Motion Force Work and Energy

Rest

An object is said to be at rest if it does not change its position with respect to its surroundings with the passage of time.

Motion

A body is said to be in motion if its position changes continuously with respect to the surroundings (or with respect to an observer) with the passage of time.

Concept of a Point Object

In mechanics while studying the motion of an object, sometimes its dimensions are of no importance and the object may be treated as a point object without much error. When the size of the object is much less in comparision to the distance covered by the object then the object is considered as a point object.

Frame of Reference

To locate the position of object we need a frame of reference. A convenient way to set up a frame of reference is to choose three mutually perpendicular axes and name them x-y-z axes. The co-ordinates (x, y, z) of the particle then specify the position of object w.r.t. that frame. If any one or more co-ordinates change with time, then we say that the object is moving w.r.t. this frame.

Motion in One, two and three Dimensions

(a) Motion in 1-D:
If only one of the three co-ordinates specifying the position of object changes with respect to time then the motion of object is called one dimensional (1-D). In such a case the object moves along a straight line and the motion therefore is also known as rectilinear or linear motion.
E.g. (i) Motion of train along straight railway track.
(ii) An object falling freely under gravity.
(b) Motion in 2-D:
If two of the three co-ordinates specifying the position of object change with respect to tome, then the motion of object is called two dimensional (2-D). In such a motion the object moves in a plane.
E.g. (i) Motion of queen on carom board.
(ii) An insect crawling on the floor of the room.
(iii) Motion in 3-D:
If all the three co-ordinates specifying the position of object changes with respect to tome, then the motion of object is called three dimensional (3-D). In such a motion the object moves in a space.

E.g. (i) A bird flying in the sky (also kite).

(ii) Random motion of gas molecules.

Types of Motion

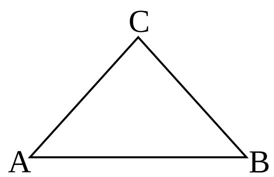
(i) Linear motion (or translatory motion):
The motion of a moving car, a person running, a stone being cropped.
(ii) Rotatory motion:
The motion of an electric fan, motion of earth about its own axis.
(iii) Oscillatory motion:
The motion of a simple pendulum, a body suspended from a spring (also called to and fro motion).

Scalar and Vector Quantities

(a) Scalar quantity:
Any physical quantity, which can be completely specified by its magnitude alone, is a scalar quantity or a scalar.
Eg. Charge, distance, area, speed, time, temperature, density, volume, work, power, energy, pressure, potential etc.
(b) Vector quantity : Any physical quantity, which requires direction in addition to its magnitude is known as a vector.
Eg. Displacement, velocity, acceleration, force, momentum, weight, electric field etc.

Distance and Displacement

(a) Distance:
Distance is the actual length of path traveled by a body in a given time.
Eg: Consider a body traveling from A to B along any path between A and B. The actual length of the path that a body travels between A and B is known as the distance. Here if the body goes from A to B via C, the distance travel will be ACB (AC+CB). The distance traveled will be different for different paths between A and B.



It is a scalar quantity:
(b) Displacement:
The distance traveled in a given direction is the displacement. Thus displacement is the shortest distance between the given points. It is a vector quantity. S.I. unit of distance or displacement is metre.

❖ **NOTE:**

If a body travels in such a way that it comes back to its starting position, then the displacement is zero. However, distance traveled zero.

Uniform and Non-Uniform Motion

(a) Uniform Motion:
A body gas a uniform motion if it travels equal distances in equal intervals of time, no matter how small these time intervals may be.
For example, a car running at a constant speed of say, 10m/s, will cover equal distances of 10 metres in every second, so its motion will be uniform.
(b) Non-Uniform Motion:
A body has a non-uniform motion if it travels unequal distances in equal intervals of time.
For example, it we drop a bal form the roof of a building, we sill find that it covers unequal distances in equal interval of time.

Speed

The distance traveled by a body in unit time is called its speed. Therefore, speed $= \frac{Distacne}{Time}$ or $v = \frac{d}{t}$
S.I. unit of speed or average speed is m/sec. it is a scalar quantity.
(a) Average Speed:
For an object moving with variable speed, it is the total distance traveled by an object divided by the total time taken to cover that distance.

$$Average\ speed = \frac{total\ distance\ travelled}{total\ time\ taken}$$

(b) Uniform speed (or constant Speed):
When an object covers equal distances in equal intervals ot time, it is said to move with uniform speed.
Eg. A car moves 10 m in every second so its motion is uniform.
(c) Variable Speed (Non-Uniform Motion) :
If a body covers unequal distances in equal intervals of time, its motion is said to be non-uniform.
(d) Instantaneous Speed:
The speed of an object at any particular instant of time or at a particular point of its path is called the instantaneous speed of the object. It is measured by speedometer in an automobile.

Velocity

It is the rate of change of displacement.

Therefore, $velocity = \frac{displacement}{time}$ or it is the distance traveled in unit time in a given direction.

$$velocity = \frac{distance\ travelled\ in\ a\ given\ direction}{time\ taken}$$

S.I. unit of velocity is m/s. It is a vector quantity. (Magnitude of the velocity is known as speed).

1 km/h = $\frac{5}{18}$ m/s.
(a) Uniform Velocity (Constant Velocity):
If a body covers equal distances in equal intervals of time in a given direction then it is said to be moving with constant velocity.
(b) Non-Uniform Velocity (Variable Velocity):
When a body does not cover equal distances in equal intervals of time, in a given direction (in this case speed is not constant), then it is known as non uniform velocity. If speed is constant then also body can have a non-uniform velocity.
Eg: Motion of a car on a circular road with constant speed.
(c) Average Velocity:
If initial velocity of body is u and final velocity is v then the arithmetic mean of velocity is called average velocity which is given as, $v_{as} = \frac{u+v}{2}$.

Average velocity = $\frac{Total\ displacement}{Total\ time}$

(d) Instantaneous Velocity:
The velocity of an object at any given instant of time at particular point of its path is called its instantaneous velocity.

$$v = \lim_{\Delta t \to 0} \frac{\Delta \vec{x}}{\Delta t}$$

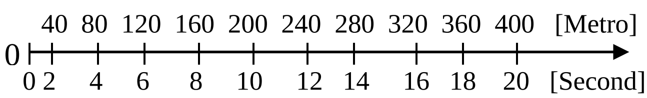
Illustrations

1. When the average speed of an object equal to the magnitude of its average velocity? Give reason also.

Sol. As average speed = $\frac{total\ path\ length}{time\ interval}$

Also, average velocity = $\frac{Displacement}{time\ interval}$. When an object moves along a straight line and in the same direction its total path length is equal to the magnitude of its displacement. Hence average speed is equal to the magnitude of its average velocity.

2. A car is moving along x-axis. As shown in figure it moves from ω to P in 18 s and returns from P to Q in 6 sec. What is the average velocity and average speed of the car in going from (i) O to P and (ii) from O to P and back to Q.



Sol. (i) Average velocity $= \frac{Displacement}{time\ interval}$

$= \frac{360}{18} = 20\ ms^{-1}$

Average speed $= \frac{path\ length}{time\ interval} = \frac{360}{18} = 20\ ms^{-1}$

(ii) From O to P and back to Q

Average velocity $= \frac{OQ}{18+6} = \frac{240}{24} = 10\ ms^{-1}$

Average speed $= \frac{path\ length}{time\ interval}$

$= \frac{OP+PQ}{18+6} = \frac{360+120}{24} = 20\ ms^{-1}$

3. A car covers the 1 st half of the distance between two places at a speed of 40 km h^{-1} and the 2[nd] half at 60 km h^{-1}. What is the average speed of the car?

Sol. Suppose the total distance covered is 2S.

Then time taken to cover first S distance with speed 40 km/h,

$t_1 = \frac{S}{40}$ h.

Time taken to cover second S distance with speed 60 km/h,

$t_2 = \frac{S}{60}$ h.

Average speed $= \frac{Total\ distance}{Time\ taken} =$

Acceleration

Mostly the velocity of a moving object changes either in magnitude or in direction or in both when the object moves. The body is then said to have acceleration. So it is the rate of change of velocity i.e. change in velocity in unit time is said to be acceleration (it is a vector quantity).

Its S.I. unit is m/s^2 and C.G.S. unit is cm/s^2.

Acceleration $= \frac{change\ in\ velocity}{time}$

$= \frac{v-u}{t} = \frac{final\ velocity - initial\ velocity}{time}$

(a) Uniform Acceleration (Uniformly Accelerated Motion):

If a body travels in a straight line and its velocity increases in equal amounts in equal intervals of time. Its motion is known as uniformly accelerated motion.

Eg: Motion of a freely falling body is an example of uniformly accelerated motion (or motion of a body under the gravitational pull of the earth).

(b) Non-Uniform Acceleration:

If during motion of a body its velocity increases by unequal amounts in equal intervals of time. Its motion is known as non-uniformly accelerated motion.

Eg.: Car moving in a crowded street.

Types of Acceleration

(i) Positive acceleration:

If the velocity of an object increases in the same direction, the object has a positive acceleration.

(ii) Negative acceleration (retardation):

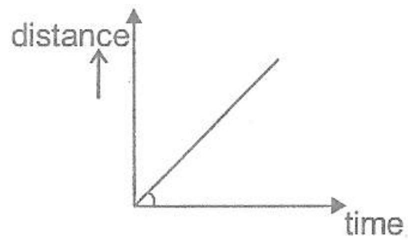
If the velocity of a body decreases in the same direction, the body has a negative acceleration or it is said to be retarding.

Eg.: A train slows down.

Distance-Time Graph

(a) Distance-time graph of uniform motion:

The distance time graph represents uniform motion if graph is like figure below.



Slope of distance-time graph represents the speed of moving object.

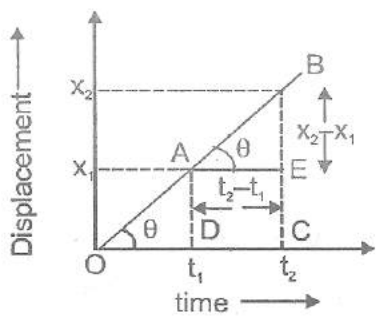
If graph is straight line as shown blown then motion is called uniform motion.

$\therefore$ Velocity $= \frac{BE}{AE} = \frac{x2 - x1}{t2 - t1}$

[From the figure given below]

If the line OAB of the graph makes an angle θ (theta) with the time axis then,

Slope = velocity = $\frac{x^2 - x^1}{t^2 - t^1} = \frac{disp.acement}{time}$



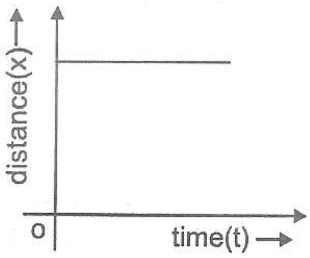
(c) Distance – Time Graph for a Stationary Body:

In figure below the x-t graph is a straight line parallel to time axis, then

Slope=tan0^0 = 0

∵ Speed = slope = 0

Hence, body.is at rest.

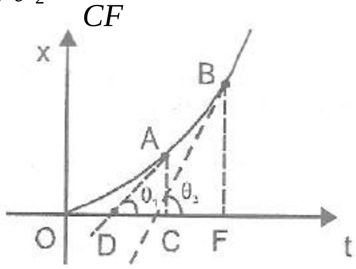


Distance – Time Graph for a body moving with Variable Speed:

Case-1: When the speed of the body increases with passage of time:

The speed of the body at any point is known as instantaneous speed and can be calculated by finding the slope at that point. So instantaneous speed of the body at point A =slope at A =tan θ_1 = $\frac{AC}{DC}$

Instantaneous speed of the body at B = slope at B = tan θ_2 = $\frac{BF}{CF}$



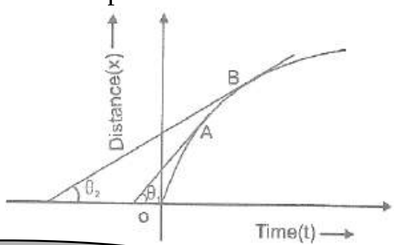
Since $\theta_2 > \theta_1$, so slope at B is greater than the slope at A. Hence speed of body at point B is greater than the speed of the body at point A.

Case-2: When the speed decreases with passage of time:

$\theta_2 < \theta_1$

∴ Slope at B < slope at A

So speed at B < speed at A.



Velocity-Time Graph

(a) Introduction:

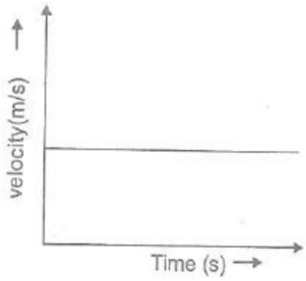
This graph is plotted between the time taken and the velocity acquired. The time is taken along X-axis and the velocity acquired is taken along Y-axis.

Since, acceleration = $\frac{change\ in\ velocity}{time}$, the slope of the velocity-time graph, gives the acceleration of the body.

Since, distance = speed × time the area enclosed between the speed – time graph and the X-axis (time axis), gives the distance covered by the body. Similarly area enclosed between the velocity-time graph and the X- axis (time axis) gives the displacement made by the body.

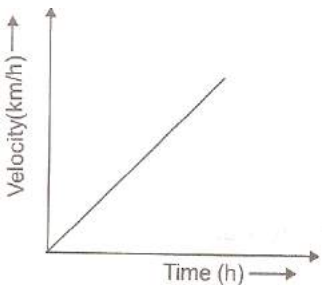
(b) Different cases:

Case-1 : The body is moving with a uniform velocity : Since the velocity of the body is uniform, the magnitude remains sane. The graph is a straight line parallel to X – axis (time-axis) as shown in figure.



Case-2: The body is moving with a uniform acceleration:

The velocity is changing by equal amounts in equal interval of time. The velocity-time graph of such a body is a straight line inclined to X – axis (time-axis) as shown is figure below.



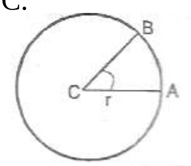
Circular Motion

Motion of a particle (small body) along a circle (circular path), is called a circular motion. If the body covers equal distances along the circumference of the circle, in equal intervals of time, the motion is said to be a uniform circular motion.

Circular motion is an accelerated motion. Since, in a circular motion, velocity changes, though in direction only, the motion is said to be accelerated.

Radian-(A unit for Plane Angle):

One radian is defined as the angle subtended at the centre of the circle by an arc equal in length to its radius.
The arc AB of the circle, has length ℓ and subtends an angle θ at the centre C.
Then, $\angle$ACB = θ radian.



$\theta = \frac{\ell}{r}$ radian.

[For ℓ = r, θ = 1 radian]
Angle subtended by the circumference at the centre,

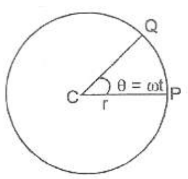
$\theta = \frac{2\pi r}{r} = 2\pi$ radian {or $2\pi^c$}

[^{c}]is symbol for radian, first as (^{o}) is symbol for degree.

Relation:
For complete circle at centre

$2\pi^c = 360^0$ or $1^c = \left[\frac{360}{2\pi}\right] = 57.3^0$

(a) Angular Displacement and Angular Velocity
In a circular motion, the angular displacement of a body is the angle subtended by the body at the centre in a given interval of time. It is represented by the symbol θ (theta). The angular displacement per unit time is called the angular velocity. It is represented by the symbol ω (omega).
Let a body moves along a circle of radius r and perform a uniform circular motion. Let the body be at point P to start with and reach point Q after time t.
Then, angular displacement = $\angle$PCQ = θ and angular velocity, $\omega = \frac{\theta}{t}$ (i.e. $\theta = \omega t$)
If the time period of the body is T, the angular displacement = $2\pi^c$



Hence $\omega = \frac{2\pi}{T}$

But $\frac{1}{T}$ = N (frequency)

There $\omega = 2\pi N$

(b) Units for θ and ω :
The unit for angular displacement is radian (a supplementary quantity).
The unit for angular velocity is radian per sec(rad/s).

(c) Relation between linear and angular quantities:
For an arc of length, ℓ
Linear distance = ℓ

Angular displacement, $\theta = \frac{\ell}{r}$

Hence, $\ell = r\theta$
For a time interval t,

Linear velocity, $v = \frac{\ell}{t}$

Angular velocity, $\omega = \frac{\theta}{t} = \frac{\ell}{rt} = \frac{v}{r}$

Hence, v = r ω

(d) Frequency and Time Period:
❖ Frequency is number of revolutions in one second.
❖ Time period is time taken in one revolution.
❖ Frequency and time period are represented by n and T respectively.

Force

Force is a push or pull which can move the object. It can change the speed of the object, it can change the direction of motion. It can change the shape of the object. **"Force is the cause which can produce acceleration in the body on which it acts".**

Effects of Force

(a) Force can make a stationary object move and can change the speed of the object:
Eg:
(i) A stationary football can be made to move by giving it a small push.
(ii) The moving toy car can be made to stop by applying a force.

(b) Force can change the direction of a moving object
Eg:
(i) A cricketer applies a tangential force to change the direction of the cricket ball.
(ii) When a football in motion kicked perpendicular to its motion, direction of motion changes.

(c) Force can change the shape and size of the object:
A force applied on an object can also change its shape and size.
Eg:
(i) When we compress a spring then its length decreases.
(ii) When we strech a spring then its length increases.

Mathematical Representation of Force

Mathematically, force F is equal to the product of mass, m of a body and acceleration, a produced in the body due to that force.
i.e. F = ma

Units of Force

(a) In C.G.S. system:
$\because$ F = ma $\rightarrow$ gram × cm/s^2 = dyne
If m = 1 gram, a = 1 cm/s^2, then F =1 dyne

When a force is applied on a 1 gram body and the acceleration produced in the body is 1 cm/s^2 then the force acting on the body will be one dyne.

(b) In S.I. system:

$F = ma \rightarrow kg \times m/s^2$ = Newton

If m =1 kg and a = 1 m/s^2 then by F = ma,

$F = 1\times 1 = 1\ kg \times m/s^2$ = Newton.

If a force is applied on a body of mass 1 kg and acceleration produced in the body is 1 m/s^2 then the force on the body will be one Newton.

Resultant Force

If a single force acting on a body produces the same acceleration as produced by a number of forces, then that single force is called the resultant force of these individual forces.

NOTE:

❖ If the two forces act in the same directions on an object, then net force acting on it is the sum of two forces.

❖ If the two forces act in the opposite directions on an object, the net force acting on it is the difference between the two forces.

Balanced and Unbalanced Forces

If a set of forces acting on a body produces no acceleration in it, the forces are said to be balanced forces. If it produces a non-zero acceleration, the forces are said to be unbalanced forces. If two forces balance each other, they must be in opposite direction and have equal magnitudes.

Contact Force

Force which acts on a body only when the body is in contact with the force is known as contact force.

(i) Normal force:

If contact forces between the bodies are perpendicular to the surface in contact, the forces are known as normal forces.

(ii) Force of friction:

Two bodies placed in contact can also exert forces parallel to the surfaces in contact, such a force is called force of friction or simply friction.

(iii) Muscular force

The force resulting due to the action of muscles is known as the muscular force.

Since muscular force can be applied only when it is in contact with an object. It is also called a contact force.

Non-Contact Force:

(i) Gravitational force:

The force with which two objects attract each other is called the force of gravitation. The force of gravitation acts even if the two objects are not connected by any means. If, however, the masses of the objects are small, the force of gravitation between them is small and cannot be detected easily.

The force of attraction between any two particles in the universe is called gravitation or gravitational force.

Force of gravity:

The earth attracts all the bodies towards its centre. The force exerted by the earth on the body is known as weight of the body or force of gravity. It acts in vertically downward direction.

If mass of the body is m and acceleration due to gravity is g. Then force of gravity or weight = mg.

The value of g on the surface of earth is 9.8 m/s^2.

The value of g at the centre of earth is zero.

(ii) Electrostatic force:

The force acting between the charges is known as electrostatic force. If q_2 are the charges then the electrostatic force force acting between them would be,

$$F = \frac{kq_1q_2}{r^2},\ k = 9\times 10^9\ Nm^2/C^2$$

Important note:

So far, we know of only four fundamental forces in the universe, They are gravitational force, electromagnetic force, weak force and strong interactions, We are familiar with the first two, Weak forces come into play during radioactivity, Strong interactions are responsible for holding the nucleus of an stom together. All other forces are manifestations of these fundamental forces. For example, forces such as friction between bodies, muscular action, etc, viewed on an atomic scale arise chiefly from electrical attraction and repulsion of the electrons and nuclei making up the atoms of the material.

Work

When a force is applied on a body and it moves the body in the direction of force then work is said to be done.

Mathematically, $W = Fd$

Here, F = Force and = displacement

The S,I. unit of work is joule and the C.G.S. unit of work is erg.

1 Joule = 10^7 erg

Work done against gravity:

Let a body of mass m is placed on ground. So, its weight is mg.

On lifting it upward, a force F = mg has to be applied upward (against gravity).

Let the body be lifted up by a distance d (height h).

Work done = Force × distance

$W = Fd$, $W = mgh$
1 Joule = 1 Newton × 1 metre
Case-I : When F= 0 $\Rightarrow W = 0$
Case-II : When d = 0 $\Rightarrow W = 0$
Case-III :-When the force acts perpendicular to the circection of motion of the bldy, then no work is said to be done.

IIlustration

4. Calculate the work done to raise a body of mass 20 kg to a height of 40 m (take g = 10 m/s^2).
Sol. Here, force F = mg = 20 × 10 = 200 N.
Displacement, d = 40 m (in the direction of force) Work done,
W = F.d = mgd = 20 × 10 × 40 = 8000 J
W = 8 × 10^3 joule = 8 kilo joule.

5. pair of bullocks exerts a force of 140 N on a plough. The field being ploughed is 15 m. How much work is done in ploughing the length of the field ?
Sol. Force, F = 140 N
Displacement, d = 15 m (in the direction of force) Work done, W = Fd = 140 × 15 = 2100 joule.

Energy

Capacity of doing work or total work done by a man or by an agent is called the energy of the man or the agent.
C.G.S. and S.I. units of energy are same as that of work done.
NOTE:
(i) Kilo watt × hour (kWh) is commercial unit of energy.
1 kWh = 1000 watt × 60 × 60 s
= 3.6 × 10^6 watt × s.
1 kWh = 3.6 × 10^6 J
(ii) Electron volt is also the unit of energy. The energy of an electron, when it is accelerated by a potential difference of 1 volt, is known as one electron volt.
1 electron volt = 1.6 × 10^{-19} J.

Different Forms of Energy

(i) Heat energy:
When we burn coal, wood or gas, heat energy is released. Steam possess heat energy that is why in a steam engine, the heat energy of steam is used to get the work done. Sun also radiates heat energy.
(ii) Light energy:
It is a form of energy which gives us the sensation of vision. Natural source of light is the sun. An electric bulb also emit light energy.
(iii) Sound energy:
The energy emitted by a vibrating wire, gunning fork, vibrating membrane etc, that can be sensed by human ears is called sound energy.
Eg.: Whistle, flute, sitar, all emits sound energy when they are made to vibrate.
(iv) Magnetic energy:
A magnet also possess energy known as magnetic energy. When a current is passed through a coil, it behaves like a magnet until the current flows trough it. Hence it stores magnetic energy until the current flows through it.
(v) Electrical energy:
An electric cell stores electrical energy. Two charges placed at some distance experience a force. They also possess electrical energy.
Eg.: A charged body possess electrical energy.
(vi) Chemical energy:
It is the energy possessed by fuels like petrol, diesel, gas, etc. The chemical energy of petrol or diesel is utilized to move vehicles etc. The food we eat also possess chemical energy.
(vii) Solar energy:
The energy radiated by the sun is solar energy. Sun is the natural source of energy.
(viii) Nuclear energy:
Sometimes, a heavy nucleus breaks into two or more lighter nuclei with the release of some energy. This energy is called nuclear energy and the process is called nuclear fission. On the other hand, when two lighter nuclei combine to form a heavy nucleus, the process is called nuclear fusion.
(ix) Mechanical energy:
The energy possessed by a body due to its state of rest or state of motion is called mechanical energy. Mechanical energy is of is the sum of kinetic energy and potential energy.
(A) Kinetic energy:
Energy of a body due to its velocity is known as the kinetic energy of the body. If a body of mass m is moving with velocity v, then its kinetic energy = $\frac{1}{2}mv^2$
(B) Potential energy:
The energy possessed by a body, due to its position or configuration, is called potential energy.
Eg. : (i) When a body is lifted up to a height from the ground, then the work cone against the force of gravity, is stored in the body in the form of gravitational potential energy.
(ii) When a spring is stretched or compressed, then the work done against elasticity is stored in the spring in the form of elastic potential energy.
Expression for gravitational potential energy:
(i) For a freely falling body potential energy changes into kinetic energy.
(ii) For an upward projected body, kinetic energy changes into potential energy.

6. Find the energy possessed by the object of mass 10 kg when it is at a height of 6 m above the ground (g = 10 ms^{-2}).
Sol. Mass of object, m = 10 kg
Height from ground, h = 6m
Acceleration due to gravity, g = 10 m/s^2
Potential energy, U = mgh = 10 × 10 × 6 = 600 J.

7. A bag of wheat weighs 20 kg. To what height should it be raised so that its potential energy may be 9800 J (g = 9.8 m/s^2) ?

Sol. Mass of bag, m = 200 kg.
Potential energy, U = 9800 joule.
Acceleration due to gravity g = 9.8 m/s^2
Height of the bag, h = ?
Potential energy, U = mgh
9800 = 200 × 9.8 × h

$$h = \frac{9800}{200 \times 9.8} = 5m$$

h = 5m.

Transformation of Energy

In our daily life, we observe that energy is converted form one form to the other. Conversion of energy form one form to the other is called **transformation of energy**.

Examples of conversion of energy:

(i) Mechanical energy into electrical energy:
Water in the reservoirs of a dam has potential energy. When it falls, it tends to lose its potential energy and gains kinetic energy which helps rotate the turbine connected to generators or dynamo at the bottom of the dam. Thus, in hydroelectric generators the potential energy of water is transformed to kinetic energy and then to electrical energy

(ii) Electrical energy into mechanical energy:
In an electric motor, electrical energy is transformed onto mechanical energy. Electric motor is used to run electrical appliances like water pump, washing machines, etc.

(iii) Electrical energy into heat energy:
In electrical appliances like electric iron, electric heater, geyser, oven, electrical energy is transformed into heat energy.

(iv) electrical energy into light energy:
When an electric bulb is switched on, electrical energy gets converted into heat and light energy.

(v) Electrical energy into sound energy:
In an electric bell, the electrical energy is transformed into sound energy.

(vi) Light energy into electrical energy:
In a photoelectric cell, light energy is converted into electrical energy. In solar cells, light energy gets converted into electrical energy.

(vii) Heat energy into mechanical energy:
In a steam engine, when coal burns, its chemical energy gets converted into heat energy which, in turn gets converted into mechanical energy which runs the engine.

(viii) Chemical energy into mechanical energy:
Chemical energy of petrol or diesel is transformed into mechanical energy to run automobiles.

(ix) Chemical energy into heat energy:
When we burn various fuels like wood, coal gas etc., the chemical energy is transformed into heat energy.

(x) Chemical energy into electrical energy:
An electric cell is used to draw current is such a way that the chemical energy is converted into electrical energy.

(xi) Light energy into chemical energy:
Green plants absorb sunlight which in turn gets converted into the form of chemical energy.

EXERCISE

1. If force and displacement of particle in the direction of force are doubled. Work would be:
(A) Double (B) 4 times
(C) Half (D) ¼ times

2. Burning of coal is an example of conversion of:
(A) chemical energy into light and heat energy
(B) mechanical energy to heat energy
(C) heat energy to light energy
(D) light energy to heat energy

3. The decrease in the potential energy to a ball of mass 20 kg whigh falls from a height of 50 cm, is
(A) 968 J (B) 98J
(C) 1980 J (D) None of these

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

5. Which is not a unit of energy?
(A) watt second (B) kilo watt hour
(C) watt (D)Joule

6. The work is said to be done when:
(A) a body moves
(B) a force is applied which brings about motion
(C) a force is applied but no motion is produced
(D) none of these

7. A fast wind can turn the blades of a windmill because it possess :
(A) potential energy (B) kinetic energy
(C) chemical energy (D) heat energy

8. When we compress a coil spring, we do work on it. The elastic potential energy:
(A) increases (B) decreases
(C) disappears (D)remains the same

9. What is the work done by gravity on a man standing on a platform?
(A) zero
(B) Positive
(C) Negative
(D) Depends on the particular situation

10. A body at rest can have:
(A) speed (B) energy
(C) momentum (D) velocity

11. A force of 10N works on a ball over a distance of 5m. The force is antiparallel to the displacement of the ball. What is the total work done by the force?
(A) -50 J (B) zero
(C) 2J (D) 50J

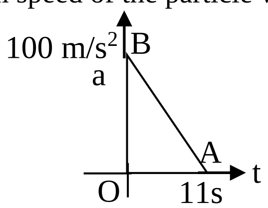
12. Energy is measured in the same units as:
(A) Power (B) Force
(C) Work (D) None of the above

13. The potential energy is always the same for an object with the same:
(A) Velocity (B) Speed
(C) Acceleration (D) Position

14. A 150m long train is moving with a uniform velocity of 45 km/h. The time taken by the train to cross a bridge of length 850m is:
(A) 56 s (B) 68 s
(C) 80 s (D) 92 s

15. A man walks on a straight road from his home to market 2.5 km away with a speed of 5km/h. Finding the market closed, he instantly turns and walks back home with a speed of 7.5 km/h. the average speed of the man over the interval of time 0 to 40 min, is equal to :
(A) 5 km/h (B) 25/4 km/h
(C) 30/4 km/h (D) 45/8 km/h

16. A particle starts form rest. Its acceleration (a) versus time (t) is as shown in the figure. The maximum speed of the particle will be:



(A) 110 m/s (B) 55 m/s
(C) 550 m/s (D) 660 m/s

17. The angular velocity of the second's hand of a clock is:
(A) 0.105 rad/s (B) 1.105 rad/s
(C) 2.102 rad/s (D) 3.120 rad/s

18. A bus is moving eastward. It covers a distance of 200 kilometers in 4 hours, Its velocity is:
(A) 50 km/h (B) 20 km/h
(C) 40 km/h (D) 60 km/h

19. Mohan takes 20 minutes to cover a distance of 3.2 kilometers due north on a bicycle, his velocity in kilometer/hour:
(A) 8.1 (B) 9.6
(C) 1.2 (D) 7.2

20. The initial velocity of a cyclist was 4 m/s. His acceleration is $2m/s^2$, his velocity after 5 seconds is:
(A) 12 m/s (B) 10 m/s
(C) 14 m/s (D) 8 m/s

21. The initial velocity of a body is 15 m/s. If it is having an acceleration of 10 m/s2, then the velocity of body after 10 seconds from start :
(A) 110 m/s (B) 105 m/s
(C) 120 m/s (D) 115 m/s

22. Which of the following class of forces is different form others?
(A) Pulling of a cart
(B) Stretching of a coiled spring
(C) Kicking of a football
(D) Electric force

23. The speed of a falling body increases contentiously. This is because:
(A) no force acts on it
(B) it is very light
(C) the air exerts the frictional force
(D) the earth attracts it

24. If an object is in a state of equilibrium:
(A) it is at rest
(B) it is in accelerated motion
(C) it is in motion at constant velocity
(D) both (A) and (C)

25. If a boat is moving along at constant speed, it may be assumed that:
(A) a net force is pushing it forward
(B) the sum of only vertical forces is zero
(C) the buoyant force is greater than gravity
(D) the sum of all forces is zero

26. A moving object can come to rest if it :
(A) has a frictional force acting on it
(B) has no net force acting on it
(C) is completely isolated
(D) none of these

27. The necessary force required in Newton to produce a pressure of 50 $Newton/meter^2$ on a rectangle of area 10 square meter will be:
(A) 500 (B) 60
(C) 5 (D) 0.2

28. Four bodies are of m, 2m, 3m, 4m masses. In which body acceleration produced will be maximum on applying equal amount of force an each one of them.
(A) m (B)2m
(C) 3m (D) 4m

29. 20 Joules work is done in displacing a body by 4 meter in the direction of the force. The value of the force applied in Newton is:
(A) 4 (B) 5
(C) 24 (D) 80

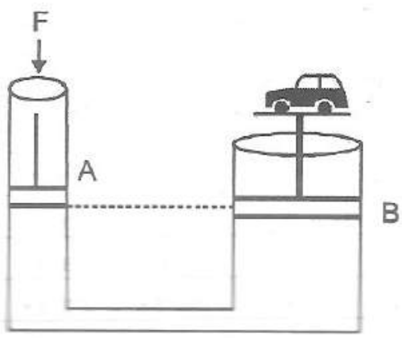
30. Some physical quantities and their units are given in column I and II respectively.

Column-I	**Column-II**
(a) Momentum	(i) $\frac{kg \times m}{Sec.}$
(b) Pressure	(ii) Newton × meter
(c) Work	(iii) Newton/m^2
(d) Power	(iv) $\frac{newton \times m}{Sec.}$

(A) a (i), b (iii), c (ii), d (iv)
(B) a(i), b(iv), c(iii), d (ii)
(C) a(ii), b(iii), c (i), d (iv)
(D) a(iii), b(i), c (iv), d (ii)

31. Light object (mass m_1 and velocity v_1) and heavy object (mass m_2 and velocity v_2) posses equal kinetic energy, then correct statement is:
(A) $m_1v_1<m_2v_2$ (B) $m_1v_1>m_2v_2$
(C) $m_1v_1 = m_2v_2$ (D) $m_1v_2 = m_2v_1$

32. A car of mass 1000 kg is supported on piston of tube B for repairs. It is connected to tube A which is of 1/5th diameter of tube B. Tubes are full of oil. Force F applied on piston of A to support the car is:



(A) 200 kg wt (B) 200 newton
(C) 40 kg wt (D) 40 newton

33. Which of the following statements is true for a planet?
(A) Its mass increases with increasing distance form the sum.
(B) Its radius increases with increasing distance form the sum.
(C) Its period of revolution increases with increasing distance form the sum.
(D) Its period of rotaion about its own axis increases with increasing distance form the sum.

34. Consider the following motions.
(a) Rotation of the earth about its axis
(b) Revolution of the moon around the earth
(c) Motion of a mass suspended from a spring when it is pulled down slightly and then released.
(d) Motion of a string of a sitar when plucked.
Which of the following pairs of motion represents an oscillatory motion?
(A) a, c (B) a, b
(C) b, d (D) c, d

ANSWER – KEY

MOTION, FORCE, WORK AND ENERGY

Q	1	2	3	4	5	6	7	8	9	10
A.	B	A	B	C	C	V	V	A	A	B
Q	11	12	13	14	15	16	17	18	19	20
A.	A	C	D	C	D	B	A	A	B	C
Q	21	22	23	24	25	26	27	28	29	30
A.	D	D	D	D	D	A	A	A	B	A
Q	31	32	33	34						
A.	A	C	C	D						