

## FRICION CLASS 8

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Friction is one of the contact forces that arise when two surfaces (bodies) come in contact, with one another and it resists the motion of one body over another by acting in a direction opposite to the motion of the body.

So it either slows down a moving body or prevents stationary objects from moving.

### Causes of Friction

1. When 2 surfaces come in contact, their surfaces may look smooth, but actually have a lot of irregularities (i.e. they have a lot of depression & elevations).
2. When a surface tries to move on another surface, these irregularities of both get interlocked with one another.
3. This is what opposes the motion of a body trying to move & gives rise to friction.

Friction can exist between:-

- a. Solid – Solid surface- called dry friction
- b. Solid – Liquid surface- called fluid friction
- c. Solid – Gas surface- this is also called fluid friction

NOTE: Friction force has –

**Direction** : It opposes the direction of motion.

**Magnitude** : It has magnitude & is measured in Newton.

Friction acts in a direction parallel to the surface.

## Factors Affecting Friction

1. Friction depends on the nature of the surface in contact. Smooth Vs. Rough  
i.e. – If the surface in contact is rough then the frictional force acting on it will also be large & vice versa. This is because the rough surface will have larger number of irregularities than a smooth surface.  
If the surface in contact is slippery then friction becomes less.
2. Friction depends on the mass of the moving body.  
i.e. – The greater the mass of the body being moved, the greater will be its load on the other body, the greater will be the interlocking of irregularities & so greater will be the opposition by friction.

## **Friction therefore,**

1. Acts in a direction opposite to the direction of the motion.
2. Depends on the nature of surface in contact.
3. Depends on the mass of the body. The mass of the moving body decides how hard the two surfaces press each other.

NOTE: Friction does not depend upon the amount of surface area in contact between the bodies.

So, This means that even if you have two heavy objects of the same mass, where one is half as long and twice as high as the other one, they still experience the same **frictional** force when you drag them over the ground.

## Some types of Friction

1. Static Friction
2. Limiting Friction
3. Sliding Friction
4. Rolling Friction

## 1. Static Friction

- a. Static friction is the friction that arises when 2 or more objects are not moving (or are at rest), relative to one another.
- b. This static friction force varies from zero to the value where the body just begins to move.
- c. It keeps on increasing when the force applied on the body is increased.
- d. This static friction force must be overcome by the applied force for an object to move.
- e. The moment a static body starts moving, the static friction gets converted to moving friction also known as Kinetic Friction.

**Example:** Static frictional force is the one that prevents a car's wheel from slipping as the wheel rolls on the ground. Even though the wheel is in motion, the patch of the tyre in contact with the ground is stationary, relative to the ground.

## 2. Limiting Friction

The maximum amount of static friction when the motion is just impending (or about to happen) is called limiting friction.

So limiting friction is the maximum friction that balances the force applied to a body resting on a solid surface so that the body does not move.

### **Example:**

- A. When we put a heavy brick on a table and tie it with a spring balance and pull it slowly towards us, the brick does not move.
- B. This is therefore a static frictional force equal to the force applied by us, is balanced out & the brick does not move, So the reading in the spring balance is equal to static frictional force acting on it.
- C. When we keep increasing the force, a point is reached when the body is just able to move. This force is the maximum value of static friction or the limiting friction.

D. When this limiting friction is crossed and the applied force by us is exceeds the limiting friction, the brick begins to move. The friction now acting on it is called sliding friction.

### 3. Sliding Friction

- A. The friction acting on a body when it is sliding over a surface with a constant speed is called Sliding Friction.
- B. The force required to keep the body moving with the same speed gives the measure of the sliding friction.

#### **Example:**

- a. Opening the sliding doors of a balcony.
- b. Lighting a match stick.
- c. Pushing an eraser across a desk.
- d. Rubbing your palm together.

### **COMPARISON BETWEEN STATIC AND SLIDING FRICTION**

- Static friction is more than Sliding Friction.
- This is because when a body is at rest and needs to be moved, it requires a greater force to be moved from its stage of rest. However, once it gets initiated and starts moving a little force is needed to keep it moving.
- This is also because when it starts sliding, the irregularities on its surface are not able to get enough time so as to lock with those on the surface where it was kept. So, the sliding frictional force that acts on the body is slightly smaller than static frictional force that was acting earlier on it.

Hence friction force being less for now; the box moves.

→ Sliding Friction < Static friction.

#### 4. Rolling Friction

- a. When a body rolls on a surface, the force resisting the motion is learned as rolling friction.
- b. The action of rolling reduces the friction to a great extent and here makes the movement of an object easier.
- c. It also prolongs the life of the moving parts.

#### **Example:**

We see that it is difficult to drag or push a suitcase along a path, but when wheels are attached to it, the frictional force exerted by the surface on the wheels decreases & hence it becomes very easy to move the suitcase.

So we see that Rolling friction is < Sliding friction.

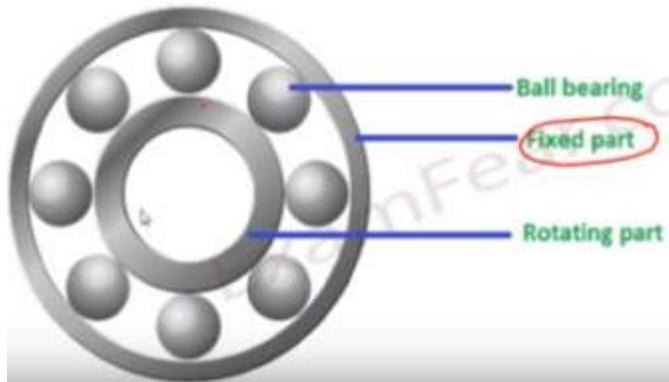
Therefore, Rolling Friction < Sliding Friction < Static Friction.

#### **NOTE:**

#### **Ball Bearings:**

1. The ball bearings or roller bearings are used in machinery like axles of ceiling fans, bicycles etc. in order to reduce friction and to move one item over another without excess wear and tear.
2. The steel balls are placed between a smooth outer (hub) & inner (like an axle) surface which are required to move together in a circular motion. The ball bearings inside the hub produce less friction and allow the hub to roll around the axle instead of rubbing against it. Rolling produces less friction

than rubbing & so this makes spinning easier, faster & with minimum wear and tear.



The outer part is the fixed part and the inner wheel is the rotating part. If the rotating part is made to move directly on the fixed part then the lot of friction will occur and a lot of heat and energy would be lost. So wheels are added between the two parts.

As the inner part moves, the balls will start rolling on the two parts. This will make movement easier by reducing friction to a very little amount.

### Advantages of Friction

1. Friction enables us to walk easily. Friction between the ground and our foot helps us to grip the ground with one foot and put the other foot forward. Since, water, oil, reduce friction, therefore we tend to slip on such a floor.
2. It helps to stop a moving object, start / stop an object (or a vehicle)
3. Matchsticks lit up because of striking them against rough surfaces.
4. We are able to write on paper because of friction between pen and pencil and the paper.
5. Friction holds the nails and screws into walls or wood firmly.
6. Brakes of vehicles like cars and cycles work due to friction. When brakes are applied, the brake shoes / pads arrest the rotating drum or disk due to friction. This then reduces or stops the wheel.
7. It also helps in grinding in a mixer

## Disadvantages of Friction

1. **Friction opposes motion:** It makes moving or sliding of heavy objects difficult. A lot of energy is utilized in overcoming it.
2. **Friction results in wear & tear:** Objects like tyres of vehicles, soles of shoes, moving parts of machines etc. wear out with time due to constant action of friction.
3. **Friction causes heat:** It produces heat. E.g. the moving parts of machinery produce a lot of heat which gets lost & wasted in the surroundings.

**Example:** When a mixer grinder is run continuously, due to friction, a part of the electrical energy is converted into heat. This heat cannot be used by the mixer grinder and hence lost.

### **Q. Why is friction a necessary evil?**

**Ans.** Though friction is a evil, since it:-

- Opposes motion
- Causes wear & tear
- Produces heat & hence wastage of valuable energy;

it still is very necessary for carrying out our life smoothly. This is because of various advantages that it has. A few being that:-

- a. It allows smooth movement of tyres, machinery in braking mechanisms etc.
- b. Hammering of nails & screws into walls or wood.
- c. Basic work like that of lighting a matchstick etc.

Since, we see that though disadvantages & evil, friction is an evil we cannot live without. Hence, it is a necessary evil in our lives.

## Ways to increase friction

One way to increase friction is to make the surface is rough.

- A. Brake shoes are used in automobiles to increase friction.
- B. The soles in our shoes are grooved. This gives the shoes a better grip on the ground so that movement becomes easy.
- C. The tyres of cars, buses, trucks etc are treaded. These uneven and rough treads help in increasing the friction between the tyre and the road providing it with a better grip.
- D. Sand and gravel is thrown on slippery ground during rainy season because this leads to increase in friction. This therefore avoids people slipping on the wet / slippery floor.
- E. Spikes are provided in the soles of shoes used by players and athletes to increase friction so that they get a firm grip on the ground.
- F. Gymnasts apply a coarse substance on their hands to improve their grip.

## Ways to decrease friction

- A. **Smoothing / polishing a surface** - While playing games like carom, boric acid powder is sprinkled on the board which helps to smoother the surface and reduces the friction between the striker / coins and the board.
- B. **Lubrication** –
  - a. Coating the moving parts of machinery with grease, oil etc. reduces friction. This is because the lubricant between the two surfaces helps to cover the irregularities on their surfaces and thereby reduces friction between them and makes move smoothly.  
It not only minimizing the friction between moving parts but also prolongs the life of the machine.
  - b. In some machines where it is not advisable to use lubricants, the friction is reduced by providing an air cushion between the parts.

- c. **Ball Bearing** - Since rolling friction is less than sliding friction, ball bearings or roller bearings are used between machines parts to reduce friction. For example: Wheels in vehicles have ball bearings, luggage is also fitted with wheels, since it becomes easy to roll the luggage on the floor instead of carrying or sliding it.
- d. **Streamlining** - Fluids such as water and air also exert friction on objects moving through them. This frictional force that fluids (liquids or gases) exert on object is called Drag. This friction or drag depends upon the nature of the fluid, the shape of the object moving in it and the speed of the object with respect to the fluid. Hence, to reduce this friction bodies are given a streamline shape, since this shape reduces the friction. Various objects like aeroplanes have a specific shape so that they are able to reduce air friction when they are travelling in air. Ships also have streamline shapes to reduce friction with water.

NOTE: Friction can be minimized but it cannot be entirely eliminated. Even a perfectly smooth looking surface will have some irregularities.

### **Fluid Friction**

1. Liquids and gases are commonly known as fluids.
2. These fluids (both liquids & gases) also exert a frictional force on objects moving through them. This frictional force exerted by fluids is called **Drag**.
3. This frictional force depends on:
  - i. the nature of the fluid (for ex. Viscosity and density of fluid – It is easier to move an object through air than through water because air has less density than water),
  - ii. the shape of the object (and its surface area)that is moving through it &
  - iii. also on the speed of the object with respect to the fluid.

4. Since valuable energy is spent in overcoming this friction, therefore efforts are made to minimize it.
5. Nature has given birds & fishes aerodynamic or stream lined shape to move in air & water. Humans have designed aeroplanes, ships and cars to have aerodynamic or stream lined shape so that they have to overcome less fluid friction.

This minimizes friction & saves a lot of fuel that would have otherwise been used to overcome fluid friction.