

# FORCE AND PRESSURE

## Force

Force is the push or pull which changes the position of body or tend to change the position of body.

Unit of force in SI system is Newton and in CGS system is Dyne.

### Relation between the Newton and Dyne

$$\begin{aligned} 1 \text{ N} &= 1 \text{ kg} \times \text{m/s}^2 \\ &= 1000 \text{ g} \times 100 \text{ cm/s}^2 \\ &= 100000 \text{ gcm/s}^2 = 10^5 \text{ dyne} \end{aligned}$$

Thus,  $1 \text{ N} = 10^5 \text{ dyne}$

## Types of Forces

There are different types of forces which are categorised into two groups, i.e. contact forces and non-contact forces.

### Contact Forces

- Contact forces are those forces which come in action only when two objects are in the actual contact with each other.
- These forces are further divided into two groups, i.e. **muscular force** and **frictional force**.
- Every action has an equal and opposite reaction. Action-reaction force are example of contact force.

### Muscular Force

- The force which results due to the action of muscles is called **muscular force**.

*In this chapter, we concentrate on the concept of force and pressure and also discuss about the different types of forces like as frictional force, magnetic force, electrostatic force, gravitational force and daily life application of pressure.*

- Both human beings and animals exert muscular force to do some work, e.g. We use muscular force in our daily life activities like walking, jumping, climbing, stretching squeezing, etc.

### Frictional Force

- If we slide or try to slide a body over a surface, the motion is resisted by a bonding between the body and the surface. This resistance is called frictional force.
- The opposite force that comes into play when one body tends to move over the surface of another body but actually motion has yet not started is called static friction.
- The maximum value of the static frictional force which comes into play when a body just begins to slide over the surface of another body is called limiting frictional force.
- When two bodies actually roll on each other (as in case of ball bearing), the rolling friction comes into play.
- When two bodies actually slide over each other, sliding friction comes into play.
- When a body moves over the other body, then the force of friction acting between two surfaces in contact in relative motion is called kinetic friction.

### Non-Contact Forces

- Non-contact forces are those forces which come into action without any contact with one another, e.g. **magnetic force**, **electrostatic force** and **gravitational force**.

### Magnetic Force

- It is a fact that magnet can exert a force (of attraction) even without touching them. Thus, **magnetic force** is non-contact force.
- A magnet also exerts a magnetic force on another magnet placed near it.
- This force can be either attractive or repulsive. For like poles, facing towards each other there is a force of repulsion, while for unlike poles facing each other, there is a force of attraction.

### Electrostatic Force

- An object having stationary electric charges on it is called **electrically charged object**.
- The fundamental property of matter, which takes part in electric and magnetic effects is electric charge.
- As the charges are of two types, i.e. positive and negative, so the term electrostatics refers to stationary electric charges.
- Force exerted by an electrically charged object is called **electrostatic force** which can be either attractive or repulsive.
- The electrostatic force of interaction can be exerted by a charged body on another charged or uncharged body even if they are not in touch with each other, therefore electrostatic force is an example of non-contact force.

### Gravitational Force

- Each and every body in this universe attract each other bodies with a certain force and this force is called **gravitational force**.
- The earth revolves around the sun in an orbit and it is due to gravitational force of attraction between them.
- In this case, if we release a small stone from some height, then it falls down towards the earth. It is due to reason, that the earth exerts an attractive force on the stone and pulls it down.
- The force with which the earth attracts the objects towards it, is called force of **gravity** or **simply gravity**.  
The gravitational force is **non-contact force**.

- Gravitational force (or gravity) is given by  
 $F = mg$

**Note** Like the earth, other planets also attract the object towards it. In that case, the term gravity is the attractive force on the objects (nearby) towards that planet.

### Thrust

- It is the force acting on an object perpendicular to its surface.

- The effect of thrust depends on the area on which it acts.
- The unit of thrust is the same as that of force, i.e. the SI unit of thrust is Newton (N). It is a vector quantity.

## Pressure

- It is the force acting perpendicularly on a unit area of an object.

$$\text{Pressure } (p) = \frac{\text{Force } (F)}{\text{Area } (A)} = \frac{\text{Thrust}}{\text{Area}}$$

- The SI unit of pressure is  $\text{Nm}^{-2}$ , which is also called pascal (Pa) named after the scientist **Blaise Pascal**. It is a scalar quantity.

$$1 \text{ Pa} = 1 \text{ Nm}^{-2}$$

- The same force acting on a smaller area exerts a large pressure while a force on a larger area exerts small pressure.

### Some Daily Life Applications of Pressure

- The handles of bags, suitcases, etc., are made broad, so that less pressure is exerted on the hand.
- Buildings are provided with board foundations, so that the pressure exerted on the ground becomes less.

- Railway tracks are laid on cement or iron sleepers, so that the pressure exerted by train could spread over the larger area and thus pressure decreases.
- Pins, needles and nails are provided with sharp pointed ends to reduce the area and hence to increase the pressure.
- Cutting tools have sharp edges to reduce the area, so that with lesser force, more pressure could exerted.
- Pressure on ground is more when a man is walking than when he is standing because in case of walking, the effective area is less.
- Depression is much more when a man stands on the cushion than when he lies down on its because in standing case, area is lesser than in case of lying.
- The tractors have broad tyres, to create less pressure on the ground, so that types do not sink into comparatively soft ground in the field.

### Atmospheric Pressure

The pressure exerted by the atmospheric gases is known as atmospheric pressure.

$$1 \text{ atm} = 1.01 \times 10^5 \text{ N/m}^2$$

## PRACTICE EXERCISE

- The CGS unit of force is
  - Dyne
  - Pascal
  - Joule
  - Watt
- Force by the virtue of bodies in contact is called
  - contact force
  - non-contact force
  - weak force
  - strong force
- If no force acts on a body, it will
  - shape gets deformed
  - move fastly
  - either in rest or in motion
  - stop moving
- When we apply a force of 1 N, we can hold a body whose mass is approximately equal to
  - 100 mg
  - 100 g
  - 1 kg
  - 10 kg
- A force of a given magnitude acts on a body. The acceleration of the body depends on the
  - mass
  - volume
  - density
  - shape

6. Kicking a ball with our legs is an example of force of  
(a) friction (b) gravitation  
(c) muscular (d) magnetic
7. The action-reaction forces  
(a) act on the same body  
(b) act on different bodies  
(c) act along different lines  
(d) act in the same direction
8. Friction force between two rough surfaces can be ..... by using lubricant.  
(a) increased (b) decreased  
(c) removed (d) kept same
9. Consider a porter standing on a platform with a suitcase which presses his head with a force of 300 N. The reaction forces is exerted by  
(a) the head on the suitcase  
(b) the earth on the suitcase  
(c) the earth on the porter  
(d) the suitcase on the earth
10. Sometimes, car skids on rainy season  
(a) water increases the friction between the road and the tyres  
(b) it is not possible to apply brakes on a wet road  
(c) the friction between the brake shoes and the wheels is reduced  
(d) water reduces the friction between the road and the tyres
11. Which of the following is not true regarding friction.  
(a) Friction wears down machine parts  
(b) Friction helps us walk  
(c) Friction helps a ship move through water  
(d) Friction produces heat
12. Ball bearings are used in bicycles, cars, etc., because  
(a) the actual area of contact between the wheel and axle is increased  
(b) the effective area of contact between the wheel and axle is increased  
(c) the effective area of contact between the wheel and axle is reduced  
(d) None of the above
13. The force of friction between two bodies is  
(a) parallel (b) perpendicular  
(c) inclined at  $30^\circ$  (d) inclined at  $60^\circ$
14. A coin flicked across a table stops because  
(a) no force acts on it  
(b) it is very heavy  
(c) the table exerts a frictional force on it  
(d) the earth attracts it
15. The soles of shoes are made up of grooves to  
(a) increase friction force acts on it  
(b) it is very light  
(c) the air exerts a frictional force on it  
(d) the earth attracts it
16. The fluid friction depends on  
(a) Speed of object with respect to fluid.  
(b) Size of object.  
(c) Shape of object.  
(d) All of above.
17. Relation between the SI unit of force and the weight of a 1 kg mass is  
(a)  $1 \text{ kgf} = 1 \text{ N}$  (b)  $1 \text{ kgf} = 0.98 \text{ N}$   
(c)  $1 \text{ kgf} = 9.8 \text{ N}$  (d)  $1 \text{ N} = 9.8 \text{ kgf}$
18. The speed of a falling body increases continuously. This is because  
(a) no force acts on it  
(b) it is very light  
(c) the air exerts a frictional force on it  
(d) the earth attracts it
19. The force of gravitation acts  
(a) only between the sun and the planets moving around it  
(b) only between the earth and the bodies on it  
(c) between all bodies in the universe  
(d) only between the sun and the earth
20. One boy is carrying a bucket of water by his one hand and wood cube with his another hand. If he places the wood cube in the bucket of water, then he will feel  
(a) same weight  
(b) more weight  
(c) less weight  
(d) None of these

- 21.** Pressure is  
 (a) scalar quantity  
 (b) vector quantity  
 (c) Both 'a' and 'b'  
 (d) None of these
- 22.** If a force of 1000 N acts on an area of  $100 \text{ m}^2$ , the pressure equals  
 (a)  $100 \text{ N/m}^2$  (b)  $10 \text{ N/m}^2$   
 (c)  $1000 \text{ N/m}^2$  (d)  $1000 \text{ Nm}^2$
- 23.** The pressure in the bottle filled with water is maximum  
 (a) in the middle of bottle  
 (b) at the top of the bottle  
 (c) first at the top then in the middle  
 (d) in the bottom of the bottle
- 24.** The bottom of dam is made thick due to  
 (a) the water exerts low pressure on bottom wall  
 (b) it is a custom  
 (c) it looks beautiful  
 (d) the water exerts more pressure on bottom wall
- 25.** The pressure on earth will be less when the man is  
 (a) lying  
 (b) sitting  
 (c) standing by one foot  
 (d) standing by two feet
- 26.** What will be the pressure when 30 N force is applied on  $120 \text{ cm}^2$  area?  
 (a)  $2.5 \times 10^3 \text{ N/m}^2$  (b)  $5 \times 10^4 \text{ N/m}^2$   
 (c)  $2.5 \times 10^2 \text{ N/m}^2$  (d)  $5 \times 10^3 \text{ N/m}^2$
- 27.** A metal cuboid of mass  $M$  kg rests on a table surface area of  $40 \text{ cm}^2$  in contact with the table. The pressure exerted by the cuboid on the table surface is 10000 Pa. Value of  $M$  is (given that  $g = 10 \text{ ms}^{-2}$ )  
 (a) 20 kg (b) 5 kg  
 (c) 4 kg (d) 2.5 kg
- 28.** One atmospheric pressure is equal to  
 (a)  $1.5 \times 10^6 \text{ N/m}^2$  (b)  $1.01 \times 10^5 \text{ N/m}^2$   
 (c)  $2.5 \times 10^5 \text{ N/m}^2$  (d) None of these

## Answers

1	(a)	2	(a)	3	(c)	4	(c)	5	(a)	6	(c)	7	(b)	8	(b)	9	(a)	10	(d)
11	(c)	12	(c)	13	(a)	14	(c)	15	(a)	16	(d)	17	(c)	18	(d)	19	(c)	20	(a)
21	(a)	22	(b)	23	(d)	24	(d)	25	(a)	26	(a)	27	(c)	28	(b)				