GRAVITATION

4
CHAPTER

CONTENTS

➢ FORCE OF GRAVITATION

Any two particles in the universe attract each other. This force is called the force of gravitation.

This concept was given by **Newton**.

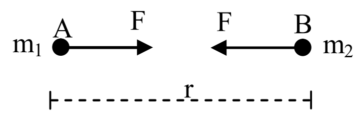
➢ NEWTON'S LAW OF GRAVITATION

According to newton, "Any two bodies in universe attract each other with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between them."

◆ **Mathematical expression**

Lat A and B be two particle of mass m_1 and m_2 respectively. Let the distance AB = r.

By the law of gravitational, the particle A attracts the particle B with a force F such that.



$F \propto m_1m_2$ (for a given pair of particles)

$F \propto \frac{1}{r^2}$ (for a given separation between the particles)

So $F \propto \frac{m_1m_2}{r^2}$

or $F = G\frac{m_1m_2}{r^2}$

Here G is a constant known as the universal constant of gravitation. $G = 6.67 \times 10^{-11}$ Nm^2/kg^2

◆ G is independent of the masses of the bodies and the distance between them.

◆ Newton's law of gravitation is applicable for everybody in the universe.

Note : The force between any two bodies in the universe is called the force of gravitation while the force with which earth attracts a body is called the force of gravity.

❖ **Some Scientific Phenomenon Based on Gravitational Force :**

◆ The gravitational force between the sun and the earth keeps the earth moving around the sun.

◆ The gravitational force b/w the earth and the moon keeps the moon moving around the earth.

◆ Existence of our solar system is due to gravitational force.

- Gravitation force of the sun and the moon on the earth's water surface is responsible for the tides in sea.
- Atmosphere above the earth is held due to gravitational force of the earth.
- Gravitational force between the sun and planet keeps the planet moving around the sun.
- Gravitational force is responsible for providing the centripetal force required by the planets.
- The attractive force of the earth is responsible for providing the centripetal force required by moon.

Newton's Third Law of Motion and Law of Gravitation :

- Newton's third law of motion is applicable to gravitation also.

  Ex. if the earth exerts a force of attraction on a body, the body also exerts an equal and opposite force of attraction on the earth.
- As a = F/m

  mass of the body is larger, acceleration produced will be smaller and vice versa.

Ex. 1 Calculate the force between two masses of 100 kg and 1000 kg separated by a distance of 10 m ($G = 6.67 \times 10^{-11}$ Nm²/kg²).

Sol. According to Newton's law of gravitation, force of attraction between two bodies is

$$F = \frac{Gm_1m_2}{r^2}$$

Here, $m_1 = 100$ kg; $m_2 = 1000$ kg ; $r = 10$ m ; $G = 6.67 \times 10^{-11} Nm^2/kg^2$

$$\therefore \quad F = \frac{6.67\times10^{-11}\times100\times1000}{(10)^2}$$

$$= 6.67 \times 10^{-8}\ N$$

Ex. 2 Given mass of earth $= 6 \times 10^{24}$ kg, radius of earth $= 6.4 \times 10^6$ m. Calculate the force of attraction experienced by a man of mass 50 kg.

Sol. Force of gravitation is given by the expression, $F = \frac{Gm_1m_2}{r^2}$

Here, mass of earth, $m_1 = 6 \times 10^{24}$ kg;

mass of man, $m_2 = 50$ kg

Distance between them is to be taken equal to the radius of earth.

$\therefore \quad r = 6.4 \times 10^6$ m

Substituting these values, we get

$$F = \frac{6.67\times10^{-11}\times6\times10^{24}\times50}{(6.4\times10^6)^2} = 488.5\ N$$

Ex. 3 Compare the gravitational forces exerted by the sun and the moon on earth. Which exerts a greater force on earth ?

(Given : mass of sun, $M_S = 4 \times 10^{31}$ kg; mass of moon, $M_m = 6.3 \times 10^{22}$ kg; distance between sun and earth, $r_{se}=1.3 \times 10^{12}$ m and the distance between moon and earth, $r_{me}= 4.5 \times 10^8$m)

Sol. If mass of sun is M_S and mass of earth is M_e and distance between the sun and earth is r_{se}, then force exerted by the sun on earth is

$$F_S = \frac{GM_sM_e}{(r_{se})^2} \quad ...(1)$$

Similarly, if mass of moon is M_m, mass of earth is M_e, the distance between moon and earth is r_{me}, then force exerted by moon on the earth is

$$F_m = \frac{GM_mM_e}{(r_{me})^2} \quad ...(2)$$

Dividing equation (1) by equation (2), we get

$$\frac{F_s}{F_m} = \frac{GM_sM_e}{(r_{se})^2} \times \frac{r_{me}^2}{GM_mM_e}$$

$$= \frac{M_s}{M_m} \times \frac{(r_{me})^2}{(r_{se})^2}$$

$$= \frac{4\times10^{31}}{6.3\times10^{22}} \times \left(\frac{4.5\times10^8}{1.3\times10^{12}}\right)^2 = 76.07$$

$\therefore$ The force exerted by the sun on earth is about 76 times the force exerted by the moon on earth.

Ex. 4 If mass and radius of earth is 6.0×10^{24} kg and 6.4×10^6 m respectively, calculate the force exerted by earth on a body of mass 1 kg. Also, calculate :

(i) acceleration produced in the body of mass 1 kg, and

(ii) acceleration produced in the earth

Sol. From Newton's law of gravitation, we know that the force of attraction between two bodies is given by

$$F = \frac{Gm_1m_2}{r^2}$$

Here, m_1 = mass of earth = 6.0×10^{24} kg;

m_2 = mass of body = 1 kg

r = distance between the two bodies

= radius of earth = 6.4×10^6 m

$G = 6.67 \times 10^{-11}$ Nm²/kg²

$$\therefore \quad F = \frac{6.67\times10^{-11}\times6.0\times10^{24}\times1}{(6.4\times10^6)^2} = 9.8 \text{ N}$$

This shows that earth exerts a force of 9.8 N on a body of mass of 1 kg. The body will exert an equal force of attraction of 9.8 N on earth.

(i) Acceleration produced in the body of mass 1kg

Force = mass × acceleration

$$\therefore \quad \text{Acceleration, } a = \frac{F}{m} = \frac{9.8}{1} = 9.8 \text{ m/s}^2$$

Thus, the acceleration produced in a body of mass 1 kg due to attraction of earth is 9.8 m/s^2, which is quite large. Thus, when a body is released, it falls towards the earth with an acceleration of 9.8 m/s^2, which can be easily observed.

(ii) Acceleration produced in the earth

Similarly, acceleration of earth is given by

$$= \frac{\text{Force}}{\text{Mass of earth}} = \frac{9.8}{6.0\times10^{24}}$$

$= 1.63 \times 10^{-24}$ m/s^2

This shows that the acceleration produced in the earth by a body of mass 1 kg is 1.63×10^{-24} m/s^2 which is very small and cannot be observed.

➢ EARTH'S GRAVITATIONAL FORCE

- The force which earth exerts on a body is called 'force of gravity'. i.e. $F = \frac{GMm}{R^2}$

Where M = mass of the earth, R = radius of the earth.

- Due to this force, a body released from some height on the earth's surface falls towards the earth with its velocity increasing at a constant rate.

◈ Acceleration due to Gravity :

- The acceleration produced in a body due to attraction of earth is called the acceleration due to gravity and is denoted by 'g'.

$$g = \frac{GM}{R^2} = 9.8 \text{ m/s}^2$$

near the earth surface

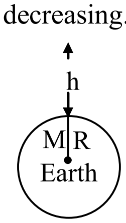
$$g \text{ on moon } \approx \frac{g_e}{6} = \frac{9.8}{6} \text{ m/s}^2$$

- A body moving upwards with some initial velocity, experiences a retardation of 9.8 m/s^2 & its velocity decreases continuously unless it becomes zero.
- After this, it again starts falling towards the earth with the same acceleration of 9.8 m/s^2.
- The value of g is minimum at equator and maximum at poles.
- The value of g does not depend upon the mass of the body falling towards the earth.

➢ VARIATION IN THE VALUE OF GRAVITATIONAL ACCELERATION (g)

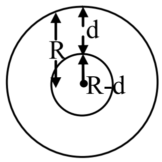
(A) Variation with altitude or height :

- When a body moves above the earth's surface the distance of the body from the centre of earth increases there by decreasing the force of attraction.
- $g = \frac{GM}{R^2}$; at the earth's surface.
- $g = \frac{GM}{(R+h)^2}$; at a height h above the earth's surface.
- As we go above the earth's surface the value of g goes on decreasing.



(B) Variation with depth d :

- As we go deeper inside the earth, the body gets attracted by the core of the earth which is smaller in mass.



- As we go inside the earth, the value of g decreases.
- Force of attraction decreases and thus decreasing the value of g and becoming zero at the centre.

(C) Variation due to rotation of the earth :

- Due to the rotation of the earth, the weight of a body is maximum at the poles and minimum at the equator.

MASS & WEIGHT

	Mass	Weight
1.	Mass of a body is defined as the quantity of matter contained in it.	Weight of a body is the force with which it is attracted towards the centre of the earth. W = mg
2.	Mass of a body remains constant and does not change from place to place.	Weight of a body changes from place to place. It depends upon the value of *g*. Weight of a body on another planet will be different.
3.	Mass is measured by a pan balance.	Weight is measured by a spring balance.
4.	Unit of mass is kg.	Unit of weight is newton or kg-wt.
5.	Mass of a body cannot be zero.	Weight of a body can be zero. Ex. astronauts experience weightlessness in spaceships.
6.	Mass is a scalar quantity.	Weight is a vector quantity.

Ex. 5 Given mass of earth is 6×10^{24} kg and mean radius of earth is 6.4×10^6 m. Calculate the value of acceleration due to gravity (g) on the surface of the earth.

Sol. The formula for the acceleration due to gravity is given by

$$g = \frac{GM}{R^2}$$

Here, $G = 6.67 \times 10^{-11}$ Nm^2/kg^2;
M = mass of earth = 6×10^{24} kg;
R = radius of earth = 6.4×10^6 m

$$g = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{(6.4 \times 10^6)^2} = 9.8 \text{ m/s}^2$$

Ex. 6 Calculate the value of acceleration due to gravity on a planet whose mass is 4 times as that of the earth and radius is 3 times as that of the earth.

Sol. If M is the mass of the earth and R is the radius of earth, the value of acceleration due to gravity on the earth (g_e) is given by

$$g_e = \frac{GM}{R^2} \quad ...(1)$$

Let us consider a planet such that mass of the planet is equal to 4 times the mass of earth.

$M_p = 4M$

Radius of the planet is equal to 3 times the radius of earth.

$R_e = 3R$

Then, acceleration due to gravity on this planet(g_p) is

$$g_p = \frac{G \times (4M)}{(3R)^2} = \frac{4}{9} \cdot \frac{GM}{R^2} \quad ...(2)$$

Dividing equation (2) by equation (1), we get

$$\frac{g_p}{g_e} = \frac{\frac{4}{9} \times \frac{GM}{R^2}}{\frac{GM}{R^2}} \text{ or } \frac{g_p}{g_e} = \frac{4}{9}$$

or $g_p = \frac{4}{9}(g_e)$

Since $g_e = 9.8$ m/s^2

$\therefore$ $g_p = \frac{4}{5} \times 9.8 = 4.35$ m/s^2

Thus, acceleration due to gravity on the given planet is 4.35 m/s^2.

Ex. 7 Given the mass of the moon = 7.35×10^{22} kg and the radius of the moon = 1740 km. Calculate the acceleration experienced by a particle on the surface of the moon due to the gravitational force of the moon. Find the ratio of this acceleration to that experienced by the same particle on the surface of the earth.

Sol. If M_m is the mass of the moon and R_m is its radius, then the acceleration experienced by a body on its surface is given by

$$a = \frac{GM_m}{R_m^2}$$

Here, $M_m = 7.3 \times 10^{22}$ kg;
$R_m = 1740$ km $= 1.74 \times 10^6$ m

$$\therefore \quad a = \frac{6.67\times10^{-11}\times7.3\times10^{22}}{(1.74\times10^6)^2} = 1.57 \text{ m/s}^2$$

While the acceleration due to gravity on the surface of the earth, is given by

$$g_e = \frac{GM_e}{R_e^2} = \frac{6.67\times10^{-11}\times6\times10^{24}}{(6.4\times10^6)^2} = 9.8 \text{ m/s}^2$$

Comparing acceleration due to gravity on moon to that on the earth is

$$\frac{a}{g} = \frac{1.57}{9.8} = 0.16$$

Ex. 8 At what height above the earth's surface the value of g will be half of that on the earth's surface ?

Sol. We know that the value of g at earth's surface is

$$g = \frac{GM}{R^2} \quad ...(1)$$

While the value of g at a height h above the earth's surface is given by

$$g' = \frac{GM}{(R+h)^2} \quad ...(2)$$

Dividing equation (2) by equation (1), we get

$$\frac{g'}{g} = \left(\frac{R}{R+h}\right)^2 \text{ or } g' = g\left(\frac{R}{R+h}\right)^2$$

Here, $g' = \frac{g}{2}$

$$\therefore \quad \frac{g}{2} = g\left(\frac{R}{R+h}\right)^2$$

or $\frac{R+h}{R} = \sqrt{2}$

or $R + h = \sqrt{2}R$

or $h = (\sqrt{2} - 1)R$

or $h = (1.41 - 1) \times 6400 = 0.41 \times 6400$
$= 2624$ km

Ex. 9 Given mass of the planet Mars is 6×10^{23} kg and radius is 4.3×10^6 m. Calculate the weight of a man whose weight on earth is 600 N. (Given g on earth = 10 m/s^2)

Sol. Weight of the man on earth, W = mg
or $600 = m \times 10$ or $m = 60$ kg
So the mass of the man is 60 kg which will remain the same everywhere.

Now acceleration due to gravity on Mars,

$$g_m = \frac{GM_m}{R_m^2}$$

Here, $M_m = 6 \times 10^{23}$ kg; $R_m = 4.3 \times 10^6$m

$$\therefore \quad g_m = \frac{6.67\times10^{-11}\times6\times10^{23}}{(4.3\times10^6)^2} = 2.17 \text{ m/s}^2$$

Now, weight of the man on Mars will be

$$W_m = m \times g_m = 60 \times 2.17 = 130.2 \text{ N}$$

EQUATIONS OF MOTION FOR FREELY FALLING OBJECT

Since the freely falling bodies fall with uniformly accelerated motion, the three equations of motion derived earlier for bodies under uniform acceleration can be applied to the motion of freely falling bodies. For freely falling bodies, the acceleration due to gravity is 'g', so we replace the acceleration 'a' of the equations by 'g' and since the vertical distance of the freely falling bodies is known as height 'h', we replace the distance 's' in our equations by the height 'h'. This gives us the following modified equations for the motion of freely falling bodies.

General equation of motion	**Equations of motion for freely falling bodies**
(i) $v = u + at$ changes to	$v = u + gt$
(ii) $s = ut + \frac{1}{2}at^2$ changes to	$h = ut + \frac{1}{2}gt^2$
(iii) $v^2 = u^2 + 2as$ changes to	$v^2 = u^2 + 2gh$

We shall use these modified equations to solve numerical problems. Before we do that, we should remember the following important points for the motion of freely falling bodies.

(i) When a body is dropped freely from a height, its initial velocity 'u' becomes zero
(ii) When a body is thrown vertically upwards, its final velocity 'v' becomes zero
(iii) The time taken by body to rise to the highest point is equal to the time it takes to fall from the same height.
(iv) The distance travelled by a freely falling body is directly proportional to the square of time of fall.

EXERCISE # 1

A. Very Short Answer Type Questions

Q.1 Give the formula to calculate the gravitational force of attraction.

Q.2 What is the value of gravitational constant ?

Q.3 What is the unit of gravitational constant ?

Q.4 Does the gravitational force between two bodies change, if some other material body is placed between them ?

Q.5 What is the approximate value of acceleration due to gravity on the surface of earth ?

Q.6 What is the unit of acceleration due to gravity?

Q.7 State the relation between g and G on earth.

Q.8 What is the effect of altitude on the value of g ?

Q.9 What is the weight of a body at a height equal to the radius of earth above the earth's surface ?

Q.10 Is the weight of body more at the equator or at poles ?

Q.11 Which force is responsible for the earth revolving round the sun ?

Q.12 A stone is released from some height, it moves towards the earth. Does the earth also move towards the stone ?

Q.13 A light and a heavy body, both are dropped simultaneously from the same height. Which will strike the ground earlier ?

Q.14 As we go inside the earth, what is the effect on the value of g ?

Q.15 What is the value of g at the centre of earth?

B. Short Answer Type Questions

Q.16 How does the gravitational force change between two objects when the distance between them is doubled ?

Q.17 Why two stones do not come closer, even if there is gravitational force of attraction between them ?

Q.18 Under what conditions our weight becomes zero? Give examples.

Q.19 An astronaut inside a spaceship orbiting round the earth feels weightlessness. Explain.

Q.20 The weight of a body is less inside the earth than on the surface. Why?

Q.21 For two bodies of different masses, acceleration due to gravity is same or different? Explain.

Q.22 Newton's law of gravitation states that there is a force of attraction between two bodies. Why do we not observe the motion of two stones lying on the floor moving towards each other ?

Q.23 Calculate the force of attraction between two bodies of masses 100 kg and 60 kg respectively separated by a distance of 5 m from each other.

Q.24 If the distance between two bodies is decreased by a factor of 4, by what factor the force of attraction will change ?

Q.25 Calculate force of attraction on a body of mass 50 kg lying on the surface of earth. Given that the mass of earth = 6×10^{24} kg radius of the earth = 6.4×10^{6} m and $G = 6.67 \times 10^{-11} Nm^2/kg^2$.

Q.26 What happens to the weight of a body when it is falling freely under gravity ?

Q.27 Although, the value of G is very small, but all the objects near the surface of earth fall towards the earth. Why ?

Q.28 Calculate the force of gravitation between two bodies each of mass 80 kg and placed 16 cm apart. (Take G = 6.67×10^{-11} Nm^2/kg^2)

Q.29 The mass of Mars is $\frac{1}{10}$ th and its radius is half of that of the earth. Calculate value of g on the surface of Mars.

Q.30 What is the weight of a body whose mass is 25 kg ?

C. Long Answer Type Questions

Q.31 Discuss the terms gravitation and gravity with suitable examples.

Q.32 State Newton's law of gravitation. State the unit and value of gravitational constant.

Q.33 Discuss the various factors on which the value of g depends.

Q.34 Compare the gravitational attraction on the earth due to the attraction of sun due to attraction of moon. Given mass of sun = 2×10^{30} kg, mass of moon = 7.35×10^{22} kg, distance of sun from earth = 1.5×10^{11} m, distance of moon from earth = 3.84×10^{8}m.

Q.35 A body weighs 160 N on the surface of the earth. Calculate his weight at a height of 3.6×10^{6} m from the surface of the earth. Radius of earth = 6.4×10^{6} m.

EXERCISE # 2

Single correct answer type questions

Q.1 When an apple falls from a tree:
(A) only earth attracts the apple
(B) only apple attracts the earth
(C) both the earth and the apple attract each other
(D) none attracts each other

Q.2 Force of attraction between two bodies does not depend upon :
(A) the shape of bodies
(B) the distance between their centres
(C) the magnitude of their masses
(D) the gravitational constant

Q.3 When the medium between two bodies changes, force of gravitation between them :
(A) will increase
(B) will decrease
(C) will change according to the environment
(D) remains same

Q.4 S.I. unit of G is :
(A) $Nm^2\ kg^{-2}$ (B) $Nm\ kg^{-2}$
(C) $N\ kg^2M^{-2}$ (D) $Nkg\ m^{-2}$

Q.5 The value of universal gravitational constant:
(A) changes with change of place
(B) does not change from place to place
(C) becomes more at night
(D) becomes more during the day

Q.6 The value of G in S.I. unit is :
(A) 6.67×10^{-9} (B) 6.67×10^{-10}
(C) 6.67×10^{-11} (D) $6.67\ x\ 10^{-12}$

Q.7 The gravitational force between two bodies varies with distance *r* as :
(A) 1/r (B) $1/r^2$
(C) r (D) r^2

Q.8. The value of G in year 1900 was $6.673 \times 10^{-11}\ Nm^2\ kg^{-2}$, The value of G in the year 2007 will be :
(A) $6.673 \times 10^{-9}\ Nm^2\ kg^{-2}$
(B) $6.673 \times 10^{-10}\ Nm^2\ kg^{-2}$
(C) $6.673 \times 10^{-2}\ Nm^2\ kg^{-2}$
(D) $6.673 \times 10^{-11}\ Nm^2\ kg^{-2}$

Q.9 Value of G on surface of earth is $6.673 \times 10^{-11}\ Nm^2\ kg^{-2}$, then value of G on surface of Jupiter is :
(A) $12 \times 6.673 \times 10^{-11}\ Nm^2\ kg^{-2}$
(B) $\frac{6.673}{12} \times 1\ 0^{-11}\ Nm^2\ kg^{-2}$
(C) $6.673 \times 10^{-11}\ Nm^2\ kg^{-2}$
(D) $\frac{6.673}{6} \times 10^{-11}\ Nm^2\ kg^{-2}$

Q.10 The earth attracts the moon with a gravitational force of 10^{20} N. Then the moon attracts the earth with a gravitational force of:
(A) 10^{-20} N (B) 10^2 N
(C) 10^{20} N (D) 10^{10} N

Q.11 The orbits of planets around the sun are:
(A) circular (B) parabolic
(C) elliptical (C) straight

Q.12 Law of gravitation is applicable for:
(A) heavy bodies only
(B) medium sized bodies only
(C) small sized bodies only
(D) bodies of any size

Q.13 The universal law of gravitation was proposed by :
(A) Copernicus (B) Newton
(C) Galileo (D) Archimedes

Q.14 Choose the correct statement :

(A) All bodies repel each other in the universe.

(B) Our earth does not behave like a magnet.

(C) Acceleration due to gravity is 8.9 ms^{-2}

(D) All bodies fall at the same rate in vacuum.

Q.15 The value of acceleration due to gravity (g) on earth's surface is :

(A) 6.67 x 10^{-11} Nm^2 kg^2

(B) 8.9 m/sec^2

(C) 9.8 m/sec^2

(D) none of these

Q.16 The acceleration due to gravity:

(A) has the same value everywhere in space

(B) has the same value everywhere on the earth

(C) varies with the latitude on the earth

(D) is greater on moon because it has smaller diameter

Q.17 When a space ship is at a distance of two earths radius from the centre of the earth, the gravitational acceleration is :

(A) 19.6 ms^{-2} (B) 9.8 m/s^{-2}

(C) 4.9 m/s^2 (D) 2.45 ms^{-2}

Q.18 If planet existed whose mass and radius were both half of the earth, the acceleration due to gravity at the surface would be :

(A) 19.6 m/sec^2 (B) 9.8 m/s^2

(C) 4.9 ms^{-2} (D) 2.45 m/s^2

Q.19 A stone is dropped from the top of a tower. Its velocity after it has fallen 20 m is [Take g = 10 ms^{-2}] :

(A) 5 ms^{-1} (B) 10 m s^{-1}

(C) 15 m s^{-1} (D) 20 m s^{-1}

Q.20 A ball is thrown vertically upwards. The acceleration due to gravity:

(A) is in the direction opposite to the direction of its motion

(B) is in the same direction as the direction of its motion

(C) increases as it comes down

(D) become zero at the highest point.

Q.21 The acceleration due to gravity on the moon's surface is:

(A) approximately equal to that near the earth's surface

(B) approximately six times that near the earth's surface

(C) approximately one-sixth of that near the earth's surface

(D) slightly greater than that near the earth's surface

Q.22 The force acting on a ball due to earth has a magnitude F_b and that acting on the earth due to the ball has a magnitude F_e Then :

(A) $F_b = F_e$ (B) $F_b > F_e$

(C) $F_b < F_e$ (D) $F_e = 0$

Q.23 Force of gravitation between two bodies of mass 1 kg each kept at a distance of 1 m is :

(A) 6.67 N (B) 6.67 × 10^{-9} N

(C) 6.67 × 10^{-11} N (D) 6.67 × 10^{-7} N

Q.24 The force of gravitation between two bodies does not depend on:

(A) their separation

(B) the product of their masses

(C) the sum of their masses

(D) the gravitational constant

Q.25 The ratio of the value of g on the surface of moon to that on the earth's surface is :

(A) 6 (B) $\sqrt{6}$

(C) $\frac{1}{6}$ (D) $\frac{1}{\sqrt{6}}$

Q.26 Order of magnitude of G in S.I. unit is :

(A) 10^{-11} (B) 10^{11}

(C) 10^{-7} (D) 10^{7}

Q.27 The S.I. unit of g is :

(A) m^2/s (B) m/s^2
(C) s/m^2 (D) m/s

Q.28 If the distance between two masses be doubled then the force between them will become :

(A) $\frac{1}{4}$ times (B) 4 times
(C) $\frac{1}{2}$ times (D) 2 times

Q.29 The type of force which exists between charged bodies is

(A) only gravitational
(B) neither gravitational nor electrical
(C) only electrical
(D) both electrical and gravitational

Q.30 The acceleration due to gravity is 9.8 m/s^2

(A) Much above the earth's surface
(B) Near the earth's surface
(C) Deep inside the earth
(D) At the centre of the earth

Q.31 A particle is taken to a height R above the earth's surface, where R is the radius of the earth. The acceleration due to gravity there is -

(A) 2.45 m/s^2 (B) 4.9 m/s^2
(C) 9.8 m/s^2 (D) 19.6 m/s^2

Q.32 When a body is thrown up, the force of gravity is :

(A) in upward direction
(B) in downward direction
(C) zero
(D) in horizontal direction

Q. 33 Mass of an object is :

(A) amount of matter present in the object
(B) same as weight of an object
(C) measure of gravitational pull
(D) none of these

Q.34 The weight of an object is :

(A) the quantity of matter it contains
(B) refers to its inertia
(C) same as its mass but is expressed in different units
(D) the force with which it is attracted towards the earth

Q.35 Weight of an object depends on :

(A) temperature of the place
(B) atmosphere of the place
(C) mass of an object
(D) none of these

Q.36 The mass of body is measured to be 12 kg on the earth. Its mass on moon will be :

(A) 12 kg (B) 6 kg
(C) 2 kg (D) 72 kg

Q.37 A heavy stone falls:

(A) faster than a light stone
(B) slower than a light stone
(C) with same acceleration as light stone
(D) none of these

Q.38 A stone is dropped from the roof of a building takes 4s to reach the ground. The height of the building is :

(A) 19.6m (B) 39.2 m
(C) 156.8 m (D) 78.4 m

Q.39 A ball is thrown up and attains a maximum height of 19.6 m. Its initial speed was:

(A) 9.8 ms^{-1} (B) 44.3 ms^{-1}
(C) 19.6 ms^{-1} (D) 98 ms^{-1}

Q.40 The value of *g* at pole is :

(A) greater than the value at the equator
(B) less than the value at the equator
(C) equal to the value at the equator
(D) none of these

Q.41 Two bodies A and B of mass 500 g and 200 g respectively are dropped near the earth's surface. Let the acceleration of A and B be a_A and a_B respectively, then:

(A) $a_A = a_B$ (B) $a_A > a_B$

(C) $a_A < a_B$ (D) $a_A \neq a_B$

Q.42 A body is thrown up with a velocity of 20 m/s. The maximum height attained by it is approximately:

(A) 80 m (B) 60 m

(C) 40 m (D) 20 m

Q.43 The weight of a body is 120 N on the earth. If it is taken to the moon, its weight will be about:

(A) 120 N (B) 60 N

(C) 20 N (D) 720 N

Q.44 Two iron and wooden balls identical in size are released from the same height in vacuum. The time taken by them to reach the ground are-

(A) not equal (B) exactly equal

(C) regularly equal (D) zero

ANSWER KEY

EXERCISE-1

1. $F = G\, m_1\, m_2 / r^2$ **2.** 6.67×10^{-11} Nm^2/kg^2 **3.** Nm^2/kg^2

4. No **5.** 9.8 m/s^2 **6.** m/s^2 **7.** $g = \frac{GM}{R^2}$

8. Decreases **9.** mg/4 **10.** poles

11. Gravitational force **13.** Both **14.** decreases **15.** zero

23. 1.6×10^{-8} N **24.** 16 times **25.** 490 N **28.** $1.\,6675 \times 10^{-5}$N

29. 3.92 m/s^2 **30.** 245 N **34.** 1800 : 1 **35.** 81.9 N

EXERCISE-2

Ques	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans	C	A	D	A	B	C	B	D	C	C	C	D	B	D	C
Ques	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans	C	D	A	D	A	C	A	C	C	C	A	B	A	D	B
Ques	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	
Ans	A	B	A	D	C	A	C	D	C	A	A	D	C	B	