Chapter

1

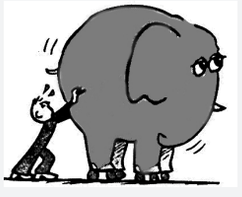
Force and Pressure

Learning Objectives

- Force – A Push or a Pull
- Force are due to an Interaction
- Exploring Forces
- Effects of Force
- Contact Forces
- Non-contact Forces
- Pressure
- Pressure Exerted by Fluids
- Atmospheric Pressure

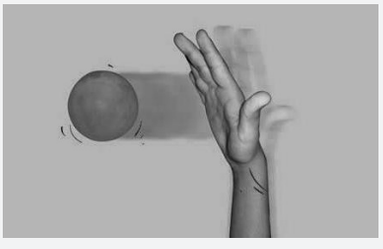
Exam Mirror

- Balanced and Unbalanced Forces
- Thrust



Critical Concepts

- Newton's Laws of Motion
- Variation of Pressure with Depth



FORCE – A PUSH OR A PULL

Think of anything around you, that one can see and even feel. Everything is in motion (almost). Birds flying in the air, vehicles on roads, blood inside our body, beating of heart etc, are some everyday examples of motion. Even the things we believe are at rest, are in motion when looked differently like earth spinning around its axis and revolving around sun. But have we ever wondered what is the cause of all these motions? The cause of motion is force-a pushing or pulling action that can either make a body move or stop a moving body. Throw a ball and it flies in the air, before falling back on ground. The 'throw' is what we call the pushing force with our hand and gravitational 'pull' of earth makes it hit the ground.

Force is an external agent which changes or tries to change the state of an object. It is a vector quantity and its S.I. **unit** is newton (N). Its **C.G.S unit** is dyne (1dyne = 10^{-5} newton).

Note that when we say "force", we imply the total force, or net force, acting on an object. Generally, more than one force act on an object. For example, when a ball is sailing through the air, the force of gravity and air resistance both act on it. The net force on the ball is the combination of force.

It is the net force that changes an object's state. If the net force on a body is zero, it will remain in its original state. The foregoing figure will help in understanding what net force is.

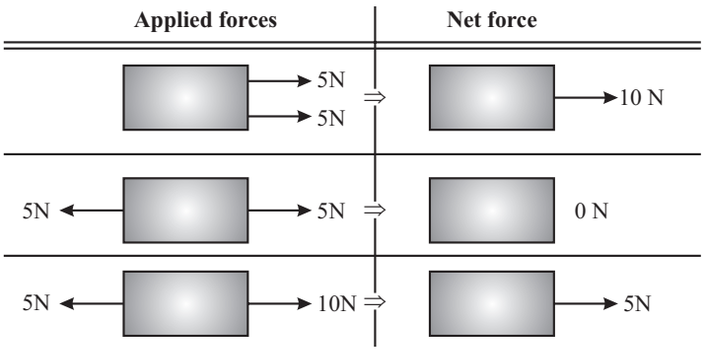


Fig. 1.1 : Net force

When the net of all the forces acting on a body is zero forces are called **balanced forces** and if net force is non-zero, forces acting on a body are called **unbalanced forces**.

Illustration 1 :

It is possible for a body to remain at rest when external forces are acting on it?

Solution :

Yes, if the resultant of all the forces on the body is zero, then body will remain at rest.

FORCES ARE DUE TO AN INTERACTION

Consider a book lying at rest on a table. It is in equilibrium. What forces act on the book? One is the force due to gravity – the weight of the book. Since the book is in equilibrium, there must be another force acting on it to produce a net force of zero an upward force opposite to the force of gravity. The table exerts this upward force, called the support force. This upward support force, often called the normal force, must be equal to the weight of the book.

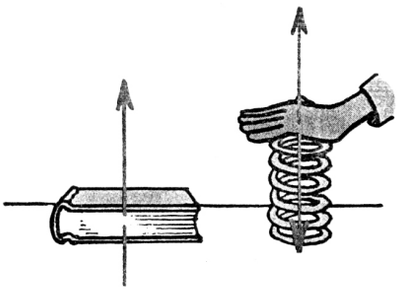


Fig. 1.2 : The table pushes up on the book with as much force as the downward force of gravity on the book. The spring pushes up on your hand with as much force as you exert to push down on the spring.

To better understand that the table pushes upon the book, compare the case of compressing a spring (figure) If you push the spring down, you can feel the spring pushing upon your hand. similarly, the book lying on the table compresses atoms in the table which behave like microscopic springs. The weight of the book (hand) tries to squeezes the atom of table (spring) and in return, the atom of the table pushes the book upward with same force cancelling the downward force and hence the book remains at rest.

EXPLORING FORCES

The exploration of forces reveals that they can either addup when applied in the same direction, subtract when applied in opposite directions, or remain balanced when equal in magnitude.

The magnitude and direction of a force determine its strength. If the magnitude and direction of applied force changes, its effect also changes.

Let's Do Activity

Aim : *To observe the effect of teamwork and direction of force on moving a heavy object.*

Requirement : *Heavy object (e.g., table, box), participants (atleast two people).*

Procedure : ☞ *Choose a heavy object that requires considerable force to move, such as a table or a box.*

☞ *Attempt to push the object by yourself and observe if you can move it. Ask one of your friends to help you in pushing the object in the same direction.*

☞ *Push the same object again, but this time ask your friend to push it from the opposite side. Observe if object moves and note the direction in which it moves.*

Fig. 1.3 (a)

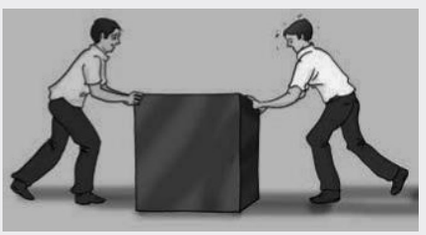


Fig. 1.3 (b)

Observation : ☞ *With the help of a friend pushing the object in the same direction, it becomes easier to move the object.*

☞ *If the object is pushed by one person from one side and by another person from the opposite side, the object may move in the direction of the stronger force.*

Conclusion : *We studied that force can change the direction of an object's movement.*

EFFECTS OF FORCE

A Force can Change the State of Motion

The application of force can change an object's state of motion by alterning its speed or direction. Examples from sports like football, volley ball, and cricket illustrate how forces impact the movement of objects, leading to changes in speed and direction.

Let's Do Activity

Aim : *To investigate the effect of force on the motion of a rubber ball placed on a level surface.*
Requirement : *Rubber ball, level surface (e.g., table top), palm.*
Procedure : ☞ *Place the rubber ball on the level surface as a table top.*
☞ *Gently push the ball along the level surface and observe if it begins to move. Place your palm in front of the moving ball and remove it as soon as the ball touches it. Observe if your palm applies a force on the ball and record any changes in the ball's speed.*
☞ *Determine if the speed increases or decreases.*

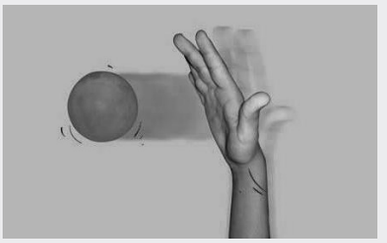


Fig. 1.4

Observation : ☞ *The ball begins to move when a force is applied to it.*
☞ *If your palm holds the moving ball, it may stop or slow down.*
Conclusion : *The activity demonstrates that applying force to a rubber ball placed on a level surface initiates its motion.*
Additional forces, such as those exerted by the palm, can affect the ball's speed and direction of motion.

Force can Change the Shape of an Object

The applied force on an object can lead to various effects. For instance, when pressure is exerted on an inflated balloon between your palms, its shape changes.
Pressing a rubber ball on a table causes a change in its shape.
These examples highlight that force can indeed modify the shape of an object.

CONTACT FORCE

Contact Forces are those forces where external agent applying the force is in contact of object on which the force is being applied. Some examples of contact forces are as follow:-

1. Frictional Force: When one body rub against another body, an opposing force is produced between them which is called frictional force. Frictional force acting opposite to the direction of motion. Walking, writing, etc. are possible due to friction.
2. Muscular Force: The push and pull action is possible only because of our muscular strength. Pushing a box, pulling a bed are some examples of muscular force, the application of which requires muscles of our body parts.

NON-CONTACT FORCE

Non-contact forces are those, where the agent applying the force is not in contact with object.

Electrostatic Force

It is the force due to which a point charge attracts or repels another point charge.

Let's Do Activity

Aim : *To observe the presence of electrostatic force between two pieces of straw.*
Requirement : *Plastic straw, table, thread, sheet of paper.*
Procedure : ☞ *Cut a plastic straw into two nearly equal pieces. Suspend one piece from the edge of a table using a piece of thread.*
☞ *Hold the other piece of straw in your hand & rub its free end with sheet of paper.*
☞ *Bring the rubbed end of second straw near the suspend straw without allowing them to touch.*

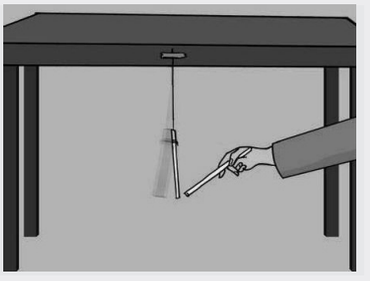


Fig. 1.5

Observation : *When the rubbed end of the straw is brought near the suspended straw, they repel each other.*
Conclusion : *The observed repulsion between the two straws demonstrate the presence of electrostatic force.*

Magnetic Force

We all are aware that magnet attracts iron object. This the example of magnetic force. Also, we know that opposite pole of magnet attract each other and like pole repel.

Let's Do Activity

Aim : *To observe the interaction between two bar magnets, specifically attraction and repulsion.*
Requirement : *Pair of bar magnets, three round-shaped pencils or wooden rollers.*
Procedure : ☞ *Place the longer side of one magnet over three round-shaped pencils or wooden rollers. Bring one end of the other magnet near the end of the magnet placed on the rollers without allowing them to touch. Observe the interaction between the magnets.*
☞ *Next, bring the other end of the second magnet near the same end of magnet placed as the rollers. Note. the behavior of the magnet placed on the rollers each time another magnet is brought near it.*

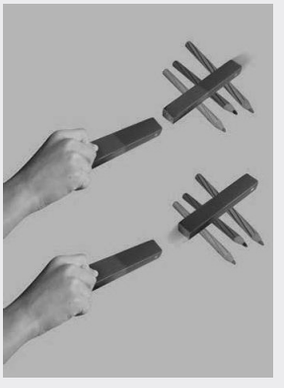


Fig. 1.6

Observation : *The magnets may attract or repel each other based on their polarity.*
Conclusion : *This activity helps in understanding the behavior of magnetic fields and the concept of magnetic poles.*

Gravitational force

The force exerted by the earth on a body is called gravitational force. This force is also called an attractive force. e.g. when a body is dropped from a height it moves in downward direction towards the earth with increasing speed.

DID YOU KNOW?

*When the force of gravity is the only force – that is, when air resistance is negligible – we say that the object is in a state of **free fall**.*

Illustration 2 :

Which force is used by an archer to pull a bow?

Solution :

Muscular force is used by an archer to pull a bow.

CONNECTING TOPIC

Newton's Laws of Motion

Newton's First Law of Motion

The first law of motion is generally called the **Law of inertia**. It is a restatement of Galileo's idea. It is stated as : *Every object continues in a state of rest or in a state of uniform motion in a straight line, unless it is compelled to change that state by external unbalanced forces exerted upon it.*

Newton's Second Law of Motion

Newton formulated his second law, one of the most central rules of nature, which relates force to mass in producing acceleration, in the following way.

The acceleration produced by a net force on an object is directly proportional to it and is in the same direction as the net force but is inversely proportional to the mass of the object.

In shorter notation,

$$\text{Acceleration} = \frac{\text{net force}}{\text{mass}}$$

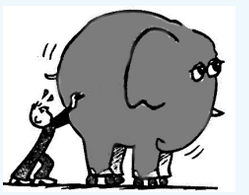


Fig. 1.7 : Acceleration depends both on the amount of push and on the mass being pushed

Newton's Third Law of Motion

According to this law, whenever an object exerts a force on another object, the latter object exerts an equal and opposite force on the first. We can call one force the action force, and the other the reaction force. In action-reaction form, the third law is stated as

To every action there is always an equal and opposite reaction.

Let's Connect

1. A man is at rest in the middle of a pond of perfectly smooth ice. He can get himself to the shore by making use of Newton's
(a) First law (b) Second law (c) Third law (d) All the laws

2. A 10 N force is applied on a body produces an acceleration of 1 m/s^2. The mass of the body is
(a) 5 kg (b) 10 kg (c) 15 kg (d) 20 kg

Solutions:

1. (c)

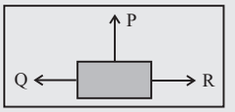
2. (b) By Newton's IInd law of motion,
$F = ma$
$\Rightarrow$ $10 = m\,(1)$ $\Rightarrow$ $m = 10$ kg.

CHECK POINT-1

1. Which of the following is an example of a non-contact force?

(a) Muscular force (b) Frictional force (c) Magnetic force (d) None of these

2. Three persons P, Q and R pull block with equal forces as shown in figure. Identify the direction of motion of the block?



(a) In horizontal direction towards left. (b) In horizontal direction towards right.
(c) In vertically upward direction. (d) The block remains stationary.

Solutions :

1. **(c)** Magnetic force is a non-contact force.

2. **(c)** It will move in vertically upward direction.

PRESSURE

Pressure is defined as the force or thrust exerted over a unit area.

$$Pressure = \frac{force / thrust}{area}$$

DID YOU KNOW?

Force is a vector quantity but pressure is a scalar.

Thrust

The net force acting normal to a surface is called thrust. Thus, a body kept in any orientation exert equal thrust on the surface. It is the net force, so, its S.I. unit is newton (N). It is also expressed in kilogramme weight (kg wt)

1 kg wt = 9.8 N

The *pressure* of the book depends on the area over which the force is distributed. Pressure may be measured in any unit of force divided by any unit of area. The standard international **(SI) unit** of pressure is newton per square metre called the *pascal* (Pa).

Huge pressure is measured in kilopascal (1 kPa = 1000 Pa).

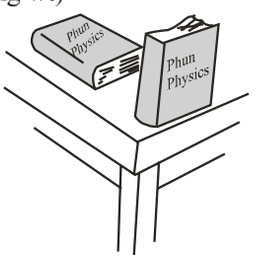
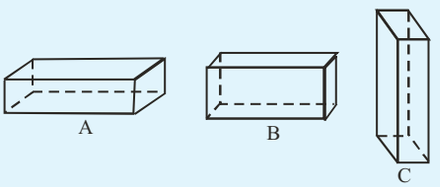


Fig. 1.8 : Although the weight of both books is the same, the up right book exerts greater pressure against the table.

Illustration 3 :

In which of the following positions A, B and C of a cuboid will it exert maximum pressure?



Solution :

P = F/A. Lesser the area, greater will be the pressure. Hence, at position C will have maximum pressure.

CASE STUDY-1 : Understand Balanced & Unbalanced Force and Pressure

If the resultant of all forces acting on a body is zero,i.e., $\Sigma F = 0$, the forces are called balanced forces. And if $\Sigma F \neq 0$ the forces are called unbalanced forces. Unbalanced forces produce motion in a stationary body or stop a moving body. Balanced forces can change the shape of a body not state of rest or of motion.

There is the relation between force (F), area (A) and pressure (P)

$$P = \frac{F}{A}$$

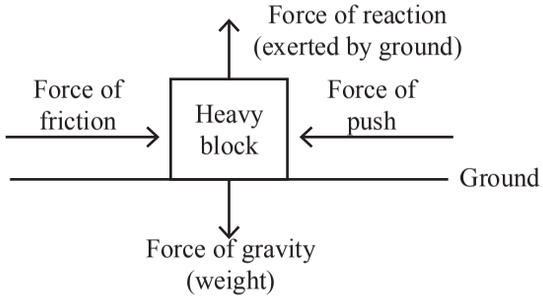


Fig. 1.9

CASE - I: Maintaining the state of rest or of uniform motion of a body. It is when the body is under the action of balanced forces.

CASE - II: Unbalanced force can change speed or direction of motion of a body.

CASE - III: To move a body always require an unbalanced force.
i.e., $\Sigma F \neq 0$

CASE - IV: If a number of forces $F_1, F_2, F_3, \ldots\ldots$ act on the body then it is in balanced or equilibrium state, when $F_1 + F_2 + F_3 + \ldots\ldots = 0$

CASE - V: Pressure, $P = \frac{F}{A}$ and for balanced force, $F = 0$. So pressure in this case is 0 or no-zero or infinity.

Think Out of the Box

Q 1. Why the shape of a balloon changes, when it is pressed between hands?

[**Hint :** Balanced forces]

Q 2. If one of the teams suddenly releases the rope in a tug of war, the other team falls backwards. Why?

[**Hint :** Unbalanced Forces]

Q 3. If we release the book from our hand, it falls to the ground. Which force acts on it?

[**Hint :** Unbalanced force]

Q 4. Bags and suitcases are provided with broad handles. Why?

[**Hint :** Pressure P = F/A]

PRESSURE EXERTED BY FLUIDS

Before, we discuss about pressure, it is important to understand what a fluid is. In simple words, fluid is a substance that can flow. So, both liquid and gas are called fluids. Fluids takes the shape of boundaries of any container in which they are put. Some might argue that why liquid and gas are put under same category, when they are two different state of matter. This is so, because of structural similarity between liquid and gas. In both liquid and gas, the atoms are losely held together which allows them to float easily. Whereas, in solids atoms are tightly packed giving it a rigid structure.

DID YOU KNOW?

Pressure plays the same role in fluids as force plays in case of solids.

Pressure in a Liquid

When we swim in a river, we feel the water pressure acting against our eardrums. The deeper we swim, the greater the pressure. The cause of this pressure is the weight of the fluid, water plus air directly above us. As we swim deeper, there is more water above us. Therefore, there is more pressure. If we swim twice as deep, there is twice the weight of water above us, so the water's contribution to the pressure felt by us is doubled. The pressure due to a liquid also depends upon its density.

Illustration 4 :

Hary says water exerts pressure on the bottom of the bucket, but Robert says water exerts pressure on the wall of the bucket. Who is correct?

Solution :

Both Hary and Robert is correct.

Let's Do Activity

Aim : *To observe the pressure exerted by water in container depends on height of the column of container.*
Requirement : *Transparent glass tube (length : about 15 cm, diameter : 5-7.5 cm), water, thin sheet of high-quality rubber.*
Procedure : ☞ *Take a transparent glass tube. Stretch a thin sheet of good quality rubber tightly over one end of pipe.*
☞ *Hold the pipe vertically by its middle. Ask a friend to pour some water into the pipe. observe if the rubber sheet bulges out & note the height of the water column in the pipe.*
☞ *Pour more water into the pipe & observe any changes in the bulge of the rubber sheet & the height of the water column. Repeat tht process several times.*

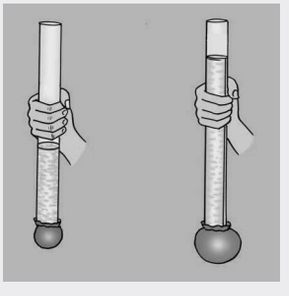


Fig. 1.10

Observation : *The amount of bulge in the rubber sheet appears to increase proportionally with the height of the water column in the pipe.*
Conclusion : *We studied that pressure exerted by the water depends on the height of column of container.*

CONNECTING TOPIC

Mathematical Expression for Fluid Pressure

Let us consider a liquid of density ρ in a beaker of base area 'A'. If 'h' be the height of the liquid column then

Volume of liquid in beaker, $V = A \times h$

Force (or thrust) acting at the bottom of the beaker is given by

F = Weight of liquid = mg

$= V\rho\, g$ ($\because$ $m = V\rho$ and $V = A \times h$)

$= (A \times h)\, \rho\, g = \rho\, g\, h\, A$

$\therefore$ Pressure at the bottom of the beaker $P = \frac{F}{A} = \frac{\rho ghA}{A} = \rho gh$,

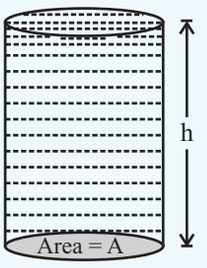


Fig. 1.11

Thus, we observe that pressure at a depth 'h' due to a liquid column is directly proportional to

(i) the density 'ρ' of the liquid.

(ii) the height 'h' of the liquid column and

(iii) the accelaration due to gravity 'g'

Let's Connect

1. Pressure at a point inside a liquid does not depend on

(a) the depth of the point below the surface of the liquid

(b) the nature of the liquid

(c) the acceleration due to gravity at that point

(d) the shape of the containing vessel

2. Two copper vessels A and B have the same base area but of different shapes. A take twice the volume of water as that B requires to fill upto a particular common height. Then the correct statement among the following is:

(a) Vessel B weighs twice that of A.

(b) Pressure on the base area of vessels A and B is same.

(c) Pressure on the base area of A and B is not same.

(d) Both vessels A and B weigh the same.

Solutions:

1. **(d)**

2. **(b)** Pressure, P = hρg.

Since water is filled upto same height so pressure at the bottom will be same.

Pressure in a Gas

The molecules in a gas are relatively farther placed with respect to a liquid. Therefore, their motions are less restricted. A gas expands, fills all space available to it, and exerts a pressure against its container.
When the volume of gas is decreased, the density, and therefore pressure, are increased.

ATMOSPHERIC PRESSURE

We live at the bottom of an ocean of air. The atmosphere, much like the water in a lake, exerts a pressure.

Just as water pressure is caused by the weight of water, **atmospheric pressure** is caused by the weight of air. We have adapted so completely to the invisible air that we sometimes forget it has weight. Perhaps a fish "forgets" about the weight of water in the same way. The reason we don't feel this weight crushing against our bodies is that the pressure (*blood pressure*) inside our bodies equals that of the surrounding air. There is no net force for us to sense.

The pressure of the atmosphere is not uniform. Atmospheric pressure is measured by **barometer**. Measurement of changing air pressure is important to meteorologists in predicting weather.

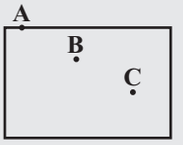
Fig. 1.12

CHECK POINT-2

1. If the force on the surface is doubled and area is reduced to half, pressure will

(a) become 2 times (b) become 3 times (c) become 4 times (d) remain unchanged

2. Fig. shows a container filled with water. Which of the following statements is correct about pressure of water?



(a) Pressure at A> Pressure at B> Pressure at C (b) Pressure at A=Pressure at B=Pressure at C
(c) Pressure at A< Pressure at B>Pressure at C (d) Pressure at A< Pressure at B<Pressure at C

Solutions :

1. (c) 2. (d)

Walk Through the Chapter

Force
Push or pull on the object (N)

Effects of Forces
- Force can change state of motion
- Force can change shape of the body

Contact Force
Force that acts at the point of contact between two objects.

Frictional Force
Force resisting the relative motion of solid surfaces, fluid layers and material elements sliding against each other.

Muscular Force
Force applied using the parts of the body like arms or legs.

Non-contact Force
Force applied to an object by another body that is not in direct contact with it.

Electrostatic Force
Attraction or repulsion of different particles based on charges.

Gravitational Force
Force between any two bodies. This force is also called an attractive force

Magnetic Force
Force experienced by a magnetic material iron/cobalt /nickel due to a magnet.

Pressure
Force per unit area

$$P = \frac{F}{A}$$

(N/m^2)

Thrust : The net force acting normal to a surface is called thrust.

Atmospheric pressure : The pressure caused by the weight of air is called atmospheric pressure. It is generally measured in mm of Hg or cm of Hg by a barometer.

$P_o = F/A = 101.3\ kN/m^2$

Variation of pressure with depth
The pressure exerted by a liquid column of height h is given by $P = h\rho g$ where, ρ = density of the liquid

Let's Revise Through FIB & T/F

1. A car at rest can be moved or a moving car can be stopped by applying.....
2. Force can change ..... of motion of the body.
3. Force cannot change shape of the body. (T/F)
4. Frictional force is a ..... force.
5. Gravitational force and electrostatic force are non-contact forces. (T/F)
6. Muscular force is a non contact force. (T/F)
7. Pressure is force per unit .....
8. The pressure exerted by mixture of atmospheric gases on its surroundings and on the surface of the earth is known as .....
9. As height of the liquid column increases, the pressure exerted by a liquid at a point .....
10. As the vertical height from mean sea level increases, the atmospheric pressure decreases. (T/F)
11. Atmospheric pressure is 1.013×10^5 N/m^2. (T/F)
12. Atmospheric pressure can be measured using barometer. (T/F)

EXERCISE-1 Master Board

Multiple Choice Questions

DIRECTIONS : *This section contains multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) out of which only one is correct.*

1. When a body is stationary, then
   (a) there is no force acting on it
   (b) the body is in vacuum
   (c) the force acting on it is not in contact with it
   (d) the net forces acting on it balances each other
2. Pressure varies with force (F) as (provided area is same)
   (a) F (b) $\frac{1}{F}$ (c) F^2 (d) $\frac{1}{F^2}$
3. Which of the following statements shows the application of low pressure in every day life?
   (a) Wide tyres of a heavy vehichle.
   (b) Cutting of an apple with sharp knife.
   (c) Hammering of a nail into wood.
   (d) Studs on the soles of soccer boots.
4. A sharp knife enable us to cut through things more easily because
   (a) The pressure exerted is lesser when the same force is used
   (b) The pressure exerted is greater when the same force is used
   (c) The sharp edge can pass through the material slowly
   (d) The sharp edge is not felt when cutting through the material.
5. Which of the following class of forces is different from others –
   (a) Pulling of a cart
   (b) Stretching of a coiled spring
   (c) Kicking of a football
   (d) Electrical force
6. A boy is pulling the cart on the road, in the process he is using his muscular force. Then muscular force is a
   (a) Contact force (b) Non-contact force
   (c) Both of these (d) None of these
7. Which of the following requires a pushing force?
   (a) Throwing a stone at a bird
   (b) Grabbing hold of a pencil
   (c) Leaves falling from a tree
   (d) A load lifted by a pulley
8. How is the strength of a force usually expressed?
   (a) By its magnitude (b) By its pressure
   (c) By its motion (d) By its direction
9. Ashwin pulls a load up an inclined plane. What forces must Ashwin need to overcome to pull it up?
   A. Non-contact force
   B. Gravitational force
   C. Frictional force
   (a) A and B only (b) B and C only
   (c) C and A only (d) A, B and C
10. Which effect of force is caused by the magnetic force between a magnet and a magnetic substance?
    (a) Change of position
    (b) Change of shape
    (c) Change of physical state
    (d) Change of chemical nature
11. Which force is involved in the following statements?
    • Hammering a nail into the wall
    • Cutting vegetables and fruits
    • Bullocks ploughing the field
    (a) Gravitational force (b) Muscular force
    (c) Electric force (d) Magnetic force

12. A bowler slides a bowling ball on the lane to hit the pins. Which effect of force is caused on the bowling ball by the exertion of force?
    (a) Stop a moving object
    (b) Change the direction of a moving object
    (c) Change the speed of a moving object
    (d) Change the position of a stationary object
13. Which of the following is NOT a force?
    (a) Bending (b) Heating
    (c) Pressing (d) Twisting
14. A weight lifter lifts the weight with the help of his hand, and has to apply large force to do this. The force, which the weight lifter has to apply to lift the weight is called _____.
    (a) Cellular force (b) Nuclear force
    (c) Muscular force (d) Magnetic force
15. Which of the following statements are true?
    I. When a batsman hits a cricket ball with his bat, the force applied by the batsman in muscular force.
    II. In an electric bell, the hammer strikes the going due to electrostatic force.
    III. During dry whether, hair tend to attract the comb while combing, this is due to magnetic force of attraction.
    IV. Walking on ice is difficult because of lack of frictional force.
    (a) I and II only (b) I and IV only
    (c) II, III and IV only (d) I, II and IV only

Assertion & Reason Questions

DIRECTIONS : *The questions in this segment consists of two statements, one labelled as "Assertion A" and the other labelled as "Reason R". You are to examine these two statements carefully and decide if the Assertion A and Reason R are individually true and if so, whether the reason is a correct explanation of the assertion. Select your answers to these items using the codes given below.*

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

1. **Assertion (A):** The pressure at a point is the ratio of force to the area on which force is acting.
   Reason (R): Pressure is the thrust acting per unit area.
2. **Assertion (A):** The blood pressure in humans is greater at the feet than at the brain
   Reason (R): Pressure of liquid at any point is proportional to height, density of liquid and acceleration due to gravity
3. **Assertion (A):** Sudden fall of pressure at a place indicates storm.
   Reason (R): Air flows from higher pressure to lower pressure.
4. **Assertion (A):** Pressure is the force acting per unit area of the surface.
   Reason (R): Force acting perpendicular to the surface is called thrust.

Very Short Answer Questions

DIRECTIONS : *Give answer in one word or one sentence.*

1. Define force.
2. What is the net force that acts on a 10-N falling object with it encounters 4N of air resistance?
3. If body A and body B are both within a system, can forces between them affect the acceleration of the system?
4. Define atmospheric pressure.
5. Which instrument is used to measure atmospheric pressure?
6. Give two examples each of contact and non-contact force.
7. Define thrust.
8. Define pressure.
9. What is the SI unit of force.
10. How pressure in a fluid vary with depth?

Short Answer Questions

DIRECTIONS : *Give answer in 2-3 sentences.*

1. State three effects that a force can produce.
2. Define force. Write its S.I. and C.G.. S. unit.
3. Define pressure. Write its S.I. unit.
4. A liquid of mass 200 g exerts a pressure of 0.1 Pa at a bottom of container. What pressure would it exert if the area of cross section of container is doubled?
5. Two bodies of masses m_1 and m_2 are allowed to fall freely from same height. If air resistance for each body is same, then will both the bodies reach the earth simultaneously?
6. A nail has 2 cm^2 at one end and $\frac{1}{100}$ cm^2 at the other end. A force of 1000 gwt is applied on the first end. Calculate the pressure acting on the wall?

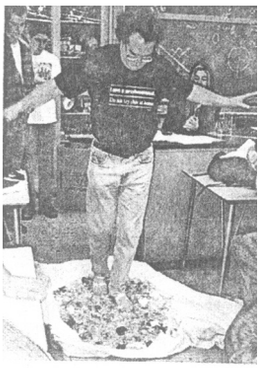
Long Answer Question

DIRECTIONS : *Give answer in 4-5 sentences.*

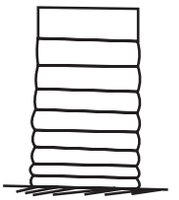
1. What is atmospheric pressure? State the various unit of atmospheric pressure. What device is used to measure atmospheric pressure?

HOTS Questions

1. The photo shows the Physics teacher Mr. Chaurasiya walking barefoot on broken glass bottles in his class. What concept is he demonstrating, and why is he carefull that broken pieces are small and numerous?



2. We can understand how pressure in water depends on depth by considering a stack of bricks. The pressure below the bottom brick is determined by the weight of the entire stack. Halfway up the stack, the pressure is half because the weight of the bricks above is half. To explain atmospheric pressure, we should consider compressible bricks like foam rubber. Why is this so?



EXERCISE-2 NCERT Questions

Text-Book Exercise

1. Give two examples each of situations in which you push or pull to change the state of motion of objects.
2. Give two examples of situations in which applied force causes a change in the shape of an object.
3. Fill in the blanks in the following statements:
   (a) To draw water from a well we have to _____ at the rope.
   (b) A charged body _____ an uncharged body towards it.
   (c) To move a loaded trolley we have to _____ it.
   (d) The north pole of a magnet _____ the north pole of another magnet.
4. An archer stretches her bow while taking aim at the target, She then releases the arrow, which begins to move towards the target. Based on this information fill up the gaps in the following statements using the following terms:
   Muscular, contact, non-contact, gravity, friction, shape, attraction
   (a) To stretch the bow, the archer applies a force that causes a change in its _____.
   (b) The force applied by the archer to stretch the bow is an example of ____ force.
   (c) The type of force responsible for a change in the state of motion of the arrow is an example of a _____ force.
   (d) While the arrow moves towards its target, the forces acting on it are due to _____ and that due to _____ of air.
5. In the following situations, identify the agent exerting the force and the object on which it acts. State the effect of the force in each case.
   (a) Squeezing a piece of lemon between the fingers to extract its juice.
   (b) Taking out paste from a toothpaste tube.
   (c) A load suspended from a spring while its other end is on a hook fixed to a wall.
   (d) An athlete making a high jump to clear the bar at a certain height.
6. A blacksmith hammers a hot piece of iron while making a tool. How does the force due to hammering affect the piece of iron?
7. An inflated balloon was pressed against a wall after it has been rubbed with a piece of synthetic cloth. It was found that the balloon sticks to the wall. What force might be responsible for the attraction between the balloon and the wall?
8. Name the forces acting on a plastic bucket containing water held above ground level in your hand. Discuss why the forces acting on the bucket do not bring a change in its state of motion.
9. A rocket has been fired upwards to launch a satellite in its orbit. Name the two forces acting on the rocket immediately after leaving the launching pad.
10. When we press the bulb of a dropper with its nozzle kept in water, air in the dropper is seen to escape in the form of bubbles. Once we release the pressure on the bulb, water gets filled in the dropper. The rise of water in the dropper is due to
    (a) pressure of water (b) gravity of the earth
    (c) shape of rubber bulb (d) atmospheric pressure

Exemplar Questions

1. Two persons are applying forces on two opposite sides of a moving cart. The cart still moves with the same speed in the same direction. What do you infer about the magnitudes and direction of the forces applied.

2. 

Fig. shows a man with a parachute. Name the force which is responsible for his downward motion. Will he come down with the same speed without the parachute?

3. Fruits detached from a tree fall down due to force of gravity. We know that a force arises due to interaction between two objects. Name the objects interacting in this case.

4. An archer shoots an arrow in the air horizontally. However, after moving some distance, the arrow falls to the ground. Name the initial force that sets the arrow in motion. Explain why the arrow ultimately falls down.

5. Two women are of the same weight. One wears sandals with pointed heels while the other wears sandals with flat soles. Which one would feel more comfortable while walking on a sandy beach? Give reasons for your answer.

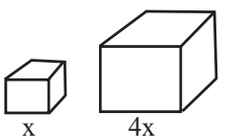
EXERCISE -3 Foundation Builder

Multiple Choice Questions

DIRECTIONS : *This section contains multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) out of which only one is correct.*

1. A cube of side 'x' rests on the floor as shown in the figure. Given that the pressure exerted by this cube on the floor is P, what is the pressure exerted by another cube of the same material of side 4x?

(Take $g = 10\ N\ kg^{-1}$)



(a) P (b) 2P

(c) 4P (d) 16P

2. The force exerted by the floor of an elevator on the foot of a person standing there, is more than his weight, if the elevator is

(a) going down and slowing down

(b) going up and speeding up

(c) going up and slowing down

(d) either (a) and (b)

3. The pressure exerted by a women wearing shoes with pointed heels is ..... than what an elephant with one foot can exert on ground

(a) much lesser (b) much greater

(c) both equal (d) none of these

4. Pressure at a certain depth in river water is P_1 and at the same depth in sea water is P_2. Then (density of sea water is greater than that of river water)

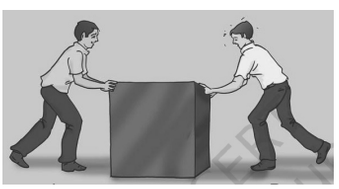
(a) $P_1 = P_2$

(b) $P_1 > P_2$

(c) $P_1 < P_2$

(d) $P_1 - P_2$ = atmospheric pressure

5. In Fig. two boys A and B are shown applying force on a block. If the block moves towards the right, which one of the following statements is correct?



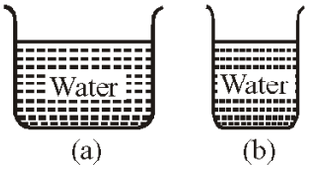
(a) Magnitude of force applied by A is greater than that of B.

(b) Magnitude of force applied by A is smaller than that of B.

(c) Net force on the block is towards A.

(d) Magnitude of force applied by A is equal to that of B.

6. From the figure, the correct observation is



(a) the pressure on the bottom of tank (a) is greater than at the bottom of (b)
(b) the pressure on the bottom of the tank (a) is smaller than at the bottom (b)
(c) the pressure depend on the shape of the container
(d) the pressure on the bottom of (a) and (b) is the same

7. We have observed that water from the leaking pipe forms fountains. What conclusion can you draw from this observation?
(a) Water exert pressure on the wall
(b) Water is flowing
(c) Water does not exert pressure
(d) Water is at rest

8. James combs his hair and brings the comb near some tiny pieces of paper. He finds the comb is attracting paper pieces. The force of attraction by the comb on the tiny piece of paper is due to which one of the following force?
(a) Magnetic force (b) Gravitational force
(c) Nuclear force (d) Electrostatic force

9. When we inflate the balloon with air, we find that its size increases. The large number of gas molecule collides with each other and creates large
(a) force (b) pressure
(c) increase in size (d) increase in mass

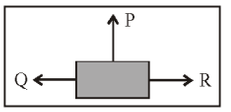
10. Which one of the following forces is a contact force?
(a) Force of gravity (b) force of friction
(c) magnetic force (d) electrostatic force

11. Air pressure is also known as atmospheric pressure. How is it caused?
(a) By the heat energy in the air
(b) By the wind that blows in the air
(c) By water vapour in the air
(d) By the air around us that presses on the surface of objects

12. A train at rest tends to move from the platform and it attains a velocity of 100 km/h within a few second. While trying to come in motion it has to overcome the
(a) Frictional force (b) Gravitational force
(c) Normal force (d) Electrostatic force

13. In a game of tug-of-war between two teams X and Y, the rope broke at a point which is nearer to X. Then which of the following is correct?
(a) X has applied more force.
(b) Y has applied more force.
(c) X and Y both have applied same force.
(d) X and Y have not applied any force.

14. Three persons P, Q and R pull block with equal forces as shown in figure. Identify the direction of motion of the block?

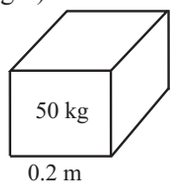


(a) In horizontal direction towards left.
(b) In horizontal direction towards right.
(c) In vertically upward direction.
(d) The block remains stationary.

15. An iron block of dimensions 5 cm × 10 cm × 15 cm has to be pushed along the floor. The force required will be minimum when the surface in contact with ground is **[Olympiad]**
(a) (10 cm × 15 cm) surface
(b) (5 cm × 15 cm) surface
(c) (10 cm × 5 cm) surface
(d) Force is same for all surfaces

16. A 20 Pa pressure is applied on the head of a nail placed perpendicular to the surface of a wall. If the area of cross-section of the tip of the nail is (1/10) times the area of cross-section of the head, the pressure exerted at the wall is **[Olympiad]**
(a) 10 Pa (b) 20 Pa
(c) 200 Pa (d) None of these

17. A cube of side 0.2 m rests on the floor, as shown. Given that the cube has a mass of 50 kg, the pressure exerted by the cube on the floor is _____.
(Take g = 10 N kg^{-1}) **[Olympiad]**



(a) 25 N m^{-2} (b) 250 N m^{-2}
(c) 1250 N m^{-2} (d) 12500 N m^{-2}

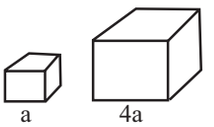
18. The pressure of the water near the bottom of the wall forming a dam does not depend on ____. **[Olympiad]**
(a) The depth of the water
(b) The cross-sectional area of the reservoir
(c) Density of water
(d) Atmospheric pressure

19. A block of mass 4 kg and dimensions 10 cm × 20 cm × 30 cm rests on the floor. If g = 10 m s^{-2}, then the maximum pressure the block can exert on the floor is **[Olympiad]**
(a) 2000 N m^{-2} (b) 1000 N m^{-2}
(c) 4000 N m^{-2} (d) 1333 N m^{-2}

20. The given figure shows a statue kept on it's both feet. It exerts a pressure of 340 Pa on the floor. What is the weight of the statue if base area of its one foot is 17 cm^2 ? **[Olympiad]**

(a) 5.780 N
(b) 1000 N
(c) 1.156 N
(d) 2000 N

21. A cube of side 'a' rests on the floor as shown in the figure. Given that the pressure exerted by this cube on the floor is P, what is the pressure exerted by another cube of the same material of side 4a? (Take g = 10 N kg^{-1}) **[Olympiad]**



(a) P
(b) 2P
(c) 4P
(d) 16P

More than One Option Correct

DIRECTIONS : *This section contains multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) out of which ONE OR MORE may be correct.*

1. Two similar buses are moving with same velocity on a straight road. One of them is empty and the other is loaded with passengers
(a) Both buses are stopped by the application of same force
(b) Loaded bus will be stopped by applying large force
(c) Loaded bus will be stopped by applying less force
(d) Empty buses will be stopped by applying less force and loaded bus will be stopped by appplying large force.

2. Which of the following action cannot be describes as pushing by a body ?
(a) kicking (b) lifting
(c) picking (d) opening

3. Choose the correct options
(a) A force is applied to an object in the direction of its motion. The speed of object will increase
(b) If no force acts on a body it will either remain in rest or move in a straight line
(c) Friction force can change speed of an object
(d) None of these

4. Choose the correct options ?
(a) A body floats in water because the net force acting on this body is zero
(b) A mountain climber experiences a nose bleed due to increase in atmospheric pressure
(c) A body floats in water because the net force acting on this body is non-zero
(d) A mountain climber experiences a nose bleed due to decrease in atmospheric pressure

5. Pressure at a point in a fluid is directly proportional to
(a) depth of the point from the surface
(b) density of the fluid
(c) acceleration due to gravity
(d) the area of cross section

6. Which of the following factors affect pressure?
(a) Area (b) Acceleration
(c) Force (d) Current

Passage/Case Based Questions

DIRECTIONS : *Read the passage (s) given below and answer the questions that follow.*

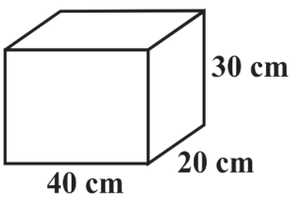
1. Liquid pressure in a container doesn't depend on the shape of the container but it only depends on the height of the liquid column.

(i) A cylinderical container is full of water. The pressure will be maximum at
(a) top surface (b) mid of container
(c) bottom (d) None of these

(ii) If half of the water is taken out, what is the pressure at the bottom? (P = pressure when container full of liquid)
(a) P (b) $\frac{1}{2}P$
(c) $\frac{3}{2}P$ (d) $2P$

2. A cuboid rests on the floor. Data of the cuboid and some other parameters are given here.

Length of cuboid	40 cm
Width of cuboid	20 cm
Height of cuboid	30 cm
Mass of the cuboid	60 cm
Acceleration due to gravity	10 N kg^{-1}



(i) By rotating the cuboid, what is the minimum pressure it can exert on the floor?
(a) 7500 Pa (b) 10000 Pa
(c) 5000 Pa (d) 20000 Pa

(ii) By rotating the cuboid, what is the maximum pressure it can exert on the floor?

(a) 3000 Pa (b) 7500 Pa

(c) 5000 Pa (d) 10000 Pa

Assertion & Reason Questions

DIRECTIONS : *The questions in this segment consists of two statements, one labelled as "Assertion A" and the other labelled as "Reason R". You are to examine these two statements carefully and decide if the Assertion A and Reason R are individually true and if so, whether the reason is a correct explanation of the assertion. Select your answers to these items using the codes given below.*

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true but R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

1. **Assertion (A):** The acceleration produced by a force in the motion of a body depends only upon its mass.
   Reason (R): Larger is the mass of the body, lesser will be the acceleration produced.
2. **Assertion (A):** If the net external force on the body is zero, then its acceleration is zero.
   Reason (R): Acceleration does not depend on force.
3. **Assertion (A):** An object can move with constant velocity if no net force acts on it.
   Reason (R): No net force is needed to move an object with constant velocity.

Numeric/Integer Type Questions

1. A force produces an acceleration of 16 m/s^2 in a body of mass 0.5 kg, and an acceleration of 4 m/s^2 in another body. If both the bodies are fastened together, the acceleration produced by that force is (1.6)x m/s^2. Find the value of x.
2. When acceleration of a block is reduced to half of its original value, mass of the block has to be increased x times to keep the force acting on it constant. Find x.
3. If the water pressure gauge shows the pressure at ground floor to be 270 k Pa, 3x metre high would water rise in the pipes of a building. Find the value of x.

SOLUTIONS

Brief Explanations of Selected Questions

Let's Revise Through FIB & T/F

1. external unbalanced force
2. direction
3. False
4. contact
5. True
6. False
7. area
8. atmospheric pressure
9. increases
10. True
11. True
12. True

EXERCISE-1 Master Board

Multiple Choice Questions

1. (d)
2. (a) Pressure $= \frac{\text{Force}}{\text{area}}$
3. (a) Wide tyres of a heavy vehicle have low pressure.
4. (b) A sharp knife enables us to cut through things more easily because the pressure exerted is greater when the same force is used.
5. (d) Electrical force
6. (a) Muscular force is a contact force
7. (a) Throwing a stone at a bird.
8. (a) The strength of a force is usually expressed by its magnitude.
9. (d) All the forces are involved to pull the load up.
10. (a) Change of position
11. (b) Muscular force
12. (d) Change the position of a stationary object.
13. (b) Heating is not a force.
14. (c) The force applied by our body to do any type of work, is a muscular force.
15. (b) In an electric bell hammer strike the gong due to electromagnetic force. During dry weather hair attract the comb due to electrostatic force of attraction.

Assertion & Reason Questions

1. (a)
2. (a) Height of the blood column in the human body is more at feet than at the brain. As P = hrg therefore the blood exerts more pressure at the feet than at the brain.
3. (a)
4. (b) Both assertion and reason are correct.

Very Short Answer Questions

1. Force is an external agent which changes or tries to change the state of an object
2. The net force will be $F_1 - F_2 = 10\ N - 4\ N = 6\ N$
3. No, if two bodies A and B are within a system, then their mutual forces are equal and opposite and cancel each other so that they do not affect the acceleration of the system.
4. The pressure exerted by air.
5. Barometer
6. **Contact force :** Frictional force and muscular force.
   Non-contact force : Gravitational force and electrostatic force.
7. Refer to theory
8. Refer to theory
9. Refer to theory
10. Pressure increases with depth.

Short Answer Questions

1. Effects produced by a force. :
   (i) Force can change speed of an object.
   (ii) Force can change the direction of motion of an object.
   (iii) Force can change the shape of an object.
2. Refer to theory
3. Refer to theory
4. $\text{Pressure} = \frac{\text{force}}{\text{area}}$
5. If the air resistance on both the bodies is same, they will reach earth at same time. This is because during free fall, irrespective of mass, all the body accelerates towards the earth with same acceleration 'g' ($= 9.8\ m/s^2$).
6. Refer to theory.

Long Answer Questions

1. The atmospheric pressure at any point is equal to the weight of a vertical column of air of unit cross-sectional area extending from that point to the top of earth's atmosphere. The atmospheric pressure is maximum at the surface of earth and goes on decreasing as we move up into the atmosphere.

Various units of atmospheric pressure

The value of atmospheric pressure on the surface of earth at sea level is called one atmosphere (1 atm.)

(i) $1\ atm = 1.013 \times 10^5\ Nm^{-2}$ in S.I. unit

$= 1.013 \times 10^6\ dyne/cm^2$ in cgs unit

(ii) 760 mm of mercury column or 760 mm Hg

(iii) For metreological purpose, we use bar

$1\ bar = 10^5\ Pa$

(iv) 1 torr = 1 mm Hg.

Device used to measure atmospheric pressure is Mercury Barometer.

HOTS Questions

1. The teacher is demonstrating the concept of pressure. The broken pieces of glass are having small cross-sectional area, so, the pressure on his feet increases and the glass pieces pierce through his skin. The relation between pressure and area is given by the formula,

   $$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

   So, for a constant force (body weight of the person) if the area decreases, pressure increases. The teacher is careful that the broken pieces are small and numerous because if the number of broken pieces is large, the combined surface area will be more, which results in a lesser pressure, and the glass pieces do not pierce through his skin.
2. Atmospheric pressure can be explained by using compressible bricks made up of foam rubber because larger the pressure, larger will be the compression on the surface of the bricks.

EXERCISE-2 NCERT Questions

Text-Book Exercise

1. (i) Applying the breaks to stop the vehicle
   (ii) Opening or shutting the door.
2. (i) Applying the force to give shape to clay and make pots.
   (ii) Bursting of a inflated balloon by pressing between the palms.
3. (a) apply the force of pull
   (b) pulls or attracts
   (c) either pull or push
   (d) repels
4. (a) shape (b) muscular
   (c) contact (d) gravity; friction
5. (a) Agent : Fingers
   Object : Lemon outer surface
   Effect : shape of piece of lemon gets changed by squeezing and juice gets extracted.
   (b) Agent : Fingers
   Object : Wall of tube and paste
   Effect : Shape of the tube gets changed and paste is squeezed out.
   (c) Agent : Weight of load
   Object : Spring
   Effect : Spring will expand downward.
   (d) Agent : Athlete
   Object : Athlete's body
   Effect : The athlete will jump on the other side of the bar at a certain height.
6. When a blacksmith hammers a hot piece of iron, he uses his muscular force. This muscular force changes the shape of iron so that it can be given a desired shape.
7. When an inflated balloon is rubbed with a piece of synthetic cloth, it becomes charged. A charged body attracts an uncharged body so, when this charged balloon is pressed against a wall, it sticks to the wall. Electrostatic force is responsible for the attraction between the balloon and the wall.
8. The forces acting on the plastic bucket containing water held above the ground level are:
   (a) Gravitational force (b) Muscular force
   These forces donot change in the state of motion of bucket because they are balancing each other and as a result the net force becomes zero.
9. The forces acting on the rocket immediately after leaving the launching pad are:
   (a) Force of gravitation in downward direction
   (b) Friction force due to air
10. The rise of water in the dropper is due to atmospheric pressure. When all the air escapes from the nozzle, the atmospheric pressure, which is acting on the water, forces the water to fill the nozzle of the dropper.

Exemplar Questions

1. Both the forces are of equal magnitudes and applied in the opposite directions.
2. Force of gravity. No, without the parachute his speed will be higher.
3. Earth and fruits.
4. The archer stretches the string of the bow by applying muscular force. In the process the shape of the bow changes. When the string is released, it regains its original position that provides the initial force to set the arrow in motion. The force of gravity that acts on the arrow in the downward direction brings it to the ground.
5. The woman wearing sandals with flat soles will feel more comfortable while walking on the sandy beach. The flat soles have larger area compared to the sandals with pointed heels. Since the two women are of the same weight, they will apply same force on the ground. Therefore, the pressure exerted by the pointed heels will be more compared to that with sandals having flat soles. As a result the pointed heel sandals will sink more in the sand than the flat sole sandals. Hence, walking with flat sole sandals will be more comfortable.

EXERCISE-3 Foundation Builder

Multiple Choice Questions

1. **(c)** The pressure exerted by another cube of the same material of side 4X is 4P.(P=F/A)
2. **(b)** 3. **(b)** 4. **(c)** 5. **(a)**

6. **(d)** Pressure = hρg i.e. pressure at the bottom is independent of the area of the bottom of the tank. It depends on the height of water upto which the tank is filled with water. As in both the tanks, the levels of water are the same, pressure at the bottom is also the same.
7. **(a)** Water exerts pressure on the wall.
8. **(d)** Electrostatic force
9. **(b)** The large number of gas molecules collides with each other and creates large pressure.
10. **(b)** Force of Friction
11. **(d)** Air pressure is also known as atmospheric pressure as the air around us that presses on the surface of objects.
12. **(a)** When an object tends to come in motion from the rest, the frictional force acting on the object.
13. **(a)** X has applied more force.
14. **(c)**
15. **(d)** Force is same for all the surfaces.
16. **(c)** For constant force, pressure $P \propto \frac{1}{A}$

so, $\frac{P_2}{P_1} = \frac{A_1}{A_2} \Rightarrow P_2 = \frac{A}{\left(\frac{A}{10}\right)} \times P_1$

$= 10\ P_1 = 10 \times 20 = 200$ Pa

17. **(d)** As we know, $P = \frac{F}{A} = \frac{mg}{A} = \frac{50 \times 10}{0.2 \times 0.2}$

$= 12500\ Nm^{-2}$

18. **(b)**
19. **(a)** Mass of the block (m) = 4 kg

weight of the block = 4 × 10 = 40 N

$\therefore$ Pressure $= \frac{\text{Force}}{\text{Area}} = \frac{40}{0.2 \times 0.1} = 2000\ N/m^2$

20. **(c)** A statue have two feet, so the area (A) = 2 × area of one foot

$A = 2 \times 17 \times 10^{-4}\ m^2$

$P = \frac{F}{A} \Rightarrow F = P \times A$

So, weight of the statue = F

$= 340 \times 2 \times 17 \times 10^{-4} = 1.156$ N

21. **(c)** The pressure exerted by another cube of the same material is side 4a is 4p. (P = F/A)

More than One Option Correct

1. **(b, d)** Inertia is ∝ mass
2. **(b, c, d)** Kicking is a pushing action while all others are pulling action.
3. **(a, b, c)**
   (a) Since the force is in the direction of motion, the speed of object will increase.
   (b) Force is required for a, b & d. In absence of a force an object will either remain at rest (static object) or move in a straight line (moving object).
   (c) Friction force between two surfaces tends to decrease the speed of a moving object.
4. **(a, d)** The weight of the body is balanced by the upthrust of water. Hence net force acting on the body is zero.
   The atmospheric pressure decreases with height due to thinning of atmosphere. Thus the internal body pressure becomes higher than atmospheric pressure causing a nose bleed.
5. **(a, c)** 6. **(a, c)**

Passage/Case Based Questions

1. **(i) (c)** Pressure depends upon the length of air column.
   (ii) (b) $P = \rho gh$
2. **(i) (c)** Minimum pressure exerted on the floor when area is maximum

   = 60 × 10/0.3 × 0.4 = 5000 Pa

   (ii) (d) Maximum pressure exerted on the floor when the area is minimum

   = 60 × 10/0.2 × 0.3 = 10000Pa

Assertion & Reason Questions

1. **(a)** 2. **(c)** 3. **(a)**

Numeric/Integer Type Questions

1. **(2)** Here, $a_1 = 16\ m/s^2$, $m_1 = 0.5$ kg,

   $F = m_1 a_1 = 16 \times 0.5$ kg = 8 N

   $m_2 = \frac{F}{a_2} = \frac{8}{4} = 2$ kg ; $m_1 + m_2 = 0.5 + 2 = 2.5$ kg,

   $F = 8$ N;

   $a = \frac{F}{m_1 + m_2} = \frac{8}{2.5} = 3.2\ m/s^2$ $\quad\therefore\quad x = 2\ m/s^2$

2. **(2)** Original acceleration = a

   Final acceleration = $\frac{a}{2}$

   Original mass = m

   Final mass = xm

   According to question,

   $ma = xm\frac{a}{2}$

   $\Rightarrow \boxed{x = 2}$

3. **(9)** Here, P = 270 kPa = 270 × 10^3 Pa $\Rightarrow$ P = hρg

   $\Rightarrow h = \frac{P}{\rho g} = \frac{270 \times 10^3}{10^3 \times 9.8} = 27$ m