The force with which earth attracts a body is called the force of gravity. A body of mass m is attracted by earth towards its centre. This force is also called the weight (W) of the body.

$$W = mg$$

**Fact File**

We have read about different types of forces such as muscular, frictional gravitational, electrostatic force, magnetic force, tension, weight, viscous force, etc. But forces are fundamentally classified into four groups (a) Gravitational force (b) weak force (c) Electromagnetic force (d) Nuclear force. Scientists believe that these four groups also belong to a single type of force which is unknown to us as of date.

(ii) ELECTROSTATIC FORCE : The force which results due to the repulsion of similar charges or attraction of opposite charges is called electrostatic force. If we rub a plastic object like a pen or a comb with hair and bring it close to tiny bits of paper, the bits of paper get attracted to the plastic object. This is due to electric force. Tiny particles of dust and smoke can also be attracted by electrostatic force. This method is used in air purifiers and in factories to purify air in chimneys, before letting it escape into the atmosphere.

(iii) MAGNETIC FORCE : This is the force exerted by magnets on each other and on some metals like iron and nickel. Since magnets attract iron, magnets are used to separate waste iron object form garbage dumps so that they can be recycled. Magnetic force and electrostatic force are inter-related and are together called electro-magnetic force.

COMPETITION WINDOW

MASS

The amount of matter contained in a body is called its mass

OR

The measure of the quantity of matter in a body is called its mass.

The mass of a body is a scalar quantity. It is independent of surroundings and the position of the body. It is a constant quantity for a given body.

Mass is measured in kilogram (kg) in S.I. System.

WEIGHT

Everybody on the surface of earth is attracted towards the centre of the earth. The force of attraction depends upon the mass of the body and the acceleration due to gravity. The weight of the body is the force with which it is attracted towards the centre of the earth. We know

$F = ma$

The acceleration produced by the force of attraction of the earth is known as acceleration due to gravity i.e., g

$\therefore \quad F = ma = mg$

But by definition this force is equal to the weight of the body i.e., F = W.

$\therefore \quad W = mg$

SI unit of weight is newton (N) and in CGS, it is measured in dyne (dyn).

**DIFFERENCES BETWEEN MASS AND WEIGHT**

| | MASS | WEIGHT |
|---|---|---|
| 1 | The mass of an object is the quantity of matter contained in it. | The weight of an object is the force with which it is attracted towards the centre of the earth |
| 2 | The SI unit of mass is kilogram (kg) | The SI unit of weight is newton (N). |
| 3 | The mass of an object is constant. | The weight of an object is not constant. It changes with the change in acceleration due to gravity (g). |
| 4 | The mass of an object can never be zero. | The weight of an object can be zero. For example, in the interplanetary space, where g = 0, the weight of an object becomes zero. |

UNBALANCED FORCES

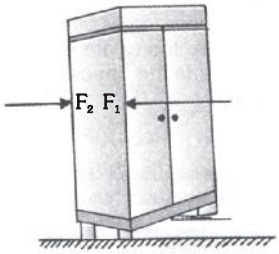
If number of forces acting on a body produce an acceleration in the body, then the forces acting are called unbalanced.

Suppose $F_1$ = 5 newton and $F_2$ = 3 Newton. In this case a resultant force is acting on the almirah towards the direction of $F_1$. We say that an unbalanced force of 2 Newton will act on the almirah towards the direction of $F_1$.

If forces acting on an object are balanced → An object at rest, remains at rest (a = 0)

→ An object in motion remains in motion with the same velocity (a = 0)

If forces acting on an object are unbalanced → Object is accelerating (Acceleration depends on) unbalanced force and mass of the object




Two opposing forces acting on the almirah

COMPETITION WINDOW

☺ 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

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 vector quantity)

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{time}} \Rightarrow \frac{v-u}{t} = \frac{\text{Final velocity} - \text{initial velocity}}{\text{time}}$$

Its SI. unit is $m/s^2$ & C.G.S. unit is $cm/s^2$

☺ Gravitational force : According to Newton

"Every body in the universe attract another body with a force which is directly proportional to product of their masses and inversely proportional to square of the distance between them."


$f_g \propto m_1 m_2$ .....(i) ; $f_g \propto \frac{1}{r^2}$ .....(ii)

From equation (i) and (ii)

$f_g \propto \frac{m_1 m_2}{r^2}$ $\quad f_g = \frac{G m_1 m_2}{r^2}$

Where G = universal gravitational constant G = $6.67 \times 10^{-11}$ $Nm^2/kg^2$ or $Nm^2\ kg^{-2}$

☺ ELECTROSTATIC FORCE : According to "Coloumb"

"The force acting between the charges is known as electric force." If $q_1$ and $q_2$ are the charges then the force acting between them would be,

$$F = \frac{K q_1 q_2}{r^2}$$

Where 'r' is the distance between $q_1$ and $q_2$, K is the Coulomb's constant

Force can be attractive or repulsive.

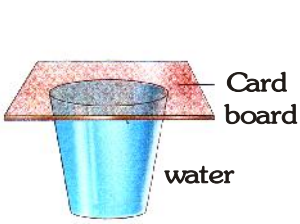
## ATMOSPHERIC PRESSURE

A layer of air called the atmosphere surrounds the earth. As you know, air is also matter and has weight. The weight of the atmosphere exerts a pressure on the surface of earth. This pressure is called atmospheric pressure. Its magnitude is around 100 kilo pascals (100 kPa) at sea level. However, as we go upward, the magnitude of atmospheric pressure decreases gradually. The following activity will show the magnitude of atmospheric pressure on the earth's surface.

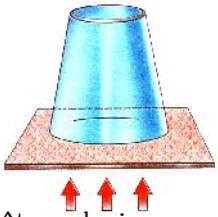
### ACTIVITY

#### THE MAGNITUDE OF ATMOSPHERIC PRESSURE

Take a glass tumbler and fill it with water to the brim. Cover it with a thick sheet of paper (or cardboard). Press your palm over the sheet and quickly invert the tumbler. Slowly remove your palm supporting the piece of paper. What do you observe? Surprised?




A glass with water covered with a sheet




Glass containing water in inverted position

You have seen that the paper did not fall (as one expected it to.) This is because the atmospheric pressure provides enough force to push the piece of paper upward.

#### BAROMETER

A barometer is a device used for measuring the atmospheric pressure.

Atmospheric pressure measurements are important to meteorologists for weather forecasts. The unit of pressure used for meteorological purpose is called the bar. A bar is a CGS unit of pressure and equals $10^5$ pascals or 1 bar = $10^5$ $Nm^{-2}$.

**Fact file**

- It has been found that when deep-sea fish are brought to the surface of the sea, their bodies burst. It is because the blood in their bodies flows at very high pressure. At the surface of the sea, the pressure outside decreases. This difference in pressure causes their bodies to burst open.
- If the air exert such a huge pressure, why do our bodies not get crushed? It is because our blood contains dissolved oxygen at a pressure that is slightly more than the atmo spheric pressure. This counterbalances the atmospheric pressure.

## LIQUID PRESSURE : A liquid exerts pressure on the wall of the container

Take some discarded plastic bottle and fix a glass tube near its bottom. It can be done by slightly heating one end of the glass tube and then inserting it near the bottom of the bottle. In case there is some leakage, your must seal it with molten wax. Now cover the free end of the glass tube with a thin rubber sheet. On filling the plastic bottle upto half with water, the rubber sheet fixed to the glass tube bulges. When more water is added in the plastic bottle, there is change in the bulge of the rubber sheet. Since the rubber sheet is fixed on the side of the container, it shows that water exerts pressure on the side of the container. In other words, liquids exert pressure on the walls of the container.

(c) Vacuum cleaner A vacuum cleaner is an electrical appliance that cleans by suction. A fan inside the vacuum cleaner lower the air pressure and creates a low pressure the device. As a result, the air and dirt particles on and near the surface are sucked into the device.

VACUUM CLEANER

- BUOYANCY : When a solid is dipped, partly or fully, in a fluid (liquid or gas) the fluid exerts an upwards force on the solid. This force is called the force of buoyancy or buoyant force.
- ARCHIMEDES' PRINCIPLE : When a solid is dipped partly or fully in fluid, the force of buoyancy is equal in magnitude to the weight of the displaced fluid.
- FLOATATION : A solid floats in a liquid if the force of buoyancy has the same magnitude as the weight of the floating body. Density of water = 1000 $kg/m^3$ = 1 $g/cm^3$.
- MATHEMATICAL EQUATIONS:

$F = ma$ F = resultant force

a = acceleration in the body

m = mass of the body

LOOKING BEYOND

Blaise Pascal : (1623-1662) was a French physicst and mathematician. When he was only three years old, his mother died, then his father devoted himself to the upbringing of the child.

He was the first to construct a calculating machine, he demonstrated atmospheric pressure, established theoretical principles for the hydraulic transmission of power and also contributed extensively to mathematics.

Following an intense religious experience in 1654, he gave up science, mathematics and technology and devoted himself to religious philosophy. He died before he was forty, having worked three careers into a short life.

An instrument called sphygmomanometer is used to measure the blood pressure of humans. The blood pressure of a person is the ratio of systolic (maximum) and diastolic (minimum) pressures. Normally it is 120/80 mm of Hg in a healthy adult. Pressures above 140/90 needs medical attention.

# EXERCISE-1 FORCE & PRESSURE

OBJECTIVE TYPE QUESTION

1. If a rock is brought from the surface of the moon :
   (A) Its mass will change (B) Its weight will change, but not mass.
   (C) Both mass and weight will change (D) Its mass and weight will remain the same.
2. When an object undergoes acceleration :
   (A) Its speed always increases (B) Its velocity always increases
   (C) It always falls towards the earth (D) A force always acts on it
3. External forces are :
   (A) Always balanced (B) Never balanced
   (C) May or may not be balanced (D) None of these
4. The net force acting on a body of mass 1 kg moving with a uniform velocity of 5 $ms^{-1}$ is :
   (A) 5 N (B) 0.2 N (C) 0 N (D) None of these
5. How many dynes are equal to 1 N?
   (A) $10^6$ (B) $10^4$ (C) $10^5$ (D) $10^3$
6. A force can :
   (A) Change the direction of a moving body (B) Change the state of rest or uniform motion of a body.
   (C) Change the shape of a body (D) All of the above
7. The S.I. unit of pressure is –
   (A) Newton (B) Dyne/$cm^2$ (C) Pascal (D) Joule
8. Which among the following will exert maximum pressure when pushed with the same amount of force?
   (A) An eraser of area 2 $cm^2$ (B) A sharpened pencil tip
   (C) The blunt end of a pencil (D) The rear portion of a closed safety pin
9. Pressure is also measured in :
   (A) Joule (B) mm of Hg (C) mm of Ag (D) Metre
10. Force per unit area is called :
    (A) Energy (B) Work (C) Pressure (D) Thrust
11. Atmospheric pressure is measured by :
    (A) Barometer (B) Manometer (C) Screw gauge (D) None of these
12. A manometer is used to measure :
    (A) Height (B) Pressure (C) Liquid density (D) Atmospheric pressure
13. How does pressure vary as we come from mountain top to sea level?
    (A) Increases (B) Decreases (C) Remains same (D) Depends on weather
14. As we go deeper beneath the surface of liquid, the pressure :
    (A) Remains same (B) Increase (C) Decreases (D) Depends on weather
15. A vacuum cleaner works on the principle of :
    (A) Electromagnetic Induction (B) Suction
    (C) Mutal Induction (D) Energy conservation
16. The S.I. unit of force is :
    (A) metre (B) Newton (C) Pascal (D) Second
17. A contact force cannot act through
    (A) Empty space (B) Touching
    (C) Touching with a metal rod (D) Touching with a wooden rod

# EXERCISE-2

## FILL IN THE BLANKS

31. The ..... or push acting on a body is commonly called force
32. The force of gravity is a ..... force.
33. Hydraulic press is based on .....
34. To draw water from a well we have to ..... at the rope.
35. A charged body ..... an uncharged body towards it.
36. To move a loaded trolley we have to ..... it.
37. The north pole of a magnet ..... the north pole of another magnet.
38. To stretch the how, the archer applies a force that causes a change in its .....
39. The force applied by the archer to starch the bow is an example of ..... force.
40. A manometer is used to measure .....
41. Pascal (Pa) is the unit of .....
42. ..... and ..... are together called fluids.
43. An instrument used to measure ..... is called a pressure gauge.
44. Pressure is also measured in .....
45. Hydraulic devices are based on .....

## COMPLETE THE FOLLOWING TABLE

| | Pressure | Force | Area |
|---|---|---|---|
| 46. | _____ | 50 N | 5 $cm^2$ |
| 47. | 15N/$cm^2$ | _____ | 5 $cm^2$ |
| 48. | 5N/$m^2$ | 500 N | _____ |
| 49. | _____ | 750 N | 25 $cm^2$ |
| 50. | 80 N/$m^2$ | 800 N | _____ |
| 51. | 45 N/$m^2$ | _____ | 10 $m^2$ |
| 52. | _____ | 200 N | 10 $cm^2$ |
| 53. | 5N/$m^2$ | _____ | 20 $m^2$ |
| 54. | 20 N/$m^2$ | 400 N | _____ |
| 55. | 40 N/$m^2$ | 800 N | _____ |

## MATCH THE COLUMN

56.

| Column-A | Column-B |
|---|---|
| (A) Opening a draw | (i) Push |
| (B) Electrostatic force | (ii) Contact force |
| (C) Moving a book placed on a table | (iii) Pull |
| (D) Muscular force | (iv) Push or pull |
| (E) Force | (v) Non-contact force |
| (F) Magnetic force | (vi) Non-contact force |
| (G) A physical quantity that determines the pressure in liquids. | (vii) Depth |
| (H) SI unit of force | (viii) Friction |
| (I) Spring balance | (ix) Muscular force. |
| (J) Force opposing the motion | (x) Weight |
| (K) Force exerted by muscles | (xi) Newton |
| (L) Thrust (SI unit) | (xii) kg wt |
| (M) Hydrostatic pressure | (xiii) N |
| (N) Weight | (xiv) $Nm^{-2}$ |

# EXERCISE-3

## SUBJECTIVE TYPE QUESTIONS

### Answer the following in one word or very briefly

72. Is weight a force? Write the SI unit of force.
73. What are different types of forces?
74. Define 1 kgf.
75. Name two units of force.
76. If force a scalar or a vector?
77. What are electrostatic forces?
78. What is the main use of a spring balance?
79. Write the SI unit of pressure.
80. What do you mean by thrust?
81. What is a manometer?
82. What is atmospheric pressure at sea level?
83. Name the natural force that show down a moving body.
84. Give two advantage of friction.
85. Give two disadvantages of friction.
86. Distinguish between mass and weight.
87. Define weight of a body. Name the unit used to measure it.
88. State and explain Pascal's law. Does it apply to gases also?
89. What are the factors on which the pressure of a liquid depends?
90. Why are railway tracks liquid on wooden or iron sleepers?
91. Why do we feel pain when we walk on a ground having small pebbles?
92. Explain how it is possible to drink a liquid by using a straw?
93. Why are dams made broader at the bottom than at the top?

### Answer the following in appropriate detail

94. Explain in suitable detail, the effect of force on a body.
95. Explain the basic principle of gravitational force. How will you measure it? Write its SI unit.
96. Define force. Briefly explain different units of force.
97. (i) What do you mean by atmospheric pressure?
    (ii) Why does a fountain pen start leaking at higher altitudes?
98. Briefly explain the principle, construction and working of a manometer.
99. (i) State Pascal's law
    (ii) Give two examples of pressure in everyday life.
100. Why is one end of a drawing pin kept wide, but the other end very sharp?
101. What is force? Explain the four effects a force can produce, giving relevant examples.
102. Explain contact and non-contact forces by giving suitable examples.
103. Distinguish between thrust and pressure. Write their units. What is the relation between them?
104. Briefly explain the principle, construction and working of a manometer.
105. Why is one end of a drawing pin kept wide, but the other end very sharp?

9. A force of 500 N acts on a square piece of plywood, each of whose sides is 5 m long. Calculate the pressure acting on the piece of plywood.

Ans. [20 N]

10. A body stands on the ground. The area below his feet is 70 $cm^2$. The pressure he exerts on the ground is 7 $N/cm^2$. Calculate the total force acting on the ground.

Ans. [490 $N/cm^2$]

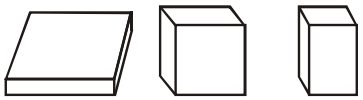
11. A force exerts a pressure of 45 $N/m^2$ when it acts on an area of 10 $m^2$. Calculate the total force.

Ans. [450 $N/m^2$]

12. A force of 400 N exerts pressure of 20 $N/cm^2$. What is the area on which the force acts?

Ans. [20 N]

13. The pic ture shows a heavy box placed on the floor in three different ways. In which case would the pressure on the floor be the least? When would it be the most? Why?

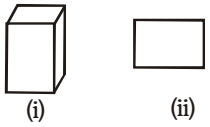



Ans. [Fig (iii) least pressure because is ara is minimum]

14. You want to lift a heavy box. The force of gravity pulls it down wards with a force of 500 N. Your father applies an upward force of 220 N form below. how much force will you have to apply to lift it upwards?

Ans. [Less than 220 N]

15. The surface area of the end of a brick 50 $cm^2$. The surface area of the base brick is 200 $cm^2$. Each brick weighs 50 N. What pressure is exerted on the ground by the brick in the two cases shown here?




Ans. [(i) for standing brick 1$N/cm^2$

[(ii) For the brick lying on its box = 0.25 N/cm