
    (3) total mechanical energy
    (4) energy of acceleration
28. Total mechanical energy is defined as
    (1) kinetic energy
    (2) potential energy
    (3) the sum of the kinetic and potential energy
    (4) the sum of the change of the kinetic and potential energy

Feature Based MCQ

29. On the basis of following features identify the correct option.
    (I) This energy is due to motion of body.
    (II) Moving air posses this energy.
    (1) Nuclear energy (2) Sound energy
    (3) Mechanical energy (4) Chemical energy
30. On the basis of following features identify the correct option.
    (I) Natural source of this energy is Sun.
    (II) This form of energy gives us the sensation of vision.
    (1) Heat energy (2) Light energy
    (3) Both (1) and (2) (4) Neither (1) nor (2)
31. On the basis of following features identify the correct option.
    (I) Unit of this quantity is joule per second.
    (II) It can be calculated by formula work/time.
    (1) Power (2) Energy
    (3) Rate of doing work (4) Both (1) and (3)
32. On the basis of following features identify the correct option.
    (I) This type of energy posses kinetic energy.
    (II) This energy is used to pump water and mill grain.
    (1) Wind energy (2) Geothermal energy
    (3) Mechanical energy (4) Both (1) and (3)

Hints SOLUTIONS

Exercise 1

1. **(3)** **2.** **(4)** **3.** **(4)**

4. **(4)** Scientific concept of work suggest that a work is said to be done if a force acts on an object and the object gets displaced.

5. **(3)** **6.** **(3)** **7.** **(4)**

8. **(1)** Work done is defined as the product of force and displacement.

9. **(4)** **10.** **(1)** **11.** **(2)**

12. **(4)** Unit of work done is Joule or Newton meter.

13. **(4)** **14.** **(1)** **15.** **(4)**

16. **(2)** Work done by a force can be both negative and positive.

17. **(4)** **18.** **(4)** **19.** **(2)**

20. **(4)** Negative value of work indicates that more than one force is acting on the object. The displacement and force are in opposite directions.

21. **(3)** **22.** **(1)** **23.** **(1)**

24. **(2)** Energy is the capacity of doing work.

25. **(1)** **26.** **(3)** **27.** **(2)**

28. **(3)** Unit of energy is same as the unit of work, i.e. Joule.

29. **(3)** **30.** **(1)** **31.** **(1)** **32.** **(1)**

33. **(2)** **34.** **(1)** **35.** **(1)** **36.** **(2)**

37. **(4)** **38.** **(4)** **39.** **(1)** **40.** **(2)**

41. **(2)** **42.** **(3)** **43.** **(4)**

44. **(3)** The gravitational potential energy is not affected by the path followed provided the overall height is same.

45. **(3)** Mechanical energy = Potential energy + Kinetic energy.

46. **(3)** Rate of doing work is called power.

47. **(4)** 1 kilowatt = 1000 W = 1000 J s^{-1} = 1000 N m s^{-1}.

48. **(4)** 1 kW h = 3.6×10^6 J; 1 kW h is the energy consumed in one hour at the rate of 1000 Js^{-1}. 1 kW h is commonly referred to as a unit of electrical energy.

49. **(3)** Energy consumed = Work done = 0.5 kW × 5 hours × 30 days = 75 kW h.

50. **(4)** Solar energy can be transformed into chemical, electrical, heat or mechanical energy by using suitable equipments.

51. **(4)** Potential energy gets converted into kinetic energy progressively and the sum of potential energy and kinetic energy at any point during the free fall remains constant.

52. **(3)** The change in momentum on collision is likely to make the object rebound. The momentum of the object can cause a crater in the ground. The kinetic energy will be converted into heat energy.

53. **(3)** Kinetic energy = $\frac{1}{2}mv^2$ $\therefore$ K.E. $\propto v^2$

If velocity is doubled then kinetic energy will become four times.

54. **(1)** Let initial kinetic energy, $E_1 = E$

Final kinetic energy, $E_2 = E + 300\%$ of $E = 4E$

As $p \propto \sqrt{E} \Rightarrow \frac{p_2}{p_1} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{4E}{E}} = 2 \Rightarrow p_2 = 2p_1$

$\Rightarrow p_2 = p_1 + 100\%$ of p_1

i.e. momentum will increase by 100%.

55. **(3)** Kinetic energy = $\frac{1}{2}mv^2$

As both balls are falling through same height therefore they possess same velocity.

But KE $\propto$ m (If v = constant)

$\therefore \frac{(KE)_1}{(KE)_2} = \frac{m_1}{m_2} = \frac{2}{4} = \frac{1}{2}$

56. **(2)** Efficiency

$$\eta = \frac{\text{useful work}}{\text{spent work}} = \frac{15gh}{(15+60)\,gh} = \frac{15}{75} = \frac{1}{5} = 20\%$$

Exercise 2

1. **(2)** **2.** **(4)** **3.** **(1)** **4.** **(3)** **5.** **(1)**

6. **(3)**

7. **(2)** If a body is under the action of a force that does no net work during any closed loop, then the force is conservative. If work is done, the force is nonconservative.

8. **(4)** Because they have equal momenta, hence equal mv, the heavy body will move very slowly and the light body will move very quickly. As Kinetic energy is $\frac{1}{2}mv^2$. Thus the speed of the light body will be high giving a higher kinetic energy to it in comparison to the kinetic energy of heavy body.

9. **(2)** Kinetic energy is a scalar quantity it does not have a direction.

10. **(1)**

11. **(2)** Yes. If a particle is moving and there is no force on it, then it will continue to move with constant velocity. Thus it will have displacement.

12. **(3)**

13. **(1)** When you walk we push the ground back but the friction tries to oppose the motion and acts in the forward direction. So the work done becomes positive.

14. **(1)** **15.** **(4)**

16. **(2)** By work-energy theorem,

Work done by all the forces = Change in K.E

or $-\mu mg\ x - \frac{1}{2}kx^2 = -\frac{1}{2}mu^2$ (x = non. compression)

or $\frac{1}{2}kx^2 + \mu mgx - \frac{1}{2}mu^2 = 0$

or $50x^2 + 4x - 0.9 = 0$ or $x = 0.1$ m = 10 cm

17. **(1)** $\frac{1}{2}mv^2 = \frac{1}{2}mu^2 - 2\mu mgx$ or $v = 10$ cms^{-1}

18. **(2)** Work done by friction in round trip,

$W = -2\,\mu mgx = -2 \times 0.2 \times 2 \times 10 \times 0.1 = 0.8$ J

19. **(1)** **20.** **(3)**

21. **(3)** A moving hammer has mechanical energy (in the form of kinetic energy).

22. **(1)** **23.** **(1)**

24. **(3)** By winding the toy we squeeze a spring inside the toy, and that spring is just waiting to be released so it can expand back to its normal size. This energy, stored in the spring, is called potential energy. It is called potential energy because it has the ability or potential to become the energy of motion.

25. **(4)** In car engine chemical energy of fuel on burning gets converted into heat energy which further gets converted into mechanical energy.

26. **(4)** **27.** **(2)** **28.** **(3)** **29.** **(3)** **30.** **(2)** **31.** **(4)** **32.** **(1)**