

CLASS 9th NOTES **PHYSICS**

FORCE AND LAWS OF MOTION

PRASHANT KIRAD

Force and Laws of Motion

Force:

- A force is an effort that changes the state of an object at rest or at motion. It can change an object's direction and velocity. Force can also change the shape of an object.

Example - opening and closing the door, pushing the table, plucking the string of a guitar, pulling ropes while playing tug of war, etc.

Effects of force:

- Force moves stationary objects.
- Force stops objects from moving
- Force changes the shape of a body
- Force changes the direction of motion



Types of Forces:

1. Balanced Force: Particles of matter are continuously moving i.e., they possess kinetic energy. As the temperature rises, particles moves faster because kinetic energy of the particles increases.

2. Unbalanced Force: Unbalanced forces acting on an object change its speed and/or direction of motion. It moves in the direction of the force with the highest magnitude.



Laws of Motion :

Galileo Galilei : Galileo first of all said that object move with a constant speed when no forces act on them. This means if an object is moving on a frictionless path and no other force is acting upon it, the object would be moving forever. That is, there is no unbalanced force working on the object.

But practically it is not possible for any object. Because to attain the condition of zero, unbalanced force is impossible. Force of friction, force of air and many other forces are always acting upon an object.

Newton's first Laws of Motion :

A body continues to be in the state of rest or uniform motion in a straight line unless acted upon by an external unbalanced force. The First Law is also called the Law of Inertia.

Inertia and Mass :

Basically, all objects have a tendency to resist the change in the state of motion or rest. This tendency is called inertia. All bodies do not have the same inertia. Inertia depends on the mass of a body. The mass of an object is the measure of its inertia.

- More the mass → more the inertia and vice versa.

Inertia of Rest : An object stays at rest, and it remains at rest until an external force affects it. Example: When a car accelerates, passengers may feel as though their bodies are moving backwards. In reality, inertia is making their bodies stay in place as the car moves forward.

Inertia of Motion : An object will continue to be in motion until a force acts on it. Example: A hockey puck will continue to slide across the ice until acted upon by an outside force.

Some more examples:

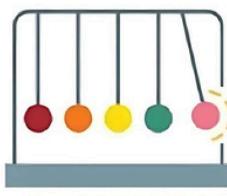
- One's body movement to the side when a car makes a sharp turn.
- Tightening of seat belts in a car when it stops quickly.
- A ball rolling down a hill will continue to roll unless friction or another force stops it.
- If pulled quickly, a tablecloth can be removed from underneath of dishes. The dishes have the tendency to remain still as long as the friction from the movement of the tablecloth is not too great.
- Shaking a bottle of ketchup. When bringing the bottom down, the suddenly stopping it, inertia is what causes the ketchup to come out of the bottle.



Soccer Ball at Rest



Roller Coaster



Swinging Pendulum



Space Travel

Second law of Motion : It states that the rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts.

Momentum (p)

Impacts produced by objects depend on their mass and velocity. The momentum of an object is defined as the product of its mass and velocity.

$$p = mv$$

- An example of momentum is a baseball flying through the air and a bullet fired from a gun.
- A moving bullet has a large momentum since it has an extremely large velocity though it carries very small mass.
- A bowling ball with large mass moving very slowly with a low velocity can have the same momentum as the base ball with the small mass which is thrown fast and has a high velocity.

Momentum and Mass and Velocity:

- Since momentum is the product of mass and velocity ($p = m \times v$) of an object. This means momentum is directly proportional to mass and velocity. Momentum increases with increase of either mass or velocity of an object.
- This means if a lighter and a higher object is moving with same velocity, then heavier object will have more momentum than the lighter one.
- If a small object is moving with great velocity, it has tremendous momentum. And because of momentum, it can harm an object more severely. For example, a small bullet having a little mass even kills a person when it is fired from a gun.
- Usually, road accidents prove more fatal because of high speed than in slower speed. This happens because vehicles running with high speed have greater momentum compared to a vehicle running with slower speed.

Mathematical formulation of second law of Motion :

$$\text{The rate of change in momentum} = \frac{m \times (v - u)}{t}$$

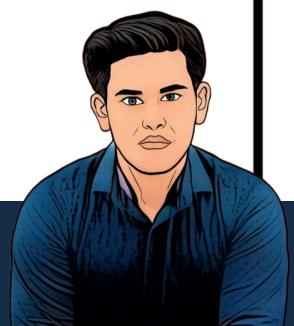
According to Newton's second law of motion, we have

$$F \propto \frac{m(v - u)}{t}$$

$$F = km \frac{(v - u)}{t}$$

$$F = kma$$

Numericals practice
krlema iss chapter me se



...(1)

Here, $a = \frac{v - u}{t}$ = the rate of change of velocity.

= acceleration

k = a constant of proportionality

Putting $m = 1\text{kg}$, $a = 1\text{ ms}^{-2}$

F becomes 1 N .

So, $1\text{ N} = k \times 1\text{ kg} \times 1\text{ ms}^{-2}$

$$\therefore k = 1$$

From equation (1), we have

$$F = ma$$

This represents the second law of motion.

Third Law of Motion :



Newton bhi keh gaya hai:
'Jaisa karoge, vaisa
bharoge!'



Two forces acting from opposite directions are called Action and Reaction forces.

For example : a ball when hits the ground (action) bounces back with a certain force (reaction).

"When one body exerts a force on the other body, the first body experiences a force which is equal in magnitude in the opposite direction of the force which is exerted".

Example :

The flight of the bird is an example of an action-reaction pair. The wings of the bird push the air downwards. The air pushes the air upwards.

- A swimmer pushes against the water, while the water pushes back on the swimmer.
- Lift is created by helicopters by pushing the air down, thereby creating an upward reaction force.
- Rock climbers pull their vertical rope downwards to push themselves upwards.

