When you push a friend on a swing, you are using a force. Pushing moves the swing in the direction of the push. The harder you push, the further the swing moves. Pulling things have a similar action. The harder you pull, the faster things move along.

Any kind of force is just a push or a pull.

Magnetism is a type of force. A magnet might pull an object towards it or push it away.

Types of Forces:

1. Contact Force.
2. Non-Contact Forces.

What is Force?

A push or a pull on an object is called force. Force has both magnitude and direction. The SI unit of force is newton. The motion imparted to objects is due to the action of a force.

Forces are due to an Interaction

At least two objects must interact for a force to come into play. Thus, an interaction of one object with another object results in a force between the two objects. More than one force may act on an object.

Exploring Forces

A force can change the state of motion of an object, i.e. a force can make a stationary body move; it can stop a moving body; it can change the speed of the moving body.

Forces in the same direction:

Forces applied on an object in the same direction add to one another. If two forces act on an object in the same direction, the net force is equal to the sum of the two forces. This always results in a stronger force than either of the individual forces alone.

Example: Two friends pushing a heavy load in the same direction.

Forces in the opposite direction

If two forces act in opposite directions on an object, the net force acting on it is the difference between the two forces.

Examples:

- Two friends pushing a heavy load in the opposite direction. The net force on an object is zero if the two forces acting on it in opposite directions are equal in magnitude.
- Kids playing friendly tug of war.

Magnitude and Direction of a Force

A force could be larger or smaller than another. The strength of a force is usually expressed by its magnitude. To completely define a force, we have to also specify the direction in which it acts. If the direction or the magnitude of the applied force changes, its effect also changes.

Important note

More than one force may be acting on an object. The effect on the object is due to the net force acting on it

Effect of Force

A Force can Change the State of Motion

A change in either the speed of an object, or its direction of motion, or both, is described as a change in its state of motion. A force may bring a change in the state of motion of an object.

Example: A fielder catches a cricket ball coming with a great speed and brings it to rest.

A Force can Change the Shape of an Object

A force on an object may change its shape.

Example: Pressing an inflated balloon by two hands compresses the balloon.

Types of Force

1. **Contact Force:** The forces which act on bodies when they are in physical contact are called the Contact forces.

Examples**:**

- Muscular force.
- Friction force.

1. **Non- Contact Force:** The forces experienced by bodies even without being physically touched, are called the Non-Contact Forces.

Examples:

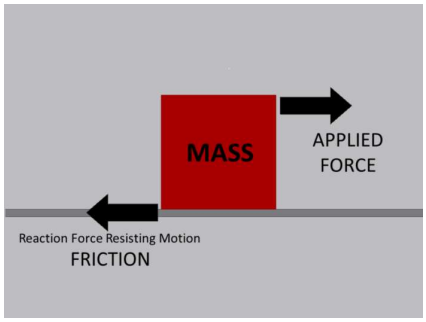
- Electrostatic force.
- Gravitational force.

- Magnetic force.

Muscular Force
The force resulting due to the action of muscles is known as muscular force. Muscular force can be applied only when it is in contact with an object.
Example: We pull a heavy load with the help of a rope. The contact is the piece of rope.
Friction
The force of friction acts whenever a surface moves over another; its direction is always opposite to the direction of motion.Force of friction arises due to contact between surfaces, it is also an example of a contact force
Example: A rolling ball comes to rest because of the force of friction acting on the ball.
Magnetic Force
A magnet can exert a force on another magnet without being in contact with it.
Example: Like poles of a pair of bar magnets repel each other and unlike poles of a pair of bar magnets attract each other.
Electrostatic Force
The force exerted by a charged body on another charged or uncharged body is known as electrostatic force. The force comes into play even when the bodies are not in contact.
Example: A straw rubbed with paper attracts another straw.
Gravitational Force
Every object in the universe, whether small or large, exerts a force on very another object. This force is known as the gravitational force. Objects or things fall towards the earth because it pulls them. This force is called the force of gravity or just gravity.
Example: An apple falling down from a tree.

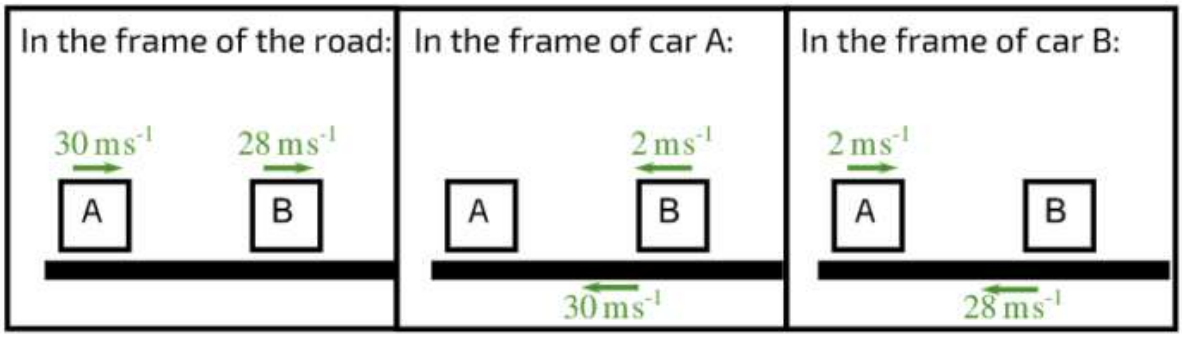
Friction force

- The external force that opposes relative motion between 2 surfaces in contact.
- Friction acts on the surface of contact of both the bodies



Relative motion

When one object moves relative to another it is called a relative motion.

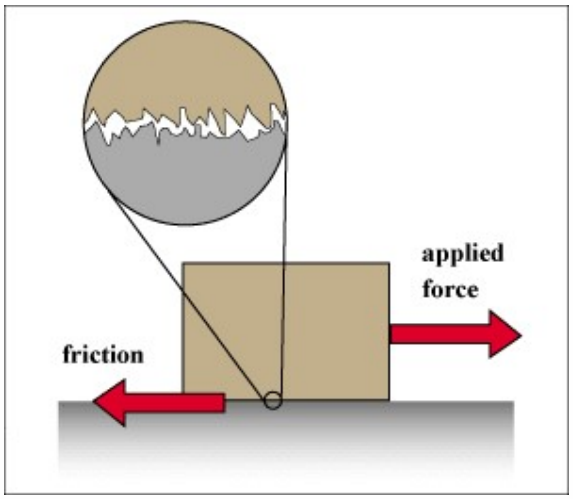


The reference frames of the road, car A, and car B

Why Friction?

Cause of friction

- Friction occurs due to surface irregularities of the two objects in contact.
- Adhesive forces between surfaces in contact.
- Plowing effect.



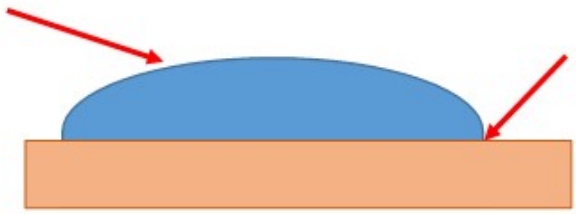
Surface irregularities

- All surfaces when zoomed into a microscopic level contain hills and valleys that interlock when they move or rub on top of each other.
    - This unevenness of the surface is called as surface irregularities or roughness.
    - Rough surfaces have larger irregularities while smoother surfaces have lesser irregularities.

Adhesive forces

- When two surfaces are in contact they start to form bonds and begin to stick to each other. This phenomenon is called as Adhesion.
- When we try to move objects that are on top of another, we are basically breaking the bonds or overcoming the adhesive forces.

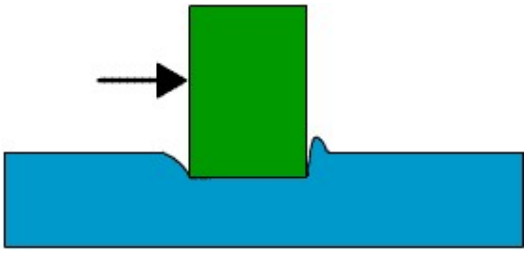
Cohesive forces is the attraction forces between the water molecules. This causes fluids to form round shapes where the molecules can be as closely packed together as possible.



Adhesive forces are the forces which attract the water molecules to other surfaces causing them to stick.

Plowing effect

- When surfaces are soft or can change their shape easily, they get deformed when they come in contact with another object. Ex: carpets, when a heavy object is placed on them, it looks like a valley that is caused by the deformation of the shape.
- This effect of the surfaces sinking into each other is known as Plowing effect.



Factors Affecting Friction

Factors affecting friction

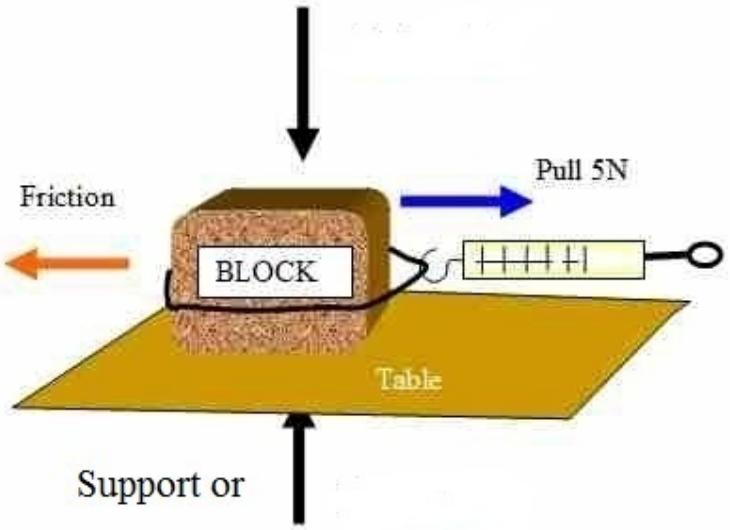
Depends on the nature of **surfaces** in contact. (Friction exists between two surfaces) E.g.: glass and rubber

Nature of surface in contact

- Friction depends on how hard the two surfaces pressed together, as more surface in contact and more bonds are formed→ more bonds to break → means more friction.
- Only the normal reaction force (exactly perpendicular) to the two surfaces increases friction.

Calculating frictional force using a spring balance

- Using a spring balance we can find the frictional forces opposed by different materials.
- Sandpaper gives a higher reading as compared to stainless steel.



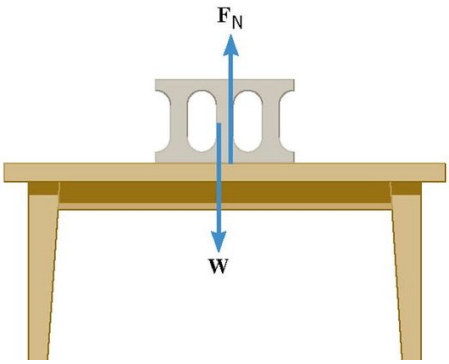
Polishing surfaces in contact to change friction

- Polishing surface reduces irregularities and therefore makes the surface smooth.
- Reduces friction.

Normal reaction force

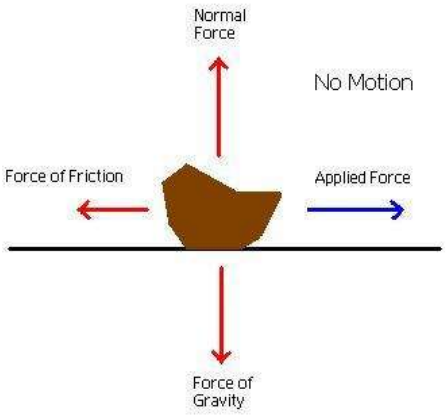
- Force applied that is exactly perpendicular to the surfaces in contact is called normal reaction force.
- It increases the frictional force.

Here, the normal reaction force and weight cancel



Static Friction

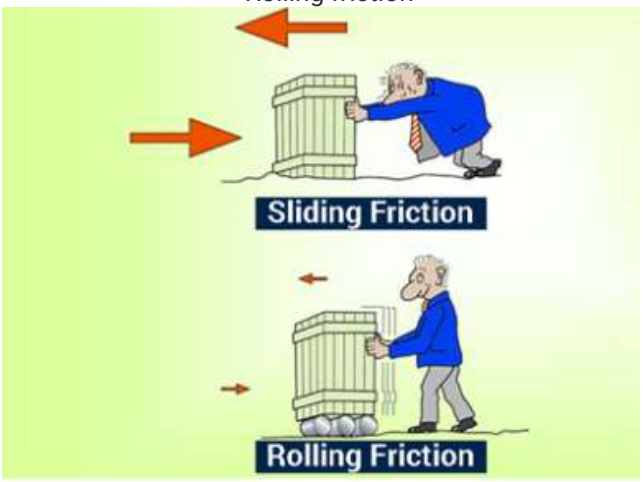
Friction due to a body at rest with the surface in contact is called as Static friction.



Kinetic Friction

- The friction that comes into play when objects are in motion is called as kinetic friction.
- Kinetic friction:

* Sliding
* Rolling friction



Friction a Frenemy?

How does friction produce heat?

As friction involves breaking bonds, they make the particles vibrate → increase kinetic energy and therefore increase heat.

Applications of friction

Writing, walking, running, tyres on a car, a nail stays in the wall due to friction, usage of a matchstick.

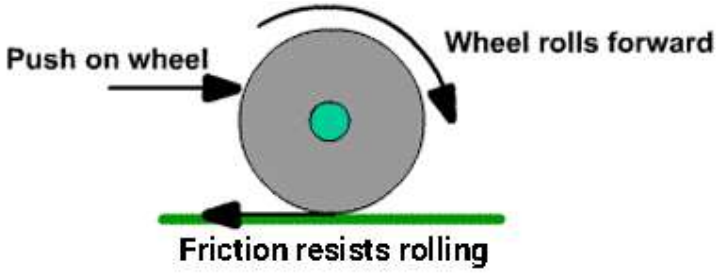
Reinvent the Wheel

Rolling and using treads to change friction

- Using ball bearings reduces friction as rolling friction is< other types of friction.
- Treads on tyres help expunge water and give better grip, by increasing friction.

Rolling friction

- Rolling provides less friction as compared to sliding.
- Rolling friction < Sliding friction.
- Machines use ball bearings to reduce the friction of moving parts.



Skydiving Cat

Drag force

- Frictional force exerted by fluids is called drag.
- The drag force on an object depends on speed as well as the shape of the body and nature of the fluid.