Class Notes

Class : IX	**Topics: (Force and Laws of Motion)** Effects of Force, Definition of force, Resultant force, Balanced force, Unbalanced force, Galileo's Observation.
Subject: Physics	

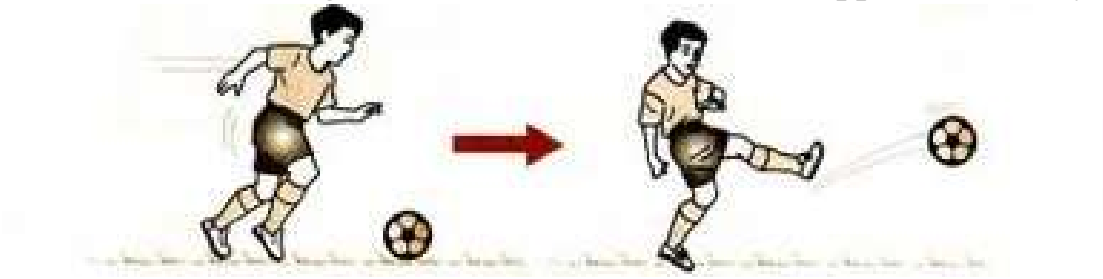
Concept of Force:

In our daily life, we observe that some effort is required to move a stationary object or to stop a moving object. In fact, no one can see a force, but it can be felt always. Before discussing the concept that what force is, we should first discuss the effects of force.

Effects of Force:

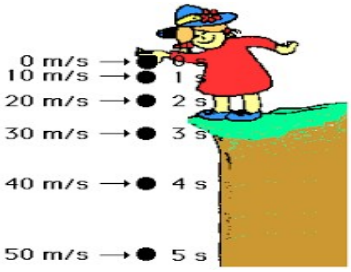
To understand the meaning of the term force, let us see some effects of the force.

1. *A force can move a stationary object.*
   A football at rest, begins to move when a footballer applies a force by kicking on it.

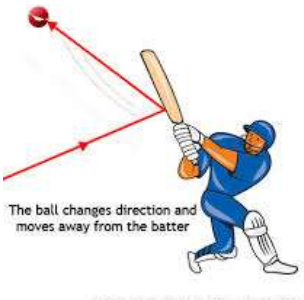


2. *A force can stop a moving object.*
   A goalkeeper collects the football or stops it by applying a force on the ball. (Can you guess in what direction the goalkeeper should apply the force to stop the ball?)

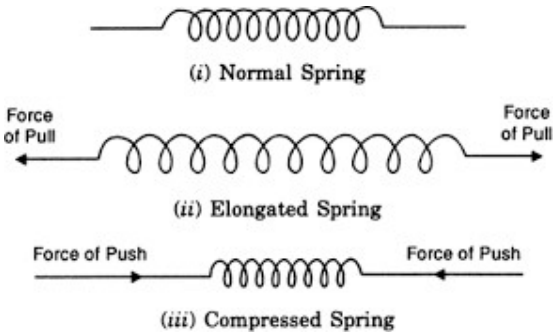
3. *A force can change the speed of a moving object.*
   You can change (increase or decrease) the speed of your bi-cycle by changing the force on the pedal. Also for a freely falling object, its speed increases due to gravity.



4. *A force can change the direction of a moving object.*
   If we hit a cricket ball by a bat then the direction of motion of the ball changes. Similarly, when a footballer hits a ball coming towards him, the direction of motion of the ball changes.



5. *A force can change the shape and size of a body.*
   This can simply be understood by stretching or compressing a spring or rubber band etc.



Definition of force:

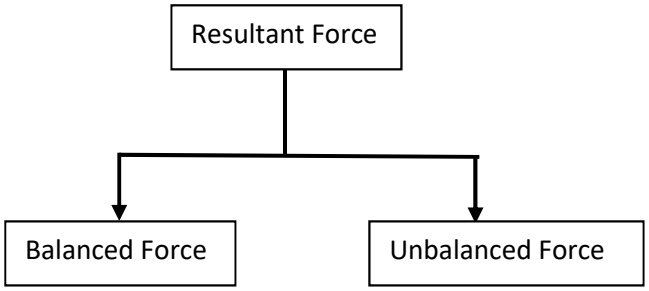
'A force is that physical quantity which causes or tends to cause a motion in a body at rest or stops a moving body or changes the direction of motion of a moving body or changes the size and shape of a body.'

Resultant Force:

Resultant force is that single force which when acting on a body produces the same effect as that produced by a number of forces. In other way, it is the sum of all the forces (with sign) acting on the body.

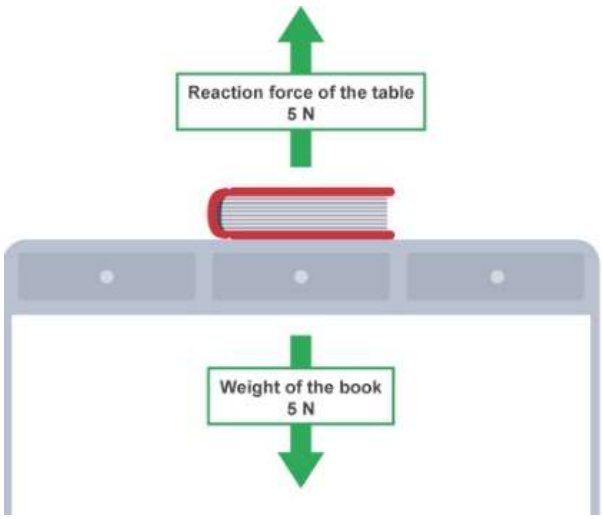
Example: Several people can jointly move a cart but a strong person can move the same cart and produces the same acceleration. The force applied by the strong person is called the resultant force.

It is also called net force.



Balanced Forces:

If the resultant force of all the forces acting on a system or a body is zero then the forces are called as balanced forces.



Example: Book kept on a table.

N.B.

i) For balanced forces, resultant is zero.

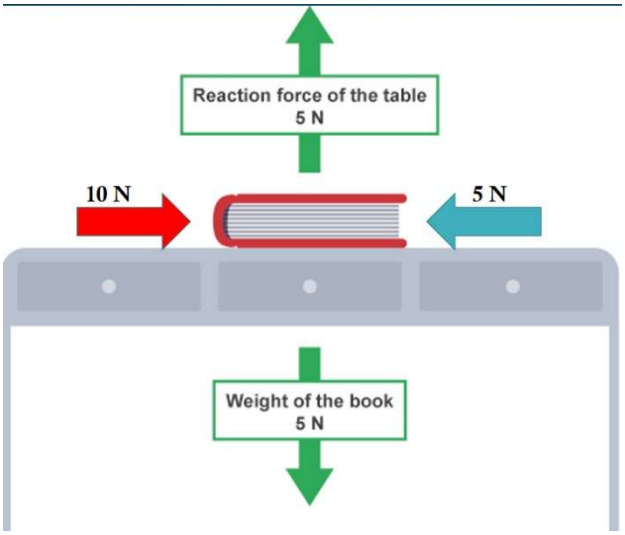
ii) Balanced forces produce zero acceleration.

iii) Balanced forces may change the shape and size of a body.

If Force is balanced ⇨ Body does not move.

Unbalanced Forces:

If the resultant force of all the forces acting on a system or a body is not zero then the forces are called as balanced forces.



Example: Book is pushed from both sides, but one of them is greater than the other.

N.B.:

i) For unbalanced forces, resultant is greater than zero.

ii) Unbalanced forces produce non-zero acceleration.

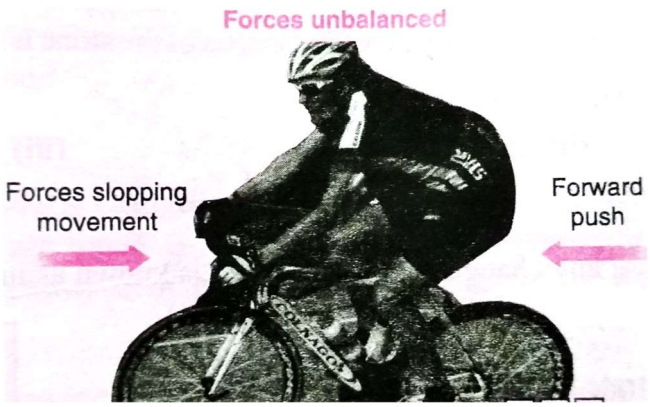
iii) Unbalanced forces may change all the effects previously mentioned.

If Force is unbalanced ⇨ Body starts moving.

Some examples of balanced and unbalanced forces:

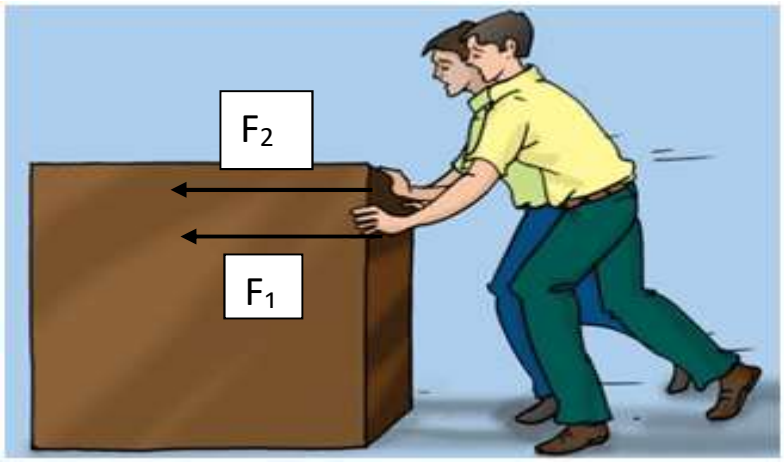
i) In a tug of war, two teams pull a rope in opposite directions. If neither of them win, then the forces are balanced. But if the rope moves in any direction i.e. a team wins, then the forces applied by both the teams are known as unbalanced forces.

ii) A bicycle will slow down if the rider stops pedalling it. This is because, when the rider stops pedalling, friction force stops the bicycle. So to keep the bicycle moving, the rider has to apply an unbalanced force on it.



Detailed Analysis of Balanced and Unbalanced forces:

Forces are applied from same direction:



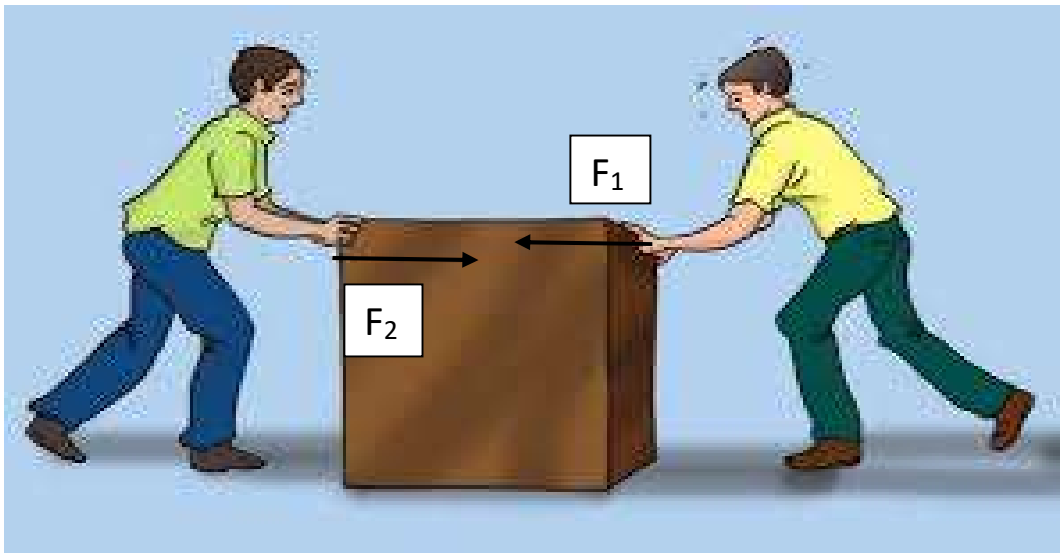
If two persons apply forces F_1 and F_2 on the block in the same direction, then the resultant force is the sum of these two forces.

Resultant force, $\mathbf{F = F_1 + F_2}$

Here, $\mathbf{F \neq 0}$,

Thus F is unbalanced and the block moves.

Forces are applied from two opposite directions:



Let us consider, two persons are applying two forces F_1 and F_2 from two opposite directions.

Now, the question is what happens to the block? Does it move or not? At this point, three different cases may arise. Let us see what possibilities are there.

- If $\mathbf{F_1 = F_2}$, then **F = 0 (Force is balanced).**
  Therefore, resultant force on the block is zero, and the block does not move.

- If $\mathbf{F_1 > F_2}$, then $\mathbf{F \neq 0}$ **(Force is unbalanced).**
  Therefore, resultant force on the block is not zero, and the block moves towards left.

- If $\mathbf{F_2 > F_1}$, then $\mathbf{F \neq 0}$ **(Force is unbalanced).**
  Therefore, resultant force on the block is not zero, and the block moves towards right.

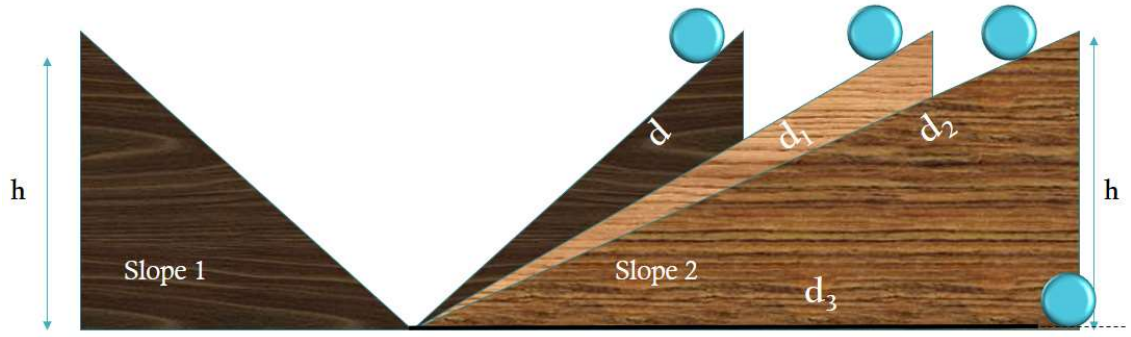
Galileo's Observation:

Background of the observation:

- Aristotle and other medieval thinkers believed that the natural state of bodies is the state of rest.
- Galileo opposed this idea and by the motion of a marble ball on an ideal frictionless wooden surface he performed an experiment and changed the concept

The Experiment:

- When the marble ball is released from left side plane, it rolls down the slope with increasing speed and goes up to the other side with decreasing speed to the same height (***h***) from which it was released. Say, in this case, the distance travelled by the ball along the slope 2 is ***d***.
- If the angle of inclination of the right side plane is gradually decreased, then the distance travelled by the ball increases (***d_1, d_2 etc.***) but it reaches to the same height (***h***).
- If the right side plane is made horizontal then the ball continues to roll forever trying to reach the same height (***h***) it was released from.



$d_3 > d_2 > d_1 > d$

Conclusion:

- Galileo suggested the idea that external unbalanced force is required to change the motion of the marble ball but no net force is needed to sustain the uniform motion of the ball.
- He, thus gave the famous principle of inertia. According to this principle, when no unbalanced force acts on a body moving with a constant velocity, then it continues in that state of motion.
- In practical situations it is difficult to achieve a zero unbalanced force since there is always a frictional force acting opposite to the direction of motion.

Application:

- This idea of Galileo helped Sir Isaac Newton to give his famous ***First law of Motion.***

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