

# Force, Work & Energy

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**Introduction:** In our daily life, we apply force on many objects, due to which the objects change their position or shape.

Eg: When a football is kicked, it moves. When we throw or smash a fully inflated balloon in between our palms, it breaks. When a cricket fielder catches the ball, it stops. In this chapter, we will study about force and its characteristics.



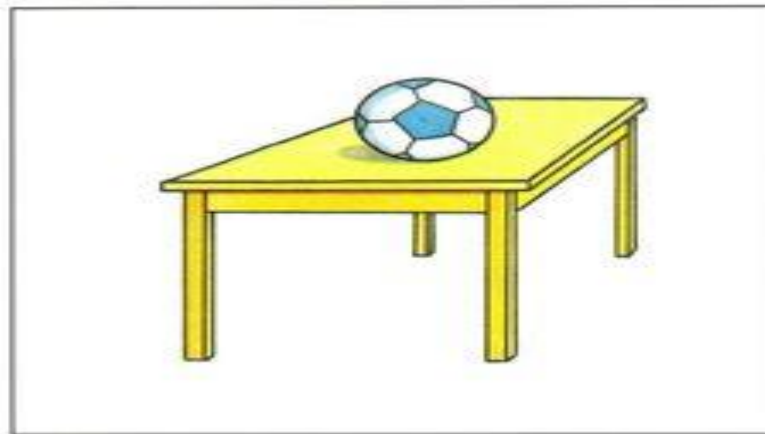
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## What causes motion?

Movement of object from one position to another is called Motion.

Eg: In case of a ball on the table, only when we apply little push or pull the ball comes into motion otherwise it remains at rest as shown in the figure below.



## Let's understand push & pull:

A **push** or a **pull** on an object is called a **Force**.

**Push** refers to the force which tends to '**move the object away**' from the direction of the force applied.

**Pull** refers to that force which tends to '**move the object towards**' the direction of the force applied.

Examples of Push:

- (i) Pushing a door open      (ii) Man pushing his luggage trolley      (iii) Man hitting a golf ball

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Examples of Pull:

(i) Opening the drawers (ii) Child pulling a wagon



As we can see in all of the above cases, two or more objects must interact for force to come into play. In the case of man pushing his luggage trolley, there is an interaction between the man and his trolley. The man is applying a 'push' on his trolley to make it move forward. In the case of the opening/pulling drawers, there is an interaction between the man and the drawer. The man is applying force to pull the drawer.

**Definition of force:**

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Force is a push or pull that can change the state of motion of an object or change its shape.



Let's consider the following sequence of events:

1. A cricket ball is initially at rest.
2. The bowler picks it up and bowls it towards the batsman.
3. The batsman hits it with the bat.

Subsequently, any of the following events could happen.

- a) The batsman hit the ball very hard such that it goes for flying in the air for a six.
- b) The batsman hits the ball such that it goes for a four along the ground.
- c) The batsman hits the ball and the bowler catches it.
- d) The batsman hits a defense shot such that it rolls on the ground for a short distance and stops.

Now from (1) to (2), the ball has changed its speed. Initially, the speed was  $0$  m/s (at rest) and then the bowler flings it. So, now it moves with a certain speed. When

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the batsman hits the ball, according to the force applied on the ball, the direction or speed or both change. Any one of the events (a),(b),(c),(d) occurs. When the strike is very hard and upwards, it goes for a six (a). When the strike is reasonably hard and along the ground, it goes for a four (b). When the bowler catches it (c), the bowler has applied a force on it to stop it. When the force of the batsman is very weak, the ball rolls on the ground and eventually stops.

## Force can change the shape of an object in some cases.

When making rotis from kneaded dough. While squeezing orange we can see the force applied on the orange will change its shape.



From the above discussion, we can summarize that Force can have any or all of the following effects on the object on which it is applied.

## Effects of force:

- Force can change the speed of an object (Batsman hitting a ball very hard)
- Force can change the direction of motion of an object (Batsman hitting a ball very hard)

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- Force can change the shape of an object. (When an elastic is pulled hard, it breaks)
- Force can move an object from rest to a state of motion (Bowler picking up a ball and then bowling it)

## Types of forces:

**Contact forces:** Force that arises with the contact of 2 or more objects involved.

**Examples:** Muscular force and Frictional Force

**Muscular force** is the type of force wherein we use our **physical strength** to change the state of motion of an object.

**Eg:** Man pushing a car, Tug of war, Cycling, Weight Lifting



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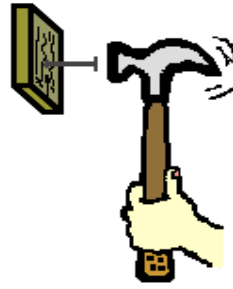
The rope may not move if the two teams pull at it with equal force

## Mechanical force:

- ✓ The force exerted by a **machine** is called mechanical force
- ✓ The force produced by a pair of scissors, the force applied on the nail by a hammer and the force produced by the engine of a car are some examples

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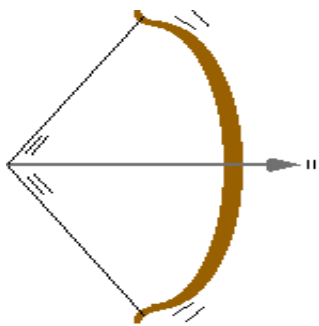


## Elastic force:

Elastic force occurs when a material is stretched or compressed.

The stretching force produced by the stretched string of a bow causes the arrow in contact with it to move forward at great speed.

Eg: catapult



**Non-contact forces:** Forces that arise without the contact of 2 or more objects involved.

**Examples:** Magnetic Force, Electrostatic Force, Gravitational force.

## Gravitational force:

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The force with which the **Earth pulls all objects towards itself** is called gravitational force.

When you throw a ball upwards, why does it come back to the ground?

Why don't the ripe fruits that fall from the tree float in the air?



When a ball is thrown up, it falls to the ground because of gravitational force. The fruit from a tree always falls downwards because of gravitational force.

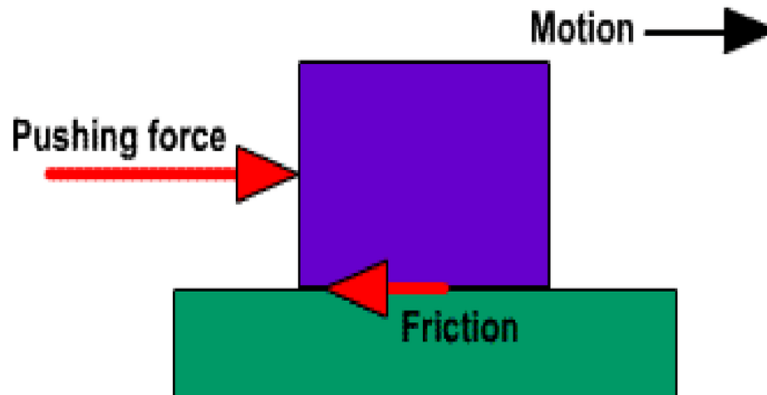
## Frictional force:

- (1) The force that opposes the motion of an object by acting opposite to the direction of the applied force is called **frictional force**.



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(2) It leads to generation of heat as two surfaces come in contact with each other.

For example, when we rub our hands together, heat is produced as a result of friction between our hands.

What kind of force is formed when you rub your hands?



**Friction force**

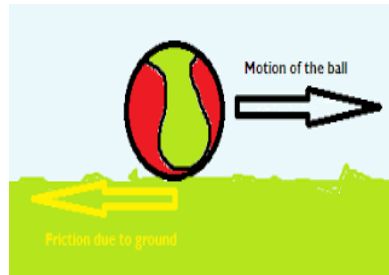
(3) Frictional force also leads to wear and tear of the surfaces of objects that come in contact with each other.

## Examples of frictional force:

What happens when you kick a foot ball?

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It moves some distance and then stops.

**Why does the ball stop?**

The ball stops due to a force applied by the ground in the opposite direction of the movement of the ball. This force is nothing but the Frictional force.

Similarly, a bicycle gradually comes to a halt when we stop pedaling it.

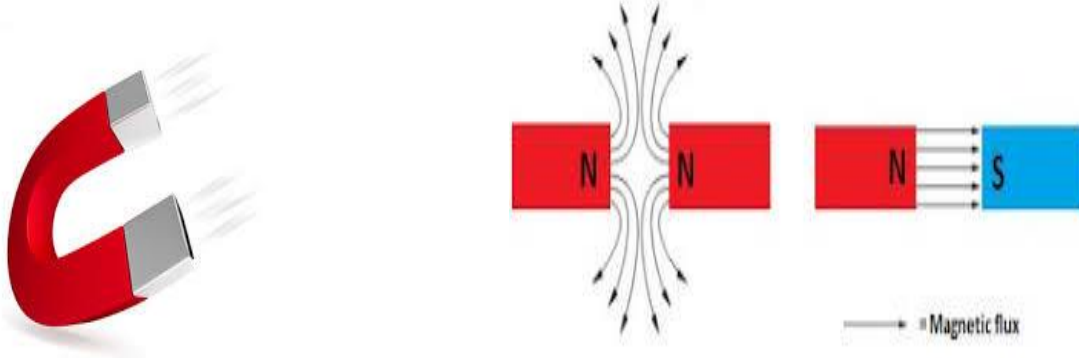


## Magnetic force:

- ✓ The force exerted by any magnetic object is called **magnetic force**.

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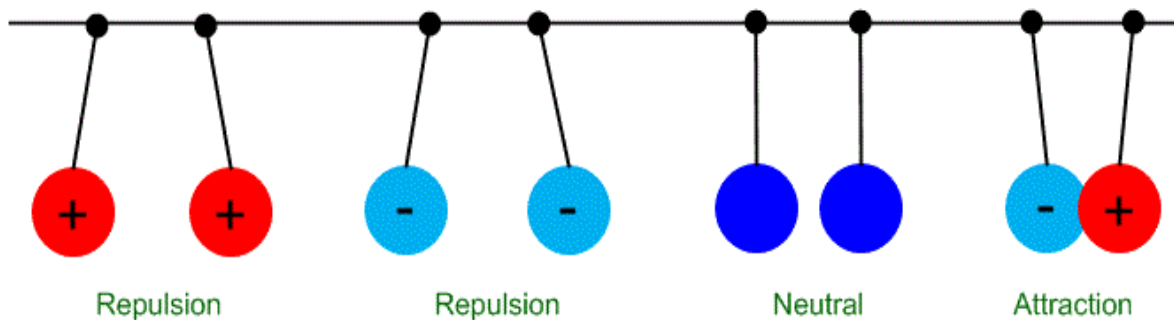
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- ✓ We know that like magnetic poles always repel each other, that is, they push each other away.
- ✓ Also, opposite magnetic poles always attract each other, that is, they pull each other towards themselves.

## Electrostatic force:

- ✓ The force exerted by a **charged particle** is called **electrostatic force**.



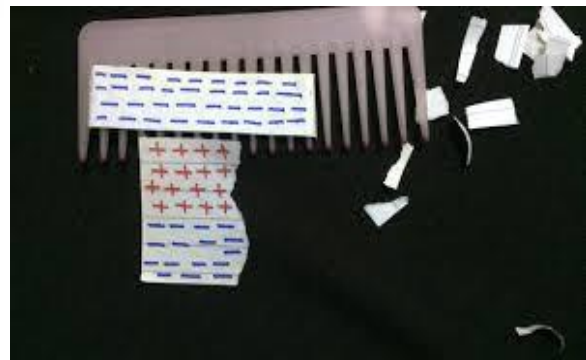
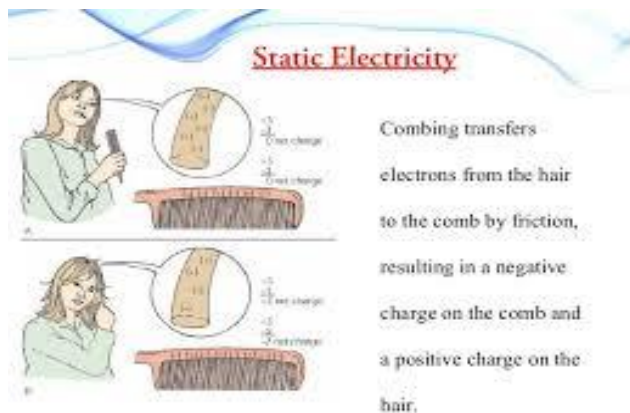
- ✓ We know that like charges always repel or push each other away.
- ✓ Similarly, opposite charges always attract or pull each other towards themselves.

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## Examples of Electrostatic force:

Take a comb and brush it on a dry hair 3-4 times and then take it near some small bits of paper. Do not touch the comb with the paper. The bits of paper would get attracted to the comb. This is because the comb is charged because of the rubbing on your hair and it attracts uncharged objects like paper.



## Work:

- ✓ When you pull a chair, pick up your book or throw a ball, you do work. It means whenever we apply **force on an object and it moves, we do some work.**

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- ✓ But even after applying force, if we are unable to move the object, the work done is **zero**. For example, when we push a wall, the wall doesn't move and hence the work done is zero.

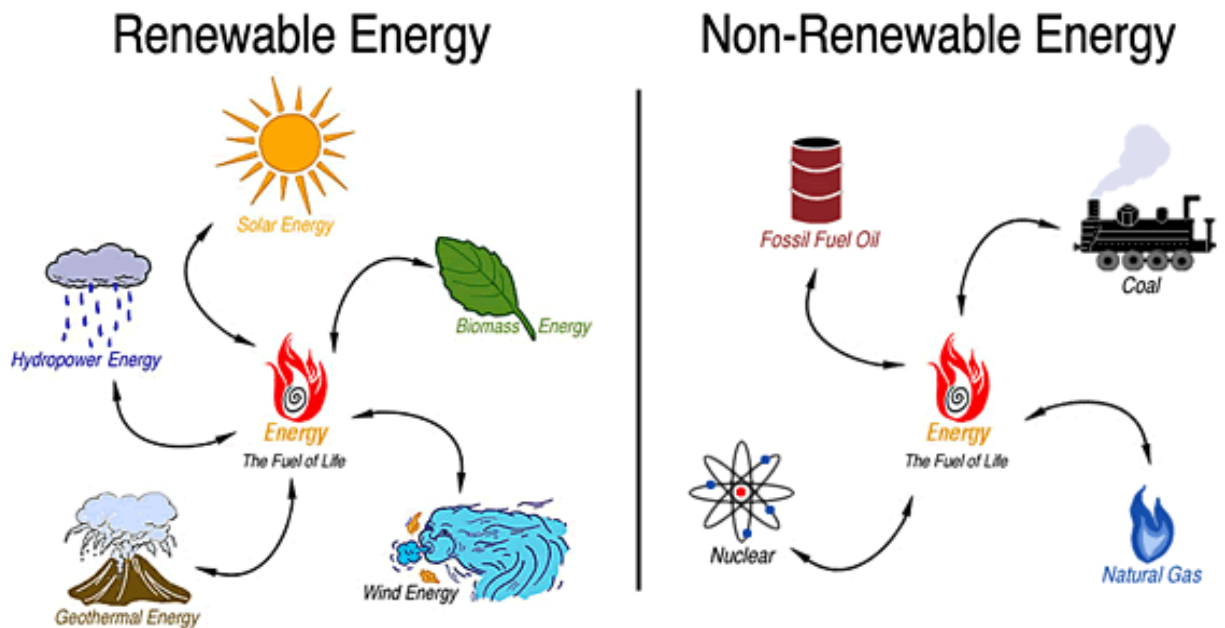
**Energy:** The ability to do work is called energy.

## **Renewable & Non-renewable sources of energy:**

A source of energy is considered **renewable** if it comes from natural sources or processes that are constantly replenished. They can never be depleted.

**Nonrenewable energy resources** include coal, natural gas, oil, and nuclear **energy**. Once these **resources** are used up, they cannot be replaced, which is a major problem for humanity.

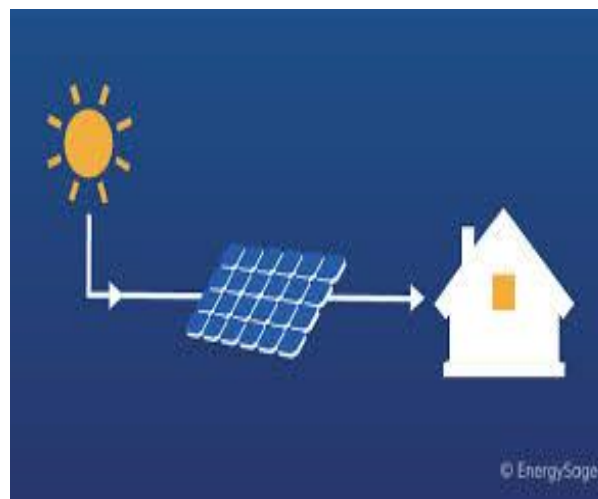
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## Sources of energy:

### Sun:

- ✓ Energy that comes from the sun is called solar energy. We get heat and light energy from the sun.



- ✓ Plants use solar energy for photosynthesis.

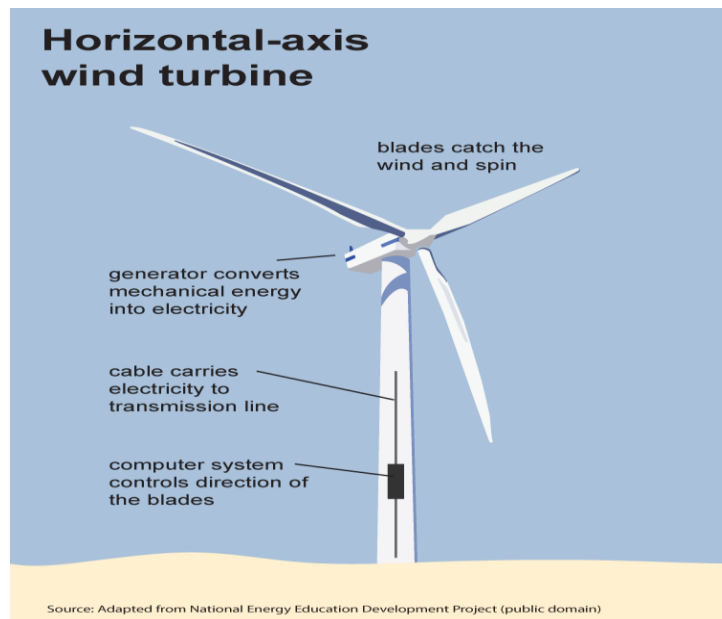
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- ✓ We use solar cookers and solar heaters to cook food and heat water.

## Wind:

- ✓ The energy present in the flow of **wind**, used by wind turbines is called **wind energy**.
- ✓ This energy is a major cheap source to produce electricity, to draw water from wells.



## Earth:

- ✓ The energy or heat present inside the Earth is known as **geothermal energy**.

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- ✓ It is a cheap & convenient heat and power resource and use of this energy don't have a side effect like greenhouse gas emission etc.
- ✓ Some examples include natural geysers, volcanoes and hot springs.

## Water:

- ✓ The energy that we get from moving water is called hydro energy.



- ✓ Dams are used for the movement of water to produce electricity.

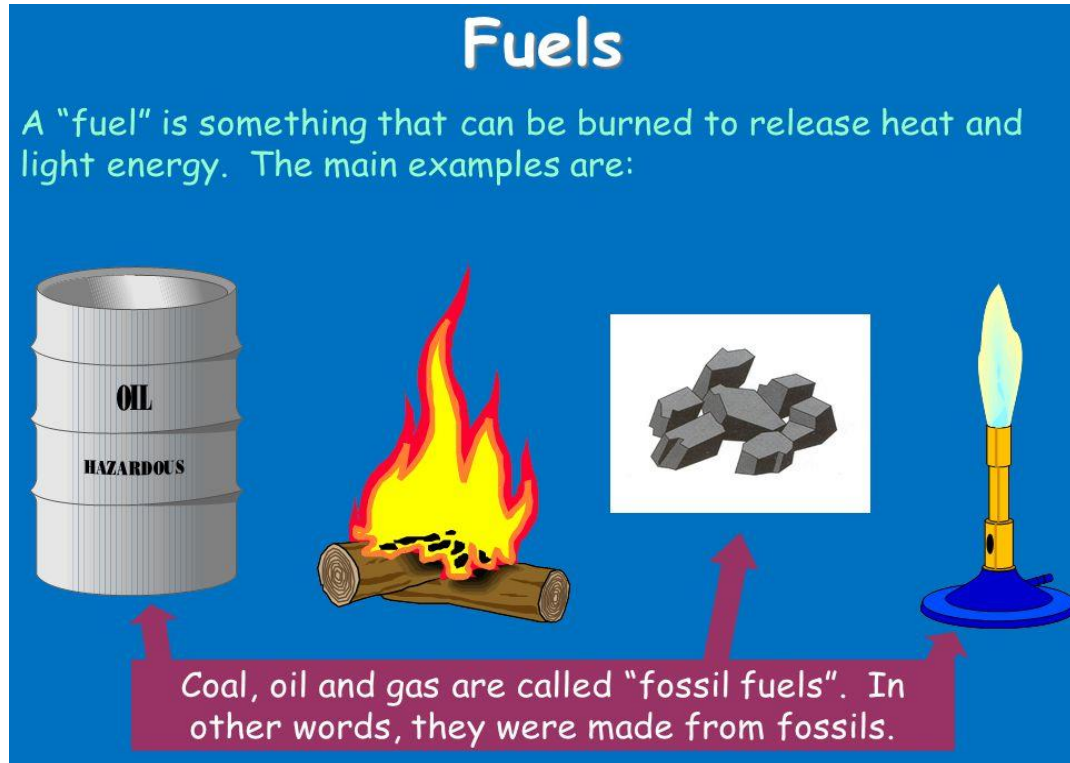
## Fuels:



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Fuels such as coal, petrol, diesel, kerosene and CNG (compressed natural gas) burn to produce heat and light energy.



## Types of Energy:

### **Light energy:**

It enables to see various objects around us. Some common sources of light energy are bulbs, torches, street lights and candles. The sun, other stars are natural sources of light.

### **Sound energy:**

- ✓ The energy produced by flutes, drums are called sound energy.

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## Heat energy:

Heat is a form of energy that is used to cook food on stove, make a room warmer by using radiators and to iron clothes.



## Electrical energy:

Most of the electrical appliances that we use in our day-to-day life, such as computers, fans, TV work using electrical energy.

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