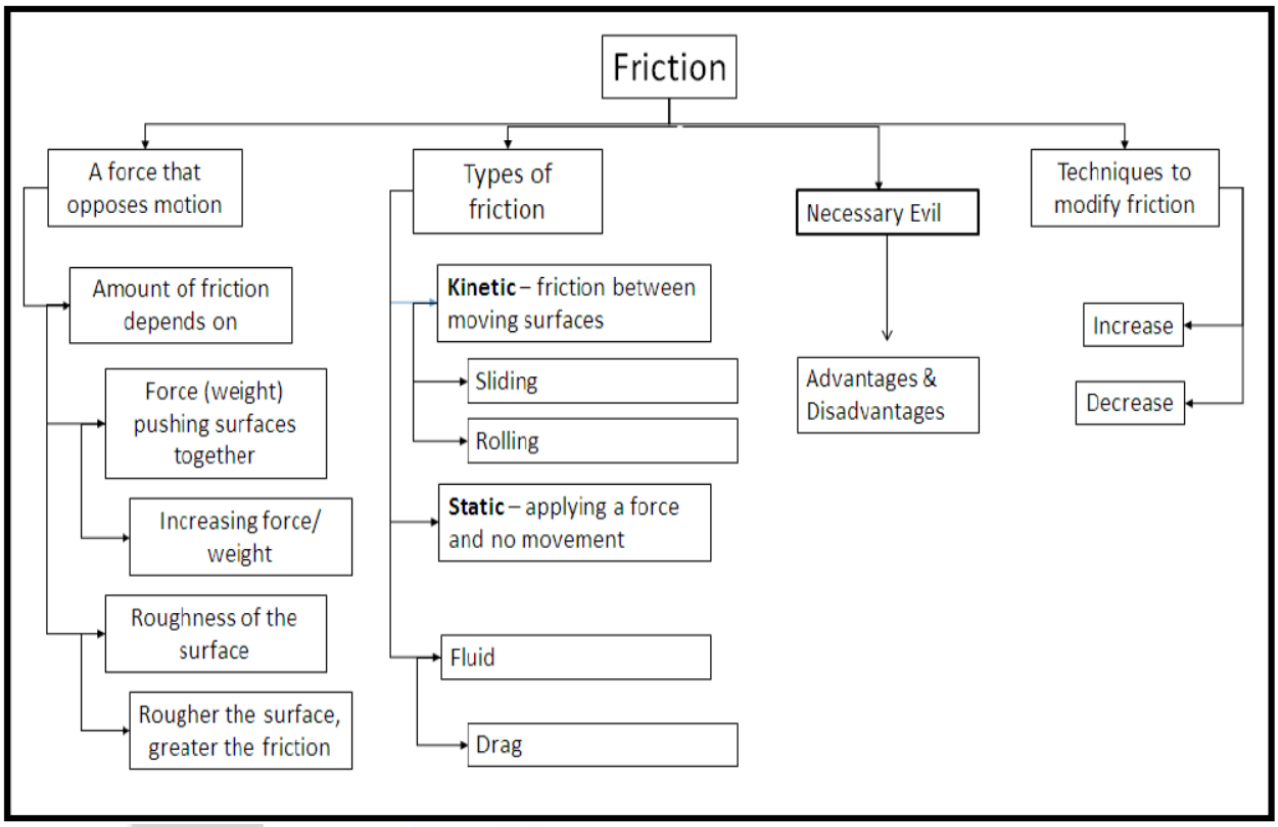
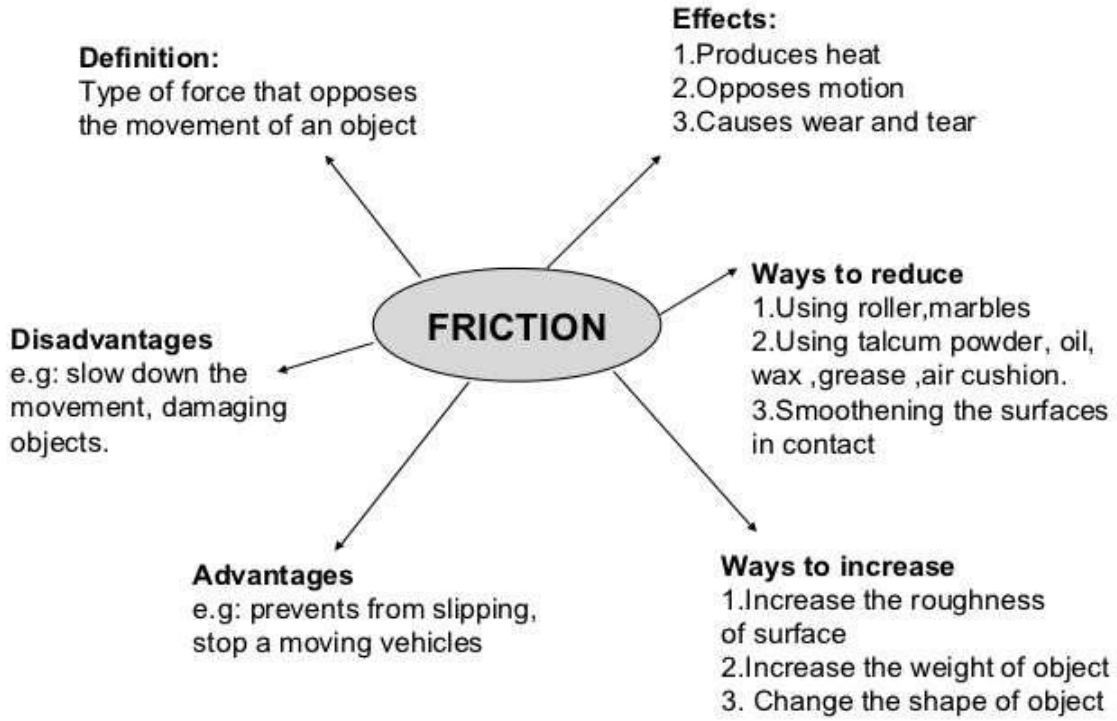
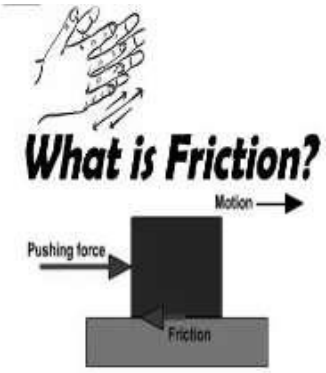
MIND MAP - FRICTION





1. WHAT IS FORCE OF FRICTION?



- A body moving uniformly along a straight line would continue to do so unless an external force is applied on it. But, in practice, we see things otherwise. For example, a ball rolling over the floor stops after some time. Similarly, when we stop paddling our bicycle, it comes to rest after some time. All these everyday examples show that there is some invisible force that opposes the motion of one body over another. **This opposing force is called 'Friction'.**
- Again, when we apply a small force on a block, it does not move. The applied force, in this case, must have been **balanced by an opposing force of friction**. Thus, force of friction comes into play even when one body tries to move over the surface of the other.
- **Magnitude of friction** is not constant; it always adjusts itself so as to be equal to the applied force and opposite in direction to the direction of the applied force. For e.g. , If you keep a pencil box on a table and try to move it with your finger and it does not move, this is because the table opposes your effort.

  Hence, we may define that:

Friction is an opposing force that comes into play when one body actually moves (slides or rolls) or even tries to move over the surface of another body.

1.1 Properties/Effects of force of friction

a) Friction comes into play between two surfaces in contact whether they are in relative motion or not with respect to each other.

b) When contacting surfaces move relative to each other, the friction between the two objects converts kinetic energy into thermal energy, or heat.

c) If the two surfaces in contact are smooth, friction is very small. If the surfaces are rough, friction is large.

d) In case one body slips over another body, the force of friction acts in a direction opposite to the direction of slipping. For example, if a book slides across the surface of a desk, then the desk exerts a friction of force in the opposite direction of its motion.

e) It causes wear and tear of the two surfaces in contact.

Advantage	Associated evil
Writing with pencil	Curbing/Shortening of pencil lead
Walking on road	Wearing out of shoe sole
Applying brake pads in brake system	Wear and tear of brake system

2. FACTORS AFFECTING FRICTION

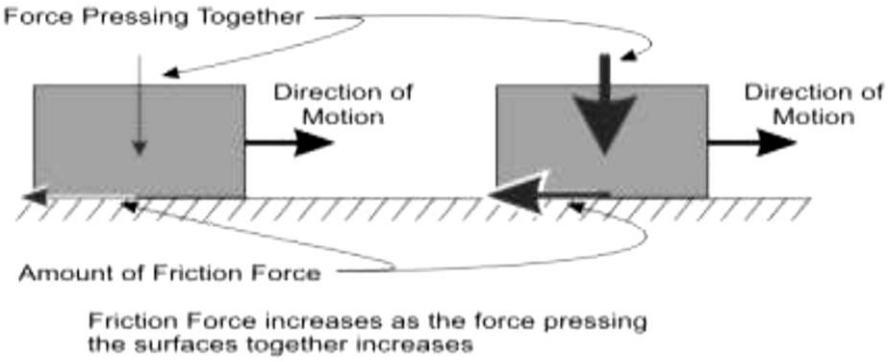
2.1 Nature of the surface in contact

(Smoothness or roughness of the two surfaces)

More the roughness of a surface, larger is the number of irregularities on its Surface & hence greater will be the friction.

2.2 On a horizontal surface, the force of friction is directly proportional to the weight of the body which moves.

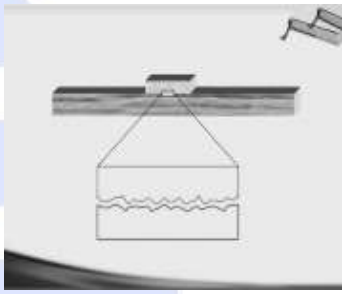
Pressing together two surfaces of objects with a greater force will increase the interlocking in the two surfaces & hence increase the friction.



Friction Force increases as the force pressing the surfaces together increases

2.3 Cause of friction

2.3.1 Due to interlocking of surfaces



No surface is perfectly smooth. Roughness of the surfaces is the cause of friction. A surface which appears to be very smooth to the naked eye is found to have irregularities (roughness) when seen through a powerful microscope. This is true for every surface. When two bodies are in contact with each other, the irregularities in the surface of one body get interlocked in the irregularities of the other surface. To move one body on the surface of the other, these inter locking have to be overcome; hence some force has to be applied. This applied force is a measure of friction between the two surfaces in contact.

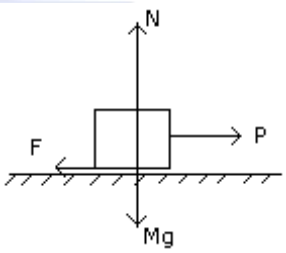
2.3.2 Types of friction

We may classify friction into 3 types:

(i) Static friction

(ii) Sliding friction

(iii) Rolling friction.



If we apply a force (P), acting to the right, the block remains stationary if P is not too large. The force that counteracts P and keeps the block at rest is called frictional force (F).

2.3.2.1 Static Friction

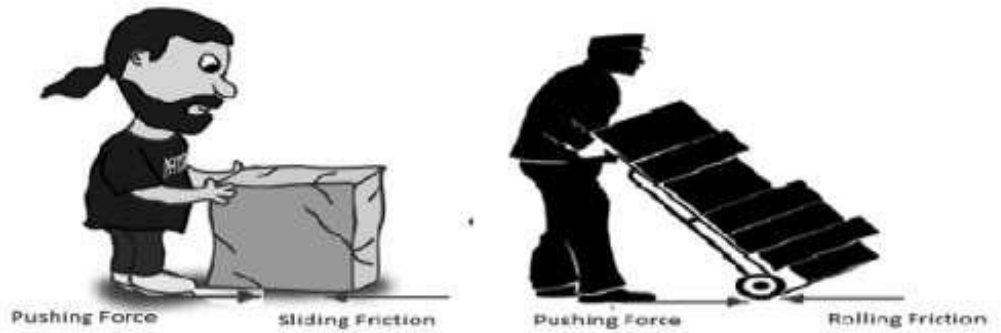
If we keep on increasing the force, the block will remain at rest and for a particular value of applied force; the body comes to state of “about to move”. The opposing force that comes into play when one body tends to move over the surface of another, when the actual motion has yet not started is called **static friction**. Static friction must be overcome before an object can be set in motion.

As we increase the applied force, a stage comes when the body is just at the verge of moving over the other. The **static friction** at this stage is obviously **maximum**. This maximum value of static friction is called **limiting friction**.

2.3.2.2 Sliding Friction

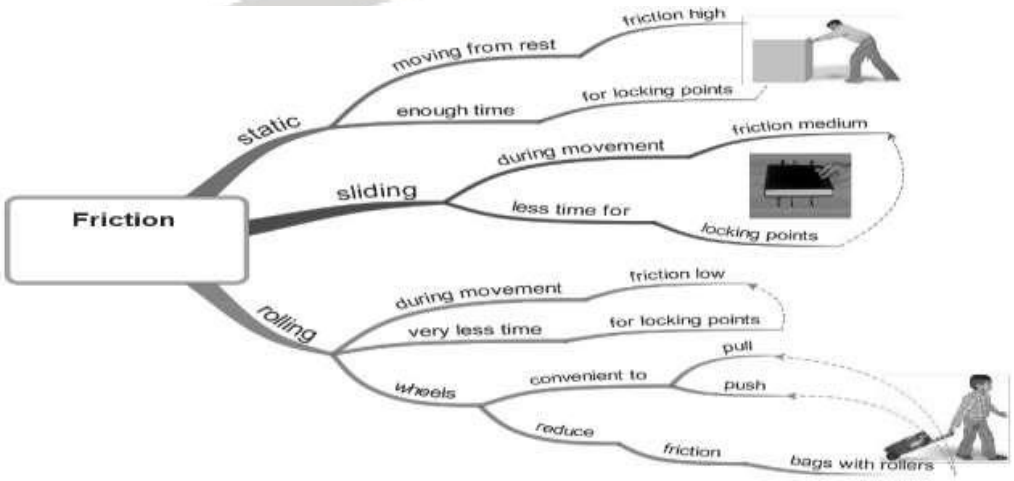
The opposing force that comes into play when one body is actually sliding over the surface of another body is called sliding friction.

- Thus it comes into play when an object is sliding (moving slowly but continuously) over another object
- Sliding friction is **smaller** than maximum value of static friction because it is easier to keep an object moving which is already in motion than to move the same object from rest.



Pushing the load manually. Slicing Friction between the surface and object

Using trolleys with wheels to move the load. Rolling friction eases the movement



2.3.2.3 Rolling Friction

The opposing force that comes into play when one body is actually rolling over the surface of another body is called rolling friction. It is much smaller than sliding friction except for special cases like ice skating. Whenever possible, sliding friction is replaced by rolling friction .This is achieved by using wheels, ball bearing, roller bearing etc.

Thus we can conclude:

Rolling friction < Sliding friction < Static friction

3. FRICTION: A NECESSARY EVIL

Friction plays dual role in our life. It impedes the motion of object, causes abrasion and wear, and converts other form of energy into heat. On the other hand, without it we could not walk, drive cars, climb ropes, or use nails.

Friction is necessary because if there is no friction between any two surfaces in contact, then

3.1 Movement of vehicles

It makes the wheels of buses, cars, two wheelers, etc., to grip the road and prevent the vehicle from skidding.

3.2 Helps us to walk

Friction enables us to walk. This is because the friction between the sole and the ground prevents us from skidding.

It is hard to walk on ice because the smooth surface of the ice products less friction than a road.

3.3 Writing work

Friction helps us to write on paper, blackboard, etc.

3.4 Application of brakes

Brakes increase friction between the road and the wheel.

3.5 Lighting of a matchstick

It is due to friction that we can light up a candle using matchstick. So friction is necessary.

Friction is considered as evil because it has certain disadvantages like:

3.6 Wear and tear

Friction wears out the rubbing surfaces like screws and ball bearings of machines or soles of shoes.

3.7 Wastage of energy

The objects in contact require more force to overcome friction between their rubbing surfaces. This results in wastage of energy.

3.8 Damage to the machine

Friction generates heat. This heat raises the temperature of a machine, sometimes causing damages to its parts. Hence, proper arrangements have to be made to keep the machine cool.

4. METHODS TO INCREASE FRICTION

4.1 By making rough surface

We can increase the friction by making the surface rough. Tyres of the vehicles are treaded to prevent skidding.

- Spikes are provided in the shoes of players and athletes.
- Gymnasts apply some coarse substance on their hands for better grip.
- Grooves are made in the soles of shoes to prevent slipping.
- Wet and snow covered roads are dusted with sand or salt to increase friction.

4.2 By increasing the mass of the object:

More is the weight, more will be interlocking. Hence friction will increase.

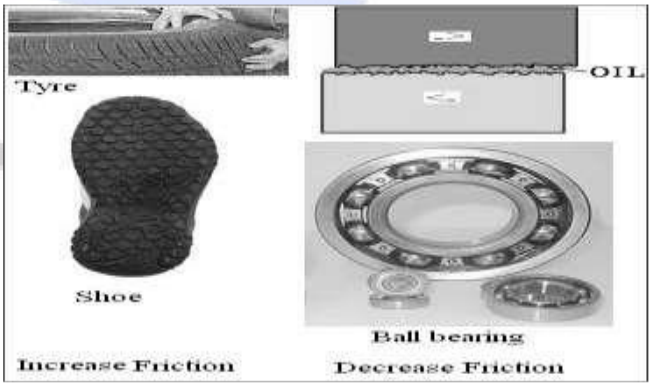
5. METHODS TO REDUCE FRICTION

5.1 Polishing a surface

When surfaces are highly polished, the irregularities of surface are covered, making them smoother. Hence friction is greatly reduced.

5.2 By using ball bearing

In machines and bicycles ball bearings are used to reduce friction between a wheel and its axle. As the wheel turns, the ball bearings turn around and prevent the wheel and axle from rubbing against each other.



5.3 By using rollers and wheels:

Devices such as tyres, ball bearings or rollers can change sliding friction into a much smaller type of rolling friction.

5.4 By streamlining

The bodies of boats and ships are streamlined to reduce water friction.

5.5 By lubricating

A common way to reduce friction is by using a lubricant, such as oil, water, or grease, which is placed between the two surfaces.

Graphite: Graphite is very soft and can be ground to a very fine state. It is then used as a lubricant in those parts of machinery, where oil cannot be applied.

6. FLUID FRICTION

(Friction due to liquids and gases)

- The friction exhibited whenever an object moves through a fluid (water or air) is called fluid friction. The liquids and gases exert lesser friction as compared to solid surface.
- Fluid friction reduces the speed of the moving objects and results in loss of energy of the body in overcoming the fluid friction.
- Air exerts frictional force on cars, bus, aeroplane, birds etc.
- Water exerts frictional force on objects like bats, ships, submarines, fish etc.
- **The frictional force exerted by a fluid (air/water) is called drag.**

The magnitude of drag depends on

(i) speed of the object moving through the fluid

(ii) shape of the object

(iii) nature of the fluid

6.1 Minimizing Drag

- Giving special shapes like streamlined shape to objects. For e.g. an aeroplane, boats etc. are made streamlined to minimize the force of friction with the medium they travel.
- Meteors burn out after entering earth"s atmosphere because of the friction due to air. The meteors enter the earth"s atmosphere at very high speeds, the friction due to air is large and hence temperature of meteors increases thus burning it.

7. ACTIVITY

MEASURING FRICTION USING SPRING BALANCE

Aim: To demonstrate the force of friction by pulling brick (any object) with the help of a spring balance.

Material required: An object (brick), a string, a spring balance, polythene bag.

Procedure:

Take an object and tie a string around it. Take a spring balance and pull the brick with it. When the brick just begins to move, note down the reading. This reading will give a measure of the force of friction between the surface of the brick and the floor.

Conclusion: Force of friction can be measured by using spring balance.