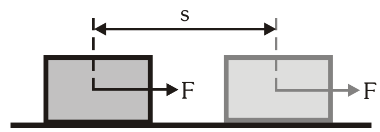
11. WORK, ENERGY, POWER

- In common usage, the word 'work' means any physical or mental exertion. But in physics, the word 'work' has a definite and precise meaning.
  - Two important conditions that must be satisfied for work to be done are : (i) a force should act on an object (ii) the object must be displaced. If any one of the above conditions does not exist, work is not done. For example, when a student holds the chair in his hand, he exerts a force to support the chair. But, work is not done on the chair as the chair does not move.
- **Mathematical definition of work :**
  - **A constant force is applied in the direction of the displacement of an object :** Let W be the work done. Here, we define work to be equal to '**the product of the force and displacement**'.

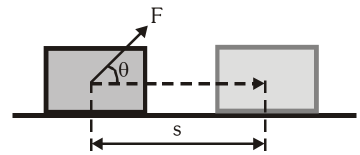
    Work done = force × displacement

    $\boxed{W = F \times s}$



Work done by a constant force acting in the direction of displacement

  - **A constant force is applied at a certain angle with the direction of the displacement of an object :** The work done on the object is given by,

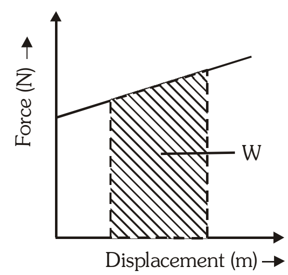


Work done by a constant force acting at an angle with the direction of displacement

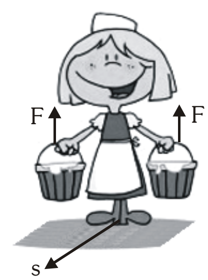
    $\boxed{W = F \times s \times \cos\theta}$

    Where, the angle between the force and the direction of the displacement is θ (see fig.).

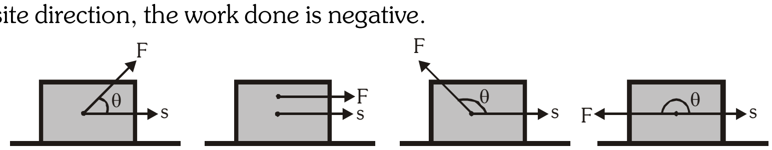
    Here, we define work to be equal to '**the force multiplied by the displacement multiplied by the cosine of the angle between them**'.



  - Area under the force (F) - displacement (s) graph gives the work done on an object or a system.
  - Work is a scalar quantity, it has only magnitude and no direction.
  - **SI unit of work :** Joule. 1 Joule = 1 newton ×meter or **1 J = 1 N m**
  - **Definition of 1 joule :** 1 J is the amount of work done on an object when a force of 1 N displaces it by 1 m along the line of action of the force.
  - **C.g.s unit of work :** erg. 1 erg =1 dyne ×cm **1 J = 10^7 ergs**
  - **Some important points related to work :**
    - If θ = 0°, then cos 0° = 1 and W = F × s.
    - If θ = 90°, then, W= 0 because cos 90° = 0. So, no work is done on a buckets being carried by a girl walking horizontally (see fig.) The upward force exerted by the student to support the bucket is perpendicular to the displacement of the bucket, which results in no work done on the bucket.



    - If θ = 180°, then cos 180° = −1 and W = − F × s.
- **Concept of negative and positive work :** The work done by a force can be either positive or negative.
  - Whenever angle (θ) between the force and the displacement is acute, i.e., 0° < θ < 90°, the work done is positive. Also, when angle (θ) between the force and displacement is zero, i.e., force and displacement are in same direction, the work done is positive.
  - Whenever angle (θ) between the force and the displacement is obtuse, i.e., 90° < θ < 180°, the work done is negative. Also, when angle (θ) between the force and displacement is 180°, i.e., force and displacement are in opposite direction, the work done is negative.



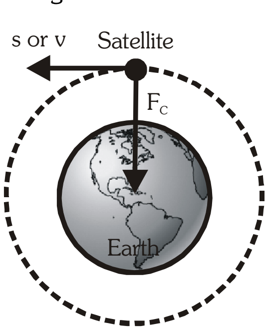
θ is acute angle
Work is positive
(a)

θ is zero
Work is positive
(b)

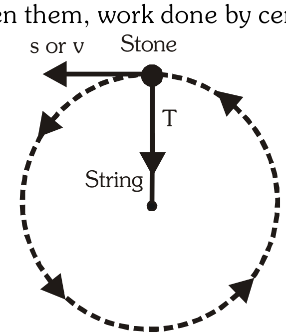
θ is obtuse angle
Work is negative
(c)

θ is 180°
Work is negative
(d)

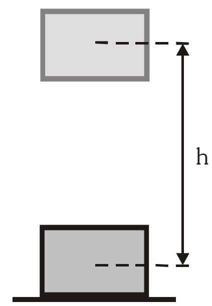
- Whenever force is in the direction of motion, velocity of the object increases and the work done is positive.
- Whenever force opposes motion, velocity of the object decreases and the work done is negative.
- Work done by the centripetal force is always zero because centripetal force (F) is always perpendicular to the displacement (s) of the particle moving along a circular path. That is, the angle (θ) between them is 90°.
  Work done, $W = F\, s \cos\theta = F\, s \cos 90° = 0$
  For example, if an electron moves around a nucleus in a circular path due to centripetal force provided by the electric force between them, if a stone is whirling in a circular path due to tension in the string, if an artificial satellite is moving around the earth in a circular path due to centripetal force provided by the gravitational force between them, work done by centripetal force is zero.



F_C is perpendicular to s
Work done by $F_C = 0$



Tension T in the string
is perpendicular to s
Work done by T = 0

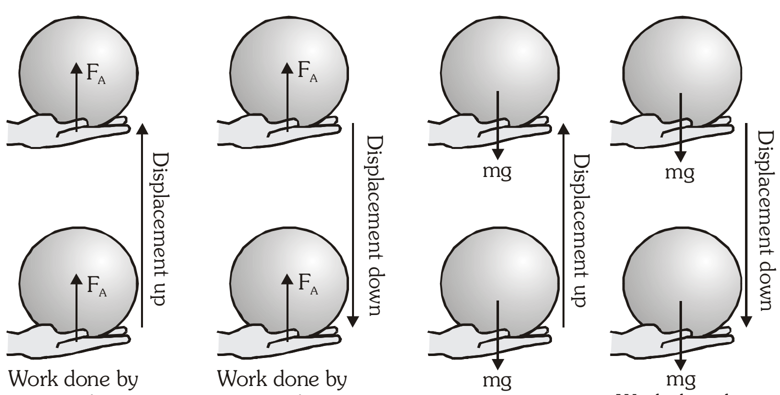


Work done
against gravity

■ **Work done by applied force against gravity :**

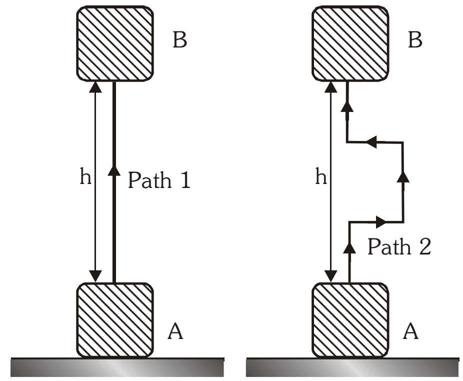
If an object is lifted up to a certain height (see fig), definitely, a work is done by the applied force. The applied force must be equal to the weight (= mg) of the object.
This work done is given by,
$\mathbf{W = F \times s = mgh}$
Where, m = mass of object ; g = acceleration due to gravity ; h = height.

- Whenever a person holds an object in his hands or supports an object over his head, he is always applying a force in upward direction.
  - When a person lifts a body from the ground i.e., displaces it in upward direction, the work done by him is positive (see fig.) as force and displacement are in same direction. When a person puts an object from a certain height to the ground i.e., displaces it in downward direction, the work done by him is negative (see fig.) as force and displacement are in opposite direction.
  - When a person lifts a body from the ground i.e., displaces it in upward direction, the work done by force of gravity is negative (see fig.) as force of gravity and displacement are in opposite direction. When a person puts an object from a certain height to the ground i.e., displaces it in downward direction, the work done by the force of gravity is positive (see fig.) as force of gravity and displacement are in same direction.



Work done by applied force is positive | Work done by applied force is negative | Work done by gravity is negative | Work done by gravity is psoitive

- The work done against gravity depends on the difference in vertical heights of the initial and final positions of the object and not on the path along which the object is moved. (Such forces which are called conservative forces; force of gravity is also a conservative force.) In the adjoining figure, in both the situations, the work done on the object is 'mgh'.



■ **Energy :** Energy is the capacity to do work. Thus, when you think of energy, think of what work is involved.

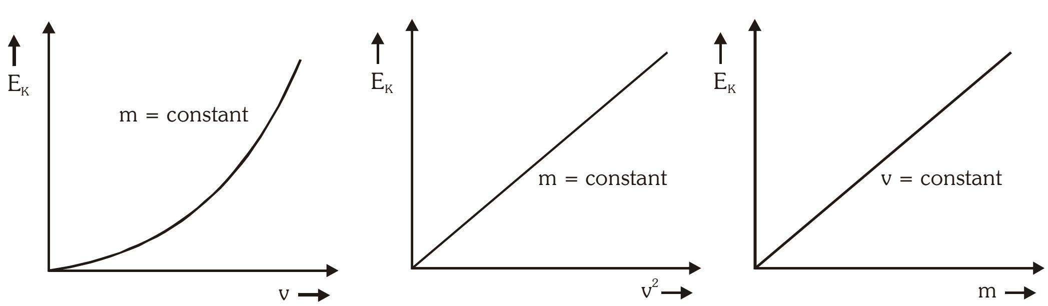
- An object that possesses energy can exert a force on another object. When this happens, energy is transferred from first object to the second object. The second object may move as it receives energy and therefore do some work. Thus, the first object had a capacity to do work. This implies that any object that possesses energy can do work.
- The object which does the work loses energy, and the object on which the work is done gains energy.
- SI unit of energy : Since, energy is the capacity to do work, its unit is same as that of work, that is, joule (J). 1 J is the energy required to do 1 joule of work. Sometimes a larger unit of energy called kilo joule (kJ) is used, 1 kJ = 1000 J.
- C.G.S. unit : Erg $1\ J = 10^7$ ergs

■ **Forms of energy :** The world we live in provides energy in many different forms. The various forms include potential energy, kinetic energy, heat energy, chemical energy, electrical energy and light energy.

- **Mechanical energy :** The capacity to do mechanical work is called mechanical energy. Mechanical energy can be of two types : (1) Kinetic energy (2) Potential energy

  The sum of the gravitational potential energy and the kinetic energy is called mechanical energy.
- **Kinetic energy :** This is the energy a body has due to its movement. To give a body KE, work must be done on the body. The amount of work done will be equal to the increase in KE.
  - Kinetic energy is the energy associated with an object in motion.
  - Kinetic energy possessed by an object of mass, m and moving with a uniform velocity, v is

    $$\boxed{E_k = \frac{1}{2}mv^2}$$
  - For a given mass, $E_K \propto v^2$. That is, more the value of v, more will be the kinetic energy.
  - For a given velocity, $E_K \propto m$. That is, more the mass, more will be the kinetic energy of a body.

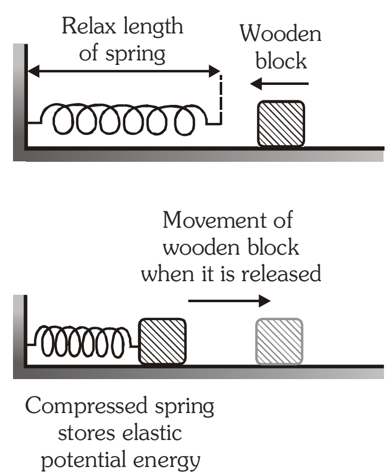


Graphs relating kinetic energy, velocity and mass.

- **Potential energy :** The energy possessed by an object due to its position or configuration is called 'potential energy'.
  - Potential energy is associated with an object that has the potential to move because of its position or configuration.
  - **Gravitational potential energy :** Gravitational potential energy is energy due to an object's position in a gravitational field.
  - Imagine an egg falling off a table. As it falls, it gains kinetic energy. But, where does the egg's kinetic energy come from ? It comes from the gravitational potential energy that is associated with the egg's initial position on the table relative to the floor.
  - We know that, the work done on the object against gravity is W = mgh. This work done is the energy gained by the object. This is the potential energy (E_p) of the object. That is,

    $$\boxed{E_p = W = mgh}$$

    The above formula actually represents, change in potential energy $\Delta E_p = (E_{pf} - E_{pi})$. Assuming initial potential energy as zero and final potential energy = E_p, we get, $\mathbf{E_p = mgh}$.
  - If in a problem, several masses are involved at different vertical positions, then you can assume the potential energy of the mass at the lowest position as zero and you find the potential energies of other masses with respect to the mass at lowest position.
  - **Elastic potential energy** : Suppose a spring is placed on a tabletop and it is fixed at one end. Now, push a block on the spring, compressing the spring, and then release the block. The block slides across the tabletop.
  - The kinetic energy of the block came from the stored energy in the compressed spring (see fig.). This potential energy is called **elastic potential energy**.
  - Elastic potential energy is stored in any compressed or stretched elastic object, such as a spring or the stretched strings of a tennis racket or guitar.
  - The length of a spring when no external forces are acting on it is called the relaxed length of the spring. The amount of energy depends on the distance the spring is compressed or stretched from its relaxed length.



  - The elastic energy stored in a spring is given by, $\boxed{E_p = \frac{1}{2}Kx^2}$

    Where, K = spring constant or force constant and x = distance compressed or stretched from the relaxed position of a spring. For strong or stiff springs, K is large and for soft spring, K is small.
- Net work done by all the forces i.e., the work done by the unbalanced force is always equal to change in kinetic energy.

  $W_{net} = \Delta KE = K_f - K_i$ or $\boxed{W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2}$ This is called **work-energy theorem**.

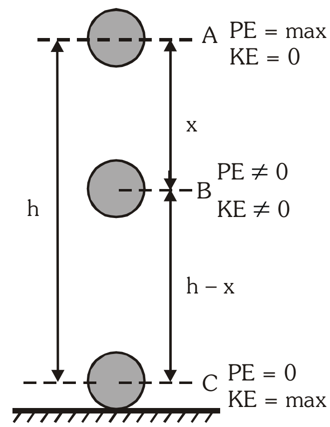
■ **The law of conservation of energy :** Energy appears in many forms, such as heat, motion, height, pressure, electricity, and chemical bonds between atoms.

- **Energy transformations :** Energy can be converted from one form to another form in different systems, machines or devices. For example, friction transforms energy of motion to energy of heat. A bow and arrow transform potential energy in a stretched bow into energy of motion (i.e., kinetic energy) of an arrow.

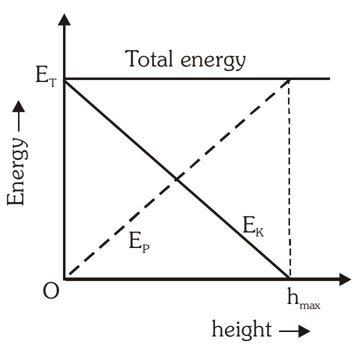
- Energy can never be created or destroyed, just converted from one form into another. This is called **the law of conservation of energy**. It applies to all forms of energy. If energy increases somewhere, it must decrease somewhere else.
- When a body is dropped from a certain height under gravity then, in the absence of any non conservative forces like air resistance, friction, etc, the total mechanical energy of the body remains constant.

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

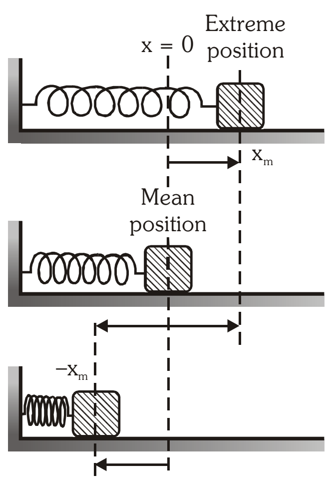
- Kinetic energy at the ground = potential energy at the maximum height. Also, at the ground, the total energy is purely kinetic energy while at the maximum height, it is purely potential energy. At any point located in between the ground and the maximum height, total energy is partly kinetic energy and partly potential energy.
- When a spring fixed at one end and held with other end is stretched or compressed on a frictionless surface and then allowed to release, it oscillates about its equilibrium position. But its total mechanical energy remains constant.

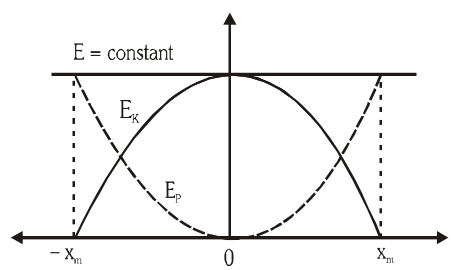


Total mechanical energy is conserved in a free fall.



E_K = kinetic energy
E_P = potential energy
Energy changes during free fall





E_K = kinetic energy
E_P = potential energy
Energy changes of a vibrating spring

■ **Power :** The rate at which work is done is more critical than the amount of work done.

- Power is the rate at which work is done. Power can also be defined as the rate at which energy is transferred.

$$P = \frac{\text{Work done}}{\text{time taken}} = \frac{W}{t} = \frac{E}{t}$$

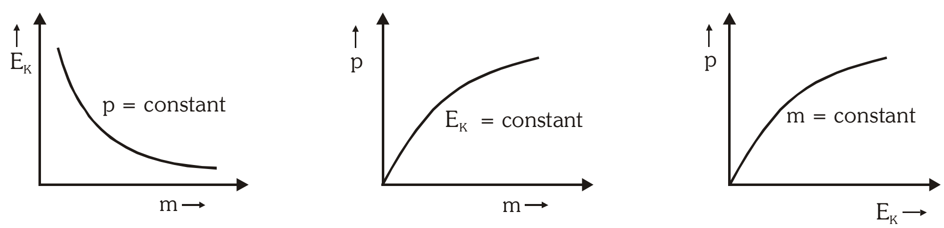
- **SI unit of power :** Watt (W) 1 Watt = 1 joule/second
  or **1 W = 1 J s⁻¹**
- **Definition of 1 watt :** If 1 joule work is done per second by a device or a machine then the power of that device or machine is 1 watt.
- A commonly used unit for power is 'horse power (h.p.)'. **1 h.p. = 746 W = 0.746 kW**
- **Power in terms of force (F) and velocity (v) :**

We know that power, $P = \frac{W}{t} = \frac{Fs}{t} = F\left(\frac{s}{t}\right)$ or $\boxed{P = F \times v}$

- **Commercial unit of energy :** A bigger unit of energy called kilowatt hour (kWh) is called commercial unit of energy.
  - **Definition of 1 kWh :** If a machine or a device of power 1 kW or 1000 W is used continuously for one hour, it will consume 1 kWh of energy. Thus, 1 kWh is the energy used in one hour at the rate of 1000 W (or 1 kW).

    1 kWh = 1 kW × 1 h = 1000 W × 3600 s = 3600000 J or **1 kWh = 3.6 × 10^6 J**.
  - **Relationship between momentum and kinetic energy :**

    $\boxed{E_K = \frac{p^2}{2m}}$ (momentum, p = mv) Also, $\boxed{p = \sqrt{2mE_K}}$
  - For a given momentum, kinetic energy is inversely proportional to mass ($E_K \propto 1/m$). This means smaller the mass, more will be the kinetic energy and vice-versa. For a given kinetic energy, momentum is directly proportional to the square root of mass ($p \propto \sqrt{m}$). This means heavier body will have more momentum and vice-versa. For a given mass, momentum is directly proportional to the square root of kinetic energy ($p \propto \sqrt{E_K}$). This means more the kinetic energy, more will be the momentum and vice-versa.



WORK, ENERGY, POWER EXERCISE

Multiple choice questions

1. In which case work is not done ?

(1) a girl swimming in a pond

(2) a windmill lifting water from a well

(3) a standing man holding a suit case in his hand

(4) a sail boat moving in the direction of wind.

2. A boy holds a 40 N weight at arm's length for 10 s. His arm is 1.5 m above the ground. The work done by the force of the boy on the weight while he is holding it is

(1) 0 J (2) 6.1 J (3) 40 J (4) 60 J

3. The work done on an object does not depend upon the

(1) displacement

(2) force applied

(3) angle between force and displacement

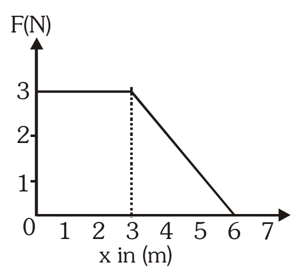
(4) initial velocity of the object

4. Work done in moving a 50 kg block through a horizontal distance of 10 m by applying a force of 100 N which makes an angle of 60° with the horizontal is

(1) 200 joule (2) 425 joule

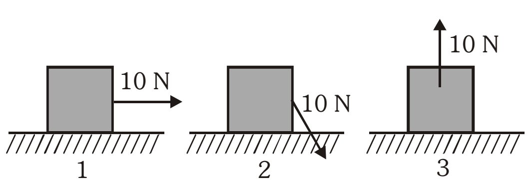
(3) 500 joule (4) 575 joule

5. A force F acting on an object varies with distance x as shown here. The force is in N and x is in m. The work done by the force in moving the object from x = 0 to x = 6 m is



(1) 4.5 J (2) 18.0 J (3) 13.5 J (4) 9.0 J

6. A crate moves 10 m to the right on a horizontal surface as a woman pulls on it with a 10 N force. Rank the situations shown below according to the work done by her force, least to greatest.



(1) 2, 1, 3 (2) 2, 3, 1

(3) 1, 3, 2 (4) 3, 2, 1

7. A sledge (including load) weighs 5000 N. It is pulled on level snow by a dog team exerting a horizontal force on it. The coefficient of kinetic friction between sledge and snow is 0.05. How much work is done by the dog team pulling the sledge 1000 m at constant speed ?

(1) 2.5×10^4 J (2) 2.5×10^5 J

(3) 5.0×10^5 J (4) 2.5×10^6 J

8. How much work is done in ergs in pulling a box 2m across a table top with a force of 20 N in horizontal direction.

(1) 20×10^5 (2) 40×10^{-7}

(3) 40×10^7 (4) 20×10^{-5}

9. A body is acted upon by a force which is proportional to the distance covered. If distance covered is denoted by x, then work done by the force will be proportional to

(1) x (2) x^2

(3) $x^{3/2}$ (4) x^4

10. The angle between the direction of applied force and displacement, for maximum work, should be :

(1) 90° (2) 45°

(3) 0° (4) 30°

11. A force of 10 N displaces an object through 20 cm and does work of 1 J in the process. Find the angle between the force and displacement.

(1) $\theta = 60°$ (2) $\theta = 30°$

(3) $\theta = 35°$ (4) $\theta = 45°$

12. In case of negative work the angle between the force and displacement is

(1) 0° (2) 45° (3) 90° (4) 180°

13. Work done is said to be positive when a force causes displacement

(1) in its own direction

(2) in the direction opposite to the applied force

(3) in the direction at right angles to the direction of applied force

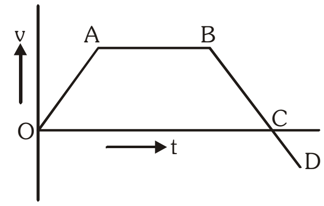
(4) none of the above

14. A man with a box on his head is climbing up a ladder. The work done by the man on the box is

(1) Positive (2) Negative

(3) Zero (4) Undefined

15. A plot of velocity versus time is shown in figure. A single force acts on the body. The correct statement is



(1) In moving from C to D, work done by the force on the body is positive
(2) In moving from B to C, work done by the force on the body is positive
(3) In moving from A to B, the body does work on the system
(4) In moving from O to A, work is done by the body and is negative

16. No work is done when an object moves
(1) along the direction of force
(2) opposite to the direction of force
(3) at any angle to the direction of force
(4) at 90° to the direction of force

17. A girl is carrying a school bag of 3 kg mass on her back and moves 200 m on a levelled road. The work done against the gravitational force will be ($g = 10\ m\ s^{-2}$)
(1) 6×10^3 J (2) 6 J (3) 0.6 J (4) zero

18. When the force applied and the displacement of the body are inclined at 90° with each other, then work done is
(1) infinite (2) maximum
(3) zero (4) unity

19. 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

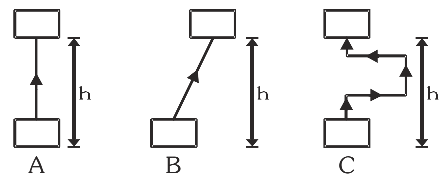
20. A body of mass m is moving in a circle of radius r with a constant speed v. The force on the body is $\frac{mv^2}{r}$ and is directed towards the centre. What is the work done by this force in moving the body over half the circumference of the circle ?
(1) $\frac{mv^2}{\pi r^2}$ (2) zero (3) $\frac{mv^2}{r^2}$ (4) $\frac{\pi r^2}{mv^2}$

21. A stone is tied to a string and whirled in a circular path. The work done on the stone is
(1) negative (2) zero
(3) positive (4) none of the above

22. A rocket rises up in the air due to the force generated by the fuel. The work done by the
(1) fuel is negative work and that of force of gravity is positive work
(2) fuel is positive work and that of force of gravity is negative work
(3) both fuel and force of gravity do positive work
(4) both fuel and force of gravity do negative work.

23. A ball of mass 1 kg thrown upwards reaches a maximum height of 5.0 m. Calculate the work done by the force of gravity during this vertical displacement.
(1) – 59 J (2) – 49 J (3) – 30 J (4) – 48 J

24. A brick was lifted from the ground to a height 'h' in 3 different ways. In which case was the work done against gravity maximum ?

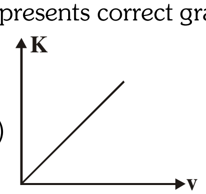


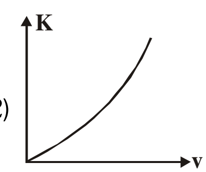
(1) Case A (2) Case B
(3) Case C (4) Equal in all 3 cases

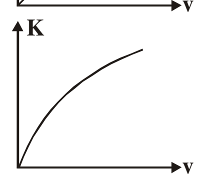
25. When speed of a motor car increases six times, then kinetic energy increases by
(1) 6 times (2) 36 times
(3) 12 times (4) 24 times

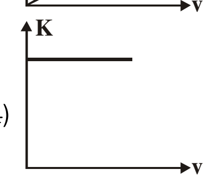
26. The KE of a body is increased most by doubling its
(1) mass (2) weight (3) speed (4) density

27. A graph was plotted between kinetic energy (K) and velocity (v) of the body. Which of the following represents correct graphical relation ?

(1)


(2)


(3)


(4)


28. What is the mass of a body which has 5 J of kinetic energy while moving at a speed of 2 m/s ?
(1) 2.5 kg (2) 4 kg (3) 5.5 kg (4) 10 kg

29. An 8000 N car is travelling at 12 m/s along a horizontal road when the brakes are applied. The car skids to a stop in 4.0 s. How much kinetic energy does the car lose in this time ? ($g = 10\ m/s^2$)
(1) 4.8×10^4 J (2) 5.76×10^4 J
(3) 1.2×10^5 J (4) 5.8×10^5 J

30. The weight of an object on the moon is one-sixth of its weight on Earth. The ratio of the kinetic energy of a body on Earth moving with speed V to that of the same body moving with speed V on the moon is

(1) 6 : 1 (2) 36 : 1 (3) 1 : 1 (4) 1 : 6

31. The kinetic energy of an object of mass 'm', moving with a velocity of 5 ms^{-1} is 25 J. If the velocity is increased by three times, the kinetic energy is

(1) 100 J (2) 225 J (3) 400 J (4) 180 J

32. When the speed of a particle is doubled, the ratio of its kinetic energy to its momentum

(1) remains the same (2) gets doubled

(3) becomes half (4) becomes four times

33. The momentum of a body is numerically equal to the kinetic energy of the body. What is the velocity of the body?

(1) $\frac{1}{\sqrt{2}}$ units (2) 2 units

(3) $\frac{1}{\sqrt{3}}$ units (4) $\sqrt{3}$ units

34. When mass is halved and velocity is doubled, the kinetic energy of a body

(1) remains same (2) is doubled

(3) is 4 times (4) is $1/4^{th}$ times

35. A 1 kg mass has kinetic energy of 1 joule when its speed is

(1) 0.45 m/sec (2) 1 m/sec

(3) 1.4 m/sec (4) 4.4 m/sec

36. Water stored in a dam possesses

(1) no energy (2) electrical energy

(3) kinetic energy (4) potential energy

37. A golf ball is struck by a golf club and falls on a green three meters above the tee. The potential energy of the ball is greatest

(1) just before the ball is struck

(2) just after the ball is struck

(3) just after the ball lands on the green

(4) when the ball reaches the highest point in its flight

38. A 2 kg block is thrown upward from a point 20 m above earth's surface. At what height above earth's surface, the gravitational potential energy of the block is increased by 500 J ?

(g = 10 $m/^2$)

(1) 5 m (2) 25 m (3) 45 m (4) 70 m

39. A body at rest can have

(1) Velocity (2) Kinetic energy

(3) Potential energy (4) Momentum

40. An object of mass 1 kg is raised through a height 'h'. Its potential energy is increased by 1 J. Find the height 'h'.

(1) 0.102 m (2) 0.105 m

(3) 0.130 m (4) 0.110 m

41. Two bodies of equal weight are kept at heights 'h' and '3h' respectively. The ratio of their PE is

(1) 1 : 3 (2) 3 : 1 (3) 1 : 9 (4) 9 : 1

42. A car is accelerated on a levelled road and attains a velocity 4 times of its initial velocity. In this process the potential energy of the car

(1) does not change

(2) becomes twice to that of initial

(3) becomes 4 times that of initial

(4) becomes 16 times that of initial

43. When speed of the moving object is doubled its

(1) acceleration is doubled

(2) momentum becomes four times more

(3) kinetic energy is increased to four times

(4) potential energy is increased

44. An aeroplane flying at a height of 20,000 m at a speed of 300 kmh^{-1} has

(1) only potential energy

(2) only kinetic energy

(3) both, potential and kinetic energy

(4) none of the above

45. When work done by force of gravity is negative

(1) PE increases (2) KE increases

(3) PE remains constant (4) PE decreases

46. A compressed spring of a watch has

(1) no energy stored in it.

(2) heat energy stored in it.

(3) kinetic energy stored in it.

(4) elastic potential energy stored in it.

47. **Statement-I :** A spring has potential energy, both when it is compressed or stretched.

Statement-II : In compressing or stretching, work is done on the spring against the restoring force.

(1) Both statements-I and II are true, statement-II is correct explanation for statement-I.

(2) Both statements-I and II are true, statement-II is not the correct explanation for statement-I.

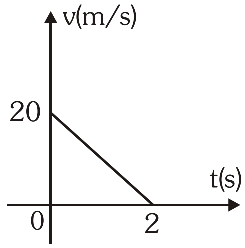
(3) Statement-I is true and statement-II is false.

(4) Statement-I is false and statement-II is true.

48. A long spring is stretched by 2 cm and its potential energy is U. If the spring is stretched by 10 cm, the potential energy stored in it will be

(1) $\frac{U}{5}$ (2) $\frac{U}{25}$ (3) 25 U (4) 5 U

49. Velocity-time graph of a particle of mass 2 kg moving in a straight line is as shown in figure. Work done by all the forces on the particle is



(1) 400 J (2) –400 J (3) –200 J (4) 200 J

50. A 5.0 kg cart is moving horizontally at 6.0 m/s. In order to change its speed to 10 m/s, the net work done on the cart must be

(1) 40 J (2) 90 J (3) 160 J (4) 400 J

51. A cricket player catches a ball of mass m that is moving towards him with speed v. While bringing the ball to rest, his hand moves back a distance d. Assuming constant retardation, the horizontal force exerted on the ball by his hand is

(1) mvd (2) mv^2/d (3) 2mv/d (4) $mv^2/(2d)$

52. A body of mass 20 kg, slows down from 5 ms^{-1} to 2 ms^{-1} by a retarding force. The work done by the force is

(1) –50 J (2) –200 J (3) –300 J (4) –210 J

53. A lorry and a car with the same kinetic energy are brought to rest by the application of brakes which provide equal retarding forces. Which of them will come to rest in a shorter distance ?

(1) Lorry
(2) Car
(3) Both will stop at the same distance
(4) Cannot be determined

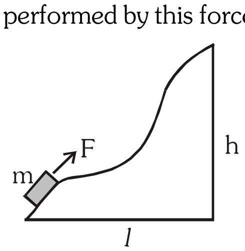
54. A photocell converts light energy into

(1) Chemical energy (2) Electrical energy
(3) Heat energy (4) Mechanical energy

55. A steam engine converts

(1) Heat energy into sound energy
(2) Heat energy into mechanical energy
(3) Mechanical energy into heat energy
(4) Electrical energy into sound energy

56. A body of mass m was slowly pulled up the hill by a force F which at each point was directed along the tangent of the trajectory. All surfaces are smooth. Find the work performed by this force.



(1) mgl (2) –mgl
(3) mgh (4) zero

57. When a cracker bursts,

(1) Electrical energy is converted into chemical energy.
(2) Potential energy is converted into kinetic energy.
(3) Kinetic energy is converted into nuclear energy.
(4) Chemical energy is converted into light and sound energy.

58. In a hydroelectric dam, the potential energy of water changes to

(1) Electrical energy only
(2) Kinetic energy only
(3) First kinetic energy and then electrical energy
(4) First electrical energy and then kinetic energy

59. A body is falling from a height h. After it has fallen a height h/2, it will possess

(1) only potential energy
(2) only kinetic energy
(3) half potential and half kinetic energy
(4) more kinetic and less potential energy

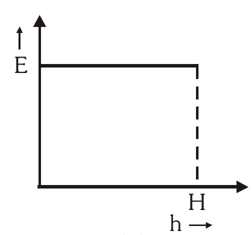
60. If the water falls from a dam into a turbine wheel 19.6 m below, then the velocity of water at the turbine is (g = 9.8 m/s^2)

(1) 9.8 m/s (2) 19.6 m/s
(3) 39.2 m/s (4) 98.0 m/s

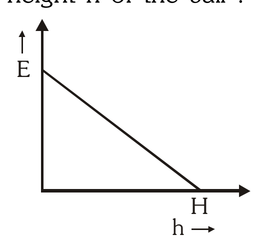
61. A 2 kg block is attached to a horizontal ideal spring with a spring constant of 200 N/m. When the spring has its equilibrium length, the block is given a speed of 5 m/s. What is the maximum elongation of the spring ?

(1) 0 m (2) 0.05 m (3) 0.5 m (4) 10 m

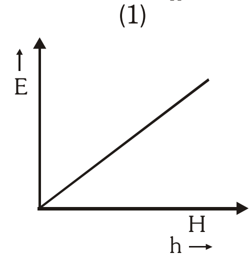
62. A ball is held at a height H above a floor. It is then released and falls to the floor. If air resistance can be ignored, which of the graphs below correctly gives relationship between the mechanical energy E of the ball and the height h of the ball ?



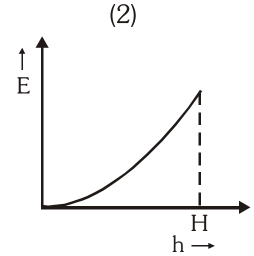
(1)



(2)



(3)



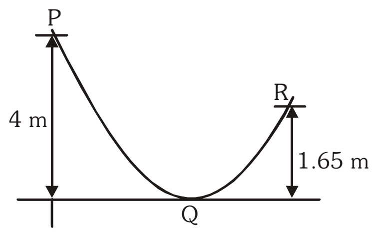
(4)

63. A 6.0 kg block is released from rest 80 m above the ground. When it has fallen 60 m its kinetic energy is approximately (g = 10 m/^{2})

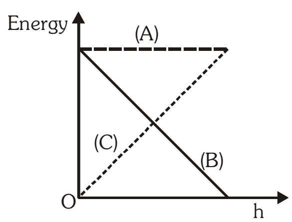
(1) 4800 J (2) 3600 J
(3) 1200 J (4) 120 J

64. A bead starts sliding from a point P on a frictionless wire with initial velocity of 5 ms^{-1}. Find the velocity of bead at point R (take g = 10 ms^{-2})

(1) 7 m/s
(2) $5\sqrt{2}$ m/s
(3) $6\sqrt{2}$ m/s
(4) 6 m/s



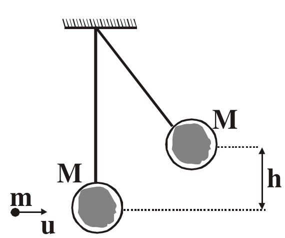
65. A cricket ball is dropped from a certain height. The energy of the ball varies with height (h) above the ground as shown in the graph. Identify lines A, B and C in the graph.



(1) A-kinetic energy, B-potential energy, C-total energy
(2) A-total energy, B-kinetic energy, C-potential energy
(3) A-potential energy, B-kinetic energy, C-total energy
(4) A-total energy, B-potential energy, C-kinetic energy

66. A bullet of mass m, moving with velocity u strikes a suspended wooden block of mass M as shown in figure. If the block rises to a height h, the initial velocity will be given by

(1) $\sqrt{2gh}$
(2) $\left(\frac{M+m}{m}\right)\sqrt{2gh}$
(3) $\left(\frac{m}{M+m}\right)\sqrt{2gh}$
(4) $\left(\frac{M+m}{M-m}\right)\sqrt{2gh}$



67. A body of mass 2 kg is projected vertically upwards with a speed of 3 m/s. The maximum gravitational potential energy of the body is

(1) 18 J (2) 4.5 J (3) 9 J (4) 2.25 J

68. A ball released from certain height loses 50% of its K.E. on striking the ground. It will attain a height again

(1) One fourth the initial
(2) Half the initial
(3) Three fourth the initial
(4) None of these

69. When time taken to complete a given amount of work increases, then

(1) power increases (2) power decreases
(3) energy increases (4) energy decreases

70. An escalator is used to move 20 people (60 kg each) per minute from the first floor of a departmental store to the second floor at a height of 5 m. Neglecting friction, the power required is (Take, g = 10 m/s^2)

(1) 100 W (2) 200 W (3) 1000 W (4) 2000 W

71. One kilowatt is approximately equal to

(1) 1.34 hp (2) 1.56 hp
(3) 2.50 hp (4) 1.83 hp

72. The work done by an electric drill rated 50 W in 30 s is

(1) 1200 J (2) 600 J (3) 900 J (4) 1500 J

73. How much time will it take to perform 440 J of work at a rate of 11 W?

(1) 50 s (2) 40 s (3) 30 s (4) 20 s

74. Two persons do the same amount of work, one in 10 s and the other in 20 s. Find the ratio of the power used by the first person to that by the second person.

(1) 6 : 1 (2) 2 : 1 (3) 5 : 1 (4) 4 : 1

75. A one kilowatt motor pumps out water from a well 10 metres deep. Calculate the quantity of water pumped out per second.

(1) 10.204 kg (2) 15.302 kg
(3) 11.201 kg (4) 16.204 kg

76. A motor boat is having a steady speed of 20 ms^{-1}. If the water resistance to the motor boat is 600 N, then the power is

(1) 12 kW (2) 120 kW
(3) 9.8 kW (4) 1200 kW

77. If a force F is applied on a body and it moves with velocity v, then power will be

(1) $F \times v$ (2) $\frac{F}{v^2}$ (3) $\frac{F}{v}$ (4) $F \times v^2$

78. A vehicle is moving on a straight horizontal road at a constant velocity of 10 m/s. The engine needs to spend 4 kJ of energy per second. The force on the vehicle is

(1) 0.2 kN (2) 0.4 kN (3) 0.6 kN (4) 1 N

79. Which one of the following is not the unit of energy ?

(1) joule (2) newton meter
(3) kilowatt (4) kilowatt hour

80. Kilowatt hour (kWh) represents the unit of

(1) power (2) impulse

(3) momentum (4) energy

81. 1 kWh equals

(1) 36×10^2 Joules (2) 36×10^4 Joules

(3) 3.6×10^6 Joules (4) none of these

82. A certain household consumes 250 units of electric energy in a house. The energy consumed in mega joule is

(1) 900 MJ (2) 750 MJ

(3) 2250 MJ (4) 1750 MJ

83. The energy consumed (in kWh) by four devices of 500 W each in 10 hours is

(1) 4 kWh (2) 5 kWh

(3) 10 kWh (4) 20 kWh

84. Two masses of 1 kg and 4 kg are moving with equal kinetic energies. The ratio of the magnitudes of linear momentum of 1 kg mass to the linear momentum of 4 kg mass is

(1) 4 : 1 (2) $\sqrt{2} : 1$ (3) 1 : 2 (4) 1 : 16

85. 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%

86. If the K.E of a body is doubled, then the momentum of the body becomes

(1) $\frac{1}{\sqrt{2}}$ times (2) $\sqrt{2}$ times

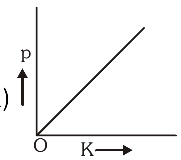
(3) $2\sqrt{2}$ times (4) none of these

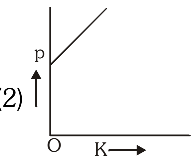
87. A gun fires a bullet with velocity v. Mass of the bullet is m. The mass of the gun is M and it recoils with velocity V. If the kinetic energy of the bullet be E_b and that of gun be E_g, then

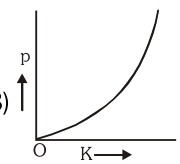
(1) $E_b = E_g$ (2) $E_b < E_g$

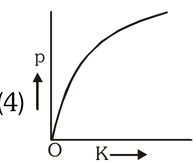
(3) $E_b > E_g$ (4) $E_b \geq E_g$

88. Which of the following graphs best represents the graphical relation between momentum (p) and kinetic energy (K) for a body in motion ?

(1) 

(2) 

(3) 

(4) 

89. When a light and a heavy body have equal K.E, then which one has a greater momentum?

(1) light body

(2) heavy body

(3) both have equal momentum

(4) uncertain

90. For same K.E., momentum shall be maximum for

(1) electron (2) proton

(3) deutron (4) α-particle

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	4	3	3	4	2	3	2	3	1	4	1	1	1	4	4	3	4	
Que.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Ans.	2	2	2	4	2	3	2	1	2	3	2	2	2	2	3	4	4	3	3	
Que.	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans.	1	1	3	3	1	4	1	3	2	3	4	4	3	2	2	3	4	3	3	
Que.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Ans.	3	1	2	3	2	2	3	2	2	3	1	4	2	2	1	1	1	2	3	
Que.	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**										
Ans.	3	1	4	3	1	2	3	4	2	4										

Multiple choice questions

1. The transfer of energy in a material medium due to the periodic motion of its particles is called
(1) stream (2) wave motion
(3) pulse (4) none of the above

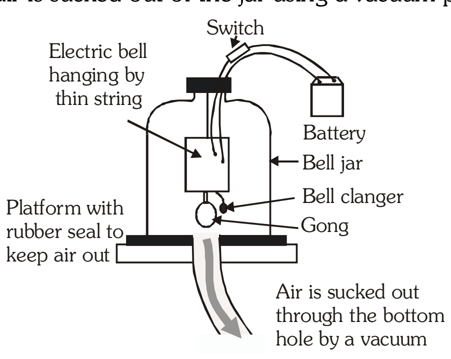
2. The sound waves in a medium are characterised by the
(1) linear motion of particles in the medium
(2) rotatory motion of particles in the medium
(3) oscillatory motion of particles in the medium
(4) none of the above

3. The velocity of sound in vacuum is :
(1) 332 ms^{-1} (2) 330 ms^{-1}
(3) 228 ms^{-1} (4) 0

4. Two persons on the surface of the moon cannot talk to each other, because
(1) there is no atmosphere
(2) 'g' is very small
(3) sound is absorbed by the surface of the moon
(4) sound produced on the moon is infrasonic

5. Non-mechanical wave can propagate in :
(1) material medium as well as vacuum
(2) in vacuum, but not in material medium
(3) in material medium but not in vacuum
(4) neither in material medium nor in vacuum

6. In the setup shown here, there is an electric bell inside a vacuum jar. The bell is turned on and all the air is sucked out of the jar using a vacuum pump.



As the air is pumped out, the sound level of the ringing bell decreases until we cannot hear it anymore.
Which of these BEST explains why this happens ?
(1) The gong slowly stops vibrating as the air level decreases.
(2) Less energy is transmitted from the bell to the surroundings as the air decreases.
(3) Energy is increasingly absorbed by the glass of the bell jar as the amount of air decreases.
(4) The energy produced by the gong is absorbed completely by the vacuum that is produced.

7. In case of longitudinal waves, the particles of medium vibrate
(1) in the direction of wave propagation
(2) opposite to the direction of wave propagation
(3) at right angles to the direction of wave propagation
(4) none of the above

8. A longitudinal waves consists of
(1) crests and troughs in the medium
(2) compressions and rarefactions in the medium
(3) both (1) and (2)
(4) neither (1) nor (2)

9. A sitar player plucks the wire of a sitar. After a short time each part of the wire starts vibrating in a direction perpendicular to the wire. The propagation of this disturbance is
(1) Longitudinal wave
(2) Transverse wave
(3) Non mechanical
(4) Both longitudinal and transverse waves

10. The depth of the troughs of a wave is called its
(1) amplitude (2) displacement
(3) frequency (4) none of these

11. In case of transverse waves the particles of a medium vibrate
(1) in the direction of wave propagation
(2) opposite to the direction of wave propagation
(3) at right angles to the direction of wave propagation
(4) none of the above

12. A transverse wave consists of
(1) crests and troughs in the medium
(2) compressions and rarefactions in the medium
(3) both (1) and (2)
(4) neither (1) nor (2)

13. The longitudinal waves can propagate only in
(1) solids (2) liquids
(3) gases (4) all the above

14. In the compression region of the medium, in case of longitudinal wave
(1) the volume momentarily decreases
(2) the density momentarily increases
(3) the pressure momentarily increases
(4) all the above

15. A part of longitudinal wave in which particles of medium are farther away than the normal particles is called
(1) rarefaction (2) trough
(3) compression (4) crest

16. In the region of compression or rarefaction, in a longitudinal wave, the physical quantity which does not change is

(1) pressure (2) mass (3) density (4) volume

17. A stretched slinky is given a sharp push along its length. A wave travels from one end to another. The wave so produced is

(1) transverse wave (2) longitudinal wave
(3) Non mechanical (4) none of the above

18. A longitudinal sound wave in air consists of

(1) a number of rarefaction pulses one after the other
(2) a number of compression pulses one after the other
(3) compression and rarefaction pulses alternating with each other
(4) a rarefaction pulse followed by compression pulse, separated by some distance.

19. The density of air at some point in a longitudinal sound wave is minimum at an instant. The pressure of air at that point is

(1) minimum
(2) maximum
(3) equal to atmospheric pressure
(4) none of the above

20. Let f be the frequency, v the speed, and T the period of a sinusoidal travelling wave. The correct relationship is

(1) $f = 1/T$ (2) $f = v + T$
(3) $f = vT$ (4) $f = v/T$

21. Water waves in the sea are observed to have a wavelength of 300m and a frequency of 0.07 Hz. The speed of these waves is

(1) 0.00021 m/s (2) 2.1 m/s
(3) 21 m/s (4) 210 m/s

22. A sound wave has a wavelength of 3.0 m. The distance from a compression center to the adjacent rarefaction center is

(1) 0.75 m
(2) 1.5 m
(3) 3.0 m
(4) need to know wave speed

23. A fire whistle emits a tone of 170 Hz. Take the speed of sound in air to be 340 m/s. The wavelength of this sound is about

(1) 0.5 m (2) 1.0 m (3) 2.0 m (4) 3.0 m

24. During a time interval of exactly one period of vibration of a tuning fork, the emitted sound travels a distance

(1) equal to the length of the tuning fork
(2) of about 330 m
(3) of one wavelength in air
(4) equal to twice the length of the tuning fork

25. A wave source produces 20 crests and 20 troughs in 0.2 sec. Find the frequency of the wave.

(1) 200 Hz (2) 500 Hz
(3) 100 Hz (4) 300 Hz

26. The time period of a sound wave travelling in a medium is T. At a given instance (t = 0) a particular region in the medium has minimum density. The density of this region will be minimum again at :

(1) $t = T$ (2) $t = T/2$
(3) $t = T/3$ (4) $t = T/4$

27. The bob of a pendulum moves from the mean position to an extreme position in 0.28 seconds. Then the time period of the pendulum is

(1) 2.24 seconds (2) 1.12 seconds
(3) 0.84 seconds (4) 3.84 seconds

28. What is the distance travelled by sound in air when a tuning fork of frequency 256 Hz completes 25 vibrations ? The speed of sound in air is 343 ms^{-1}.

(1) 18.7 m (2) 25.2 m (3) 33.5 m (4) 42.5 m

29. A wave of frequency 1000 Hz travels between X and Y, a distance of 600 m in 2 seconds. The number of wavelengths there in distance XY is

(1) 3.3 (2) 300 (3) 180 (4) 2000

30. An ultrasonic source emits sound of frequency 220 kHz in air. If this sound meets a water surface, what is the wavelength of

(a) the reflected sound,
(b) the transmitted sound? (At the atmospheric temperature, speed of sound in air = 352 m s^{-1} and in water = 1496 m s^{-1})

(1) 1.6×10^{-3} m, 6.8×10^{-3} m
(2) 1.8×10^{-3} m, 1.8×10^{-3} m
(3) 2×10^{-3} m, 3.2×10^{-3} m
(4) 2.8×10^{-3} m, 1.8×10^{-3} m

31. The frequency of a second's pendulum is

(1) 0.5 Hz (2) 1.0 Hz
(3) 2.0 Hz (4) none of these

32. The wavelength is the linear distance between

(1) two consecutive compressions
(2) two consecutive rarefactions
(3) one compression and one rarefaction
(4) both (1) and (2)

33. The change in density/pressure of a medium from maximum value to minimum value and again to maximum value, due to the propagation of a longitudinal wave is called complete

(1) oscillation (2) frequency
(3) amplitude (4) none of the above

34. If the frequency of a wave is 25 Hz, the total number of compressions and rarefactions passing through a point in 1 second is

(1) 25 (2) 50

(3) 100 (4) none of the above

35. Time period of a wave in a medium is the time taken by

(1) a compression to pass through a point

(2) a rarefaction to pass through a point

(3) an oscillation to pass through a point

(4) none of the above

36. The linear distance between a compression and a rarefaction or a crest and a trough is :

(1) $\frac{\lambda}{2}$ (2) $\frac{\lambda}{4}$ (3) λ (4) $\frac{3\lambda}{2}$

37. Which of the following properties of a sound wave are affected by the change in temperature of air:

(1) frequency (2) amplitude

(3) wavelength (4) intensity

38. The sound produced by a tuning fork has a wavelength of 1.7 m in air. What would be wave length in water if velocity of sound in air is 340 ms^{-1} and that in water is 1400 m/s ?

(1) 2 m (2) 5 m (3) 7 m (4) 9 m

39. Ships use sound waves to find the vertical distance to the seabed. A pulse of sound waves is sent out and the echoes are detected. A ship emits a pulse of waves lasting 0.50 s. The waves have a frequency of 3600 Hz. How many complete wavelengths does the pulse contain ?

(1) 1800 (2) 3600

(3) 7200 (4) 18000

40. The time period of a periodic wave is .02 seconds. At a particular position, there is a crest at t = 0. A trough will appear at this position when 't' is equal to

(1) 0.005 s (2) 0.010 s

(3) 0.015 s (4) 0.025 s

41. When sound waves travel from one medium to the other, the physical quantity that does not alter is

(1) amplitude (2) velocity

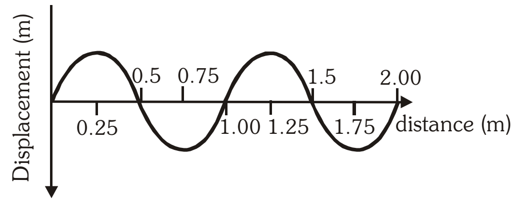
(3) frequency (4) intensity

42. The frequency of two sound sources are 480 Hz and 960 Hz respectively. If T_1 and T_2 are the time periods, the correct relation is

(1) $T_1 = T_2$ (2) $T_1 = 2T_2$

(3) $2T_1 = T_2$ (4) $3T_1 = T_2$

43. Displacement - distance graph of any wave is shown in the figure. Its wavelength will be



(1) 0.50 m (2) 1.00 m

(3) 0.75 m (4) 1.50 m

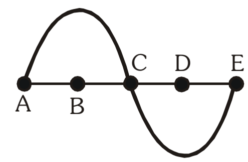
44. In the curve (see fig.) half the wavelength is

(1) A B

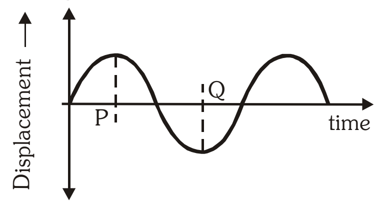
(2) B D

(3) D E

(4) A E



45. In the diagram below, the interval PQ represents:



(1) wavelength/2 (2) wavelength

(3) 2 ×amplitude (4) period/2

46. Sound travels in air if

(1) particles of medium travel from one place to another

(2) there is no moisture in the atmosphere

(3) disturbance moves

(4) both particles as well as disturbance travel from one place to another.

47. Which is not the condition for hearing sound?

(1) There must be a vibrating body capable of transferring energy.

(2) There must be a material medium to pick up and propagate energy

(3) The medium must have a large density.

(4) There must be receiver to receive the energy and interpret it.

48. The sound waves which travel in the air are called

(1) transverse waves

(2) longitudinal waves

(3) electromagnetic waves

(4) none of the above

49. An instrument commonly used in laboratory to produce a sound of some particular frequency is

(1) sonar (2) electric bell

(3) tuning fork (4) a stretched wire

50. The speed of a sound wave is determined by
(1) its amplitude
(2) its intensity
(3) its pitch
(4) the transmitting medium

51. The crack of thunder is heard after few seconds the lightning flash, because
(1) crack of thunder and lightning are not produced at same time
(2) light travels extremely fast as compared to sound
(3) sound waves slow down on passing through air
(4) none of the above

52. Arrange the following media in ascending order of speed of sound in them
I - Water   II - Steel   III - Nitrogen
(1) III, II, I   (2) I, III, II   (3) III, I, II   (4) II, I, III

53. The temperature at which the speed of sound in air becomes double of its value at 0°C is _____ °C.
(1) 819° C   (2) 891° C   (3) 189° C   (4) 918° C

54. The velocity of sound in a gas is 30 m s^{-1} at 27°C. What is the velocity of the sound in the same gas at 127°C ?
(1) 20 m s^{-1} (2) 30 m s^{-1}
(3) $20\sqrt{3}$ m s^{-1} (4) 60 m s^{-1}

55. A boy sitting in a boat fires a gun. An observer P is at a distance of 50 m from the boat. Another observer Q is a diver, who is 50 m under the boat in water. Both hear the sound of gun.
(1) P hears the sound first
(2) Q hears the sound first
(3) Both P and Q hear the sound at the same time
(4) none of the above

56. The velocity of sound is not affected by changes in
(1) temperature of medium
(2) moisture
(3) atmospheric pressure
(4) density of medium

57. **Assertion :** Sound waves travel faster on a rainy day than on a dry day.
Reason : Moisture increases the pressure.
(1) Both assertion and reason are correct and reason is the correct explanation of assertion.
(2) Both assertion and reason are true but reason is not the correct explanation of assertion.
(3) Assertion is true but reason is false.
(4) Assertion is false but reason is true.

58. Earthquake produces which kind of sound before the main shock wave begins
(1) ultrasound   (2) infrasound
(3) audible sound   (4) none of the above

59. Infrasound can be heard by
(1) dog   (2) bat
(3) rhinoceros   (4) human beings

60. A boy claps his hands. At the same time, a bat near him produces ultrasonic waves. Which of the two sounds travels faster ?
(1) Sound of clap
(2) Sound of bat
(3) Both have same speed
(4) Depends on their loudness

61. If ultrasonic, infrasonic and audio waves travel through a medium with speed v_1, v_2 and v_3 respectively, then
(1) $v_1 = v_2 = v_3$ (2) $v_1 > v_3 > v_2$
(3) $v_1 < v_3 < v_2$ (4) $v_3 \leq v_1$ and `$v_1 = v_2$

62. The sound waves having a frequency more than 20,000 Hz are called
(1) infrasonic waves   (2) supersonic waves
(3) ultrasonic waves   (4) hypersonic waves

63. The animal which cannot hear ultrasonic waves is
(1) bat   (2) cow   (3) dog   (4) dolphin

64. The minimum audible wavelength at room temperature in air, when speed of sound is 400 m/s, is about
(1) 0.2 Å
(2) 5 Å
(3) 5 cm to 200 cm
(4) 20 mm

65. A key of a mechanical piano struck gently and then struck again but much harder this time. In the second case
(1) both loudness and pitch will remain unaffected
(2) sound will be louder and pitch will also be higher
(3) sound will be louder but pitch will be lower
(4) sound will be louder but pitch will not be different

66. When we change feeble sound to loud sound we increase its
(1) frequency   (2) amplitude
(3) velocity   (4) wavelength

67. Which of the following properties of a sound wave determine its "pitch"?
(1) Amplitude
(2) Distance from source to detector
(3) Frequency
(4) Phase

68. Note is a sound
(1) of mixture of several frequencies
(2) of mixture of two frequencies only
(3) of a single frequency
(4) always unpleasant to listen

69. The same notes being played on sitar and veena differ in
(1) quality
(2) pitch
(3) both quality and pitch
(4) neither quality nor pitch

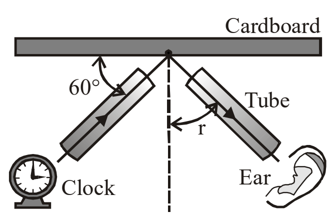
70. What is the meaning of 0 dB ?
(1) Intensity of sound is 10^{12} W/m^2
(2) Intensity of sound is 10^{-12} W/m^2
(3) Intensity of sound is 0 W/m^2
(4) None of these

71. A body travels with a velocity greater than the velocity of sound. The shape of the waveforms would be
(1) elliptical (2) spherical
(3) parabolic (4) conical

72. A bullet is moving at a speed, more than the speed of sound. It is said to be moving at
(1) supersonic speed (2) ultrasonic speed
(3) infrasonic speed (4) sonic speed

73. A sonic boom is produced in the air when an aircraft
(1) flies at a speed equal to the speed of sound
(2) flies at a speed more than the speed of sound
(3) flies at a speed less than the speed of sound
(4) climbs vertically

74. To verify the law of reflection of sound, two hollow tubes are placed in front of a smooth cardboard as shown in figure. To hear the loudest ticking sound, what must be the value of $\angle r$?



(1) 90° (2) 40° (3) 30° (4) 60°

75. An echo is heard only, if the original sound after reflection should reach the ear in :
(1) less than (1/100) s (2) less than (1/10) s
(3) more than (1/10) s (4) none of the above

76. An object is 11 km below sea level. A research vessel sends down a sonar signal to confirm this depth. After how long can it expect to get the echo? (Take the speed of sound in sea water as 1,520 m/s.)
(1) 15.30 s (2) 14.47 s
(3) 12.20 s (4) 11.13 s

77. A man fired a bullet against a wall and hears an echo after 2 s. He walks 80 m towards the wall and fired bullet, such that he hears echo after 1 s. Find the distance from wall to his 1st position.
(1) 200 m (2) 80 m (3) 120 m (4) 160 m

78. For hearing an echo, the distance to the obstacle should be
(1) less than 10 m
(2) between 10 m and 15 m
(3) 17 m or more
(4) none of the above

79. A man claps his hands at a distance of 660 m from a mountain, and hears the echo after 4 seconds. What is the speed of sound in air ?
(1) 280 m/s (2) 320 m/s
(3) 360 m/s (4) 330 m/s

80. A man stands between two cliffs and fires a gun. He hears two successive echoes after 3 sec and 5 sec. The distance between the two cliffs is (speed of sound = 340 m/s)
(1) 1340 m (2) 1330 m
(3) 1360 m (4) 1310 m

81. The minimum distance to the obstacle to hear an echo is (V is speed of sound in air)
(1) $\frac{V}{10}$m (2) $\frac{V}{20}$m (3) $\frac{V}{30}$m (4) $\frac{V}{40}$m

82. A submarine emits a SONAR plus which returns from an underwater cliff in 1.02 s. If the speed of sound in salt water is 1531 m/s, how far away is the cliff ?
(1) 500 m (2) 1 km (3) 781 m (4) 600 m

83. The roofs and walls of the auditorium are generally covered with sound absorbent materials to reduce
(1) Volume of sound
(2) Reverberation of sound
(3) Frequency of sound
(4) None of these

84. When lightning strikes, we hear multiple cracks of thunder. These multiple reflections of sound are called
(1) sonic boom (2) reverberations
(3) resonance (4) none of the above

85. In SONAR, we use
(1) ultrasonic waves (2) infrasonic waves
(3) radio waves (4) audible sound waves

86. Naval ships called "destroyers" can detect submarines in the sea. The device used by these ships is called
(1) ultra cleaner (2) sonar
(3) ultrasonograph (4) none of the above

87. The waves used in sonography are
(1) microwaves (2) ultra-violet waves
(3) ultrasonic waves (4) sound waves

88. The membrane which vibrates in the human ear is called

(1) Pinna (2) Eardrum

(3) Cochlea (4) Eustachian tube

89. Which of these is not a part of the human ear ?

(1) Cochlea (2) Hammer

(3) Vocal chords (4) Auditory nerve

90. The bat hunts its prey by emitting and receiving reflected

(1) super sonic waves (2) ultrasonic waves

(3) sonic waves (4) infrasonic waves

91. Before playing the orchestra in a musical concert, a sitarist tries to adjust the tension and pluck the string suitably. By doing so, he is adjusting

(1) intensity of sound only

(2) amplitude of sound only

(3) frequency of the sitar string with the frequency of other musical instruments

(4) loudness of sound

92. To raise the pitch of a certain piano string, the piano tuner

(1) loosens the string (2) tightens the string

(3) shortens the string (4) lengthens the string

93. A simple pendulum is transferred from the earth to the moon. It will

(1) slow down (2) become faster

(3) remain the same (4) none of these

94. The length of a pendulum is doubled and the mass of its bob is halved. Its time period would

(1) become double (2) become half

(3) become $\sqrt{2}$ times (4) remain the same

95. The oscillations of a pendulum slow down due to

(1) The force exerted by air and friction at the support

(2) The force exerted by air only

(3) The force exerted by friction at the support only

(4) none of these

96. The phenomenon in which the amplitude of oscillation of a pendulum decreases gradually is called

(1) decay period of oscillation

(2) damping

(3) building up of oscillation

(4) maintained oscillation

97. Two sources of sound are said to be in resonance when

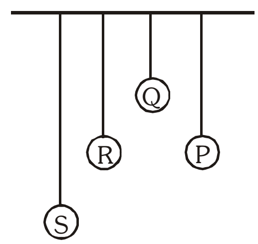
(1) They are similar

(2) They produce sounds of same frequency

(3) They are situated at a particular distance from each other

(4) They are excited by the same agency

98. Four pendulums P,Q, R & S are suspended from same elastic support as shown in figure. Out of these P and R are of the same length. Q is smaller than P and S is longest. If the pendulum bob P is displaced to give small vibration



(1) amplitude of vibration for S is maximum

(2) amplitude of vibration for R is maximum

(3) amplitude of vibration for Q is maximum

(4) amplitude of vibration for all is same

99. A regiment of soldiers is crossing a suspension bridge. They are ordered to

(1) march in steps (2) break the steps

(3) twist their bodies (4) do rock and roll

100. At resonance

(1) The amplitude of vibration is very large

(2) The amplitude of vibration is very small

(3) The waves produced are ultrasonic

(4) Frequency of vibration is double the frequency of applied force

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	4	1	1	2	1	2	2	1	3	1	4	4	1	2	2	3	1	
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	2	3	3	3	1	2	3	4	1	1	4	1	2	3	1	3	3	1	
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	2	2	2	4	3	3	2	3	4	2	3	1	3	2	3	3	2	3	
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	3	2	4	4	2	3	1	1	2	4	1	2	3	3	2	4	3	4	
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	3	2	2	1	2	3	2	3	2	3	2	1	3	1	2	2	2	2	