

# UNIT 8

## ENERGY SOURCES AND TRANSFER OF ENERGY

### WORK

#### WORKDONE BY A CONSTANT FORCE

#### WORK

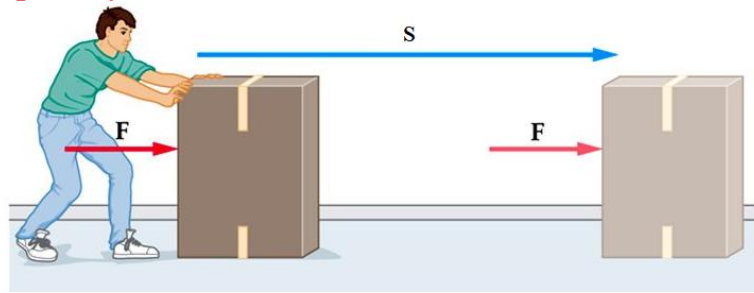
Work in physics is defined as the product of a force and the displacement in the direction of the force.

In equation form,

$$\text{Work} = (\text{Force}) (\text{displacement in the direction of force})$$

$$W = F s$$

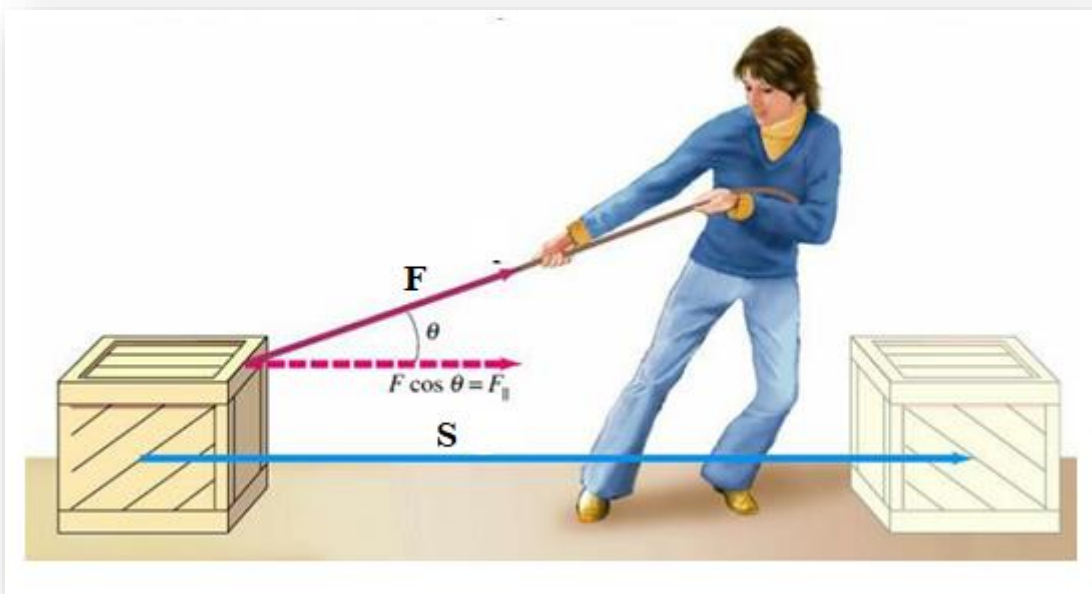
Work is a scalar quantity.



FORCE F IS MAKING AN ANGLE  $\theta$  WITH THE DIRECTION OF DISPLACEMENT OF THE BODY  
DEFINITION-2:

The work done on an object by a constant force is defined as the product of the magnitude of the displacement and the component of the force parallel to the displacement .

Formula:



In equation form, we can write

Work = (component of force) · (distance)

$$W = (F_{11}) d$$

When  $F_{11}$  is the component of the constant force  $\vec{F}$  parallel to the displacement 'S'. We can also write

$$W = (F \cos \theta) d$$

$$W = F d \cos \theta \text{ _____ (i)}$$

**When  $F$  is the magnitude of the constant force,  $S$  is the magnitude of the displacement of the object, and  $\theta$  is the angle between the direction of force and the displacement. The  $\cos \theta$  factor appears in equation (1) because  $F \cos \theta = F_{11}$  is the component of  $\vec{F}$  parallel to  $d$**

**If the force acts on a body and displacement  $d$  is produced in the direction of the force, then the work done is positive**

**The angle between the force and the displacement is  $\theta = 0^\circ$**

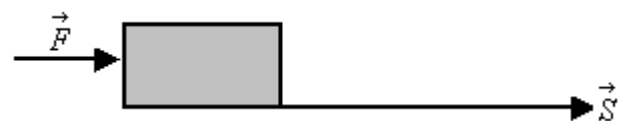
$$W = F d \cos \theta$$

$$W = F d \cos 0^\circ$$

$$W = F d (1)$$

$$W = F d$$

$$[\cos 0^\circ = 1]$$



### UNITS:

- In SI unit s, work is measured in **Newton – meters**, A special name is given to this unit, the joule (J)

$$1 \text{ J} = 1 \text{ N.m}$$

- In CGS system the unit of work is called 'erg' and is defined as, when the force of 1 dyne displace a body by 1 cm in the direction of the force, , the work done is 1 erg.

$$1 \text{ erg} = 1 \text{ dyne.cm}$$

- In British system the unit of work is measured in 'foot-pound'

### Relation

**it is easy to show that**

$$1 \text{ joule} = 10^7 \text{ ergs}$$

$$1 \text{ joule} = 0.7376 \text{ ft-lb}$$

# ENERGY

Energy is defined as the ability to do work.

## KINETIC ENERGY

### DEFINITION:

*The energy a body possesses by its motion is called its kinetic energy. It is a scalar quantity*

### FORMULA

$$K.E = \frac{1}{2}mv^2$$

The object of mass  $m$  moving with speed  $v$  kinetic energy depends upon:

- ▶ the mass  $m$  of the object- the greater the mass, the greater its K.E
- ▶ the speed  $v$  of the object- the greater the speed, the greater the K.E

## POTENTIAL ENERGY

### DEFINITION:

The Energy a body possesses by its position in a field of force is called potential energy. It is a scalar quantity.

### TYPES:

Potential energy of a system may be one of the following types.

1. Gravitational potential energy.
2. Elastic potential energy.
3. Electric potential energy etc.

## Derivation of Gravitational Potential Energy $P.E=mgh$

To derive the expression for gravitational potential energy, let us consider an object of mass " $m$ " which is raised up through height " $h$ " from the ground, as shown in Fig.

The work done in lifting it to height " $h$ " is stored in it as its gravitational potential energy " $P \cdot E$ ", i.e.

$$P \cdot E = \text{Work done}$$

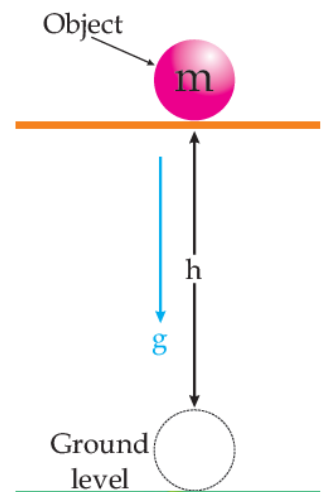
$$P \cdot E = W$$

$$P \cdot E = Fd$$

$$P \cdot E = (mg) h$$

Therefore, the equation becomes:

$$P \cdot E = mgh$$



## CONVERSION OF ENERGY FROM ONE FORM TO ANOTHER

### FOSSIL FUEL ENERGY

Fossil fuel energy is formed from decayed plants and animals that have been converted to crude oil, coal, natural gases, or heavy oils by exposure to heat and pressure in the Earth's crust over hundreds of millions of years



Fossil fuels store chemical energy. This energy is converted by oxidation through burning. Thus, burning a fossil fuel like charcoal produces heat energy and light energy.



## HYDROELECTRIC ENERGY

**Hydroelectric energy**, also known as **hydropower**, is a form of renewable energy that generates electricity by using the natural flow of moving water.

The most common type of hydroelectric power plant uses a dam on a river to store water in a reservoir. Water released from the reservoir flows through a turbine, spinning it, which in turn runs a generator to produce electricity.



## SOLAR ENERGY

The energy radiated from the sun is known as solar energy. Many devices are capable of absorbing solar energy, which is then converted into electrical energy or heat energy. These devices may be photovoltaic solar panels and solar cells. Which convert the sun's rays into electricity for different uses.

solar heaters are used to convert solar energy “sun rays” into heat energy to heat water tanks and indoor spaces



## NUCLEAR ENERGY

The energy released during a nuclear reaction such as fission or fusion reaction. All radioactive materials store nuclear energy. For example, Uranium Radium etc. It is released from the nucleus in the form of radiation in addition to heat and light. A nuclear power plant utilizes nuclear energy to produce steam to turn a turbine and generate electricity.

## Geothermal Energy

Geothermal energy is stored in the Earth as its natural heat. Deep in the Earth, there is the hot molten part called magma. Water close to magma changes to steam due to high temperature. This thermal energy is conducted to the surface of the Earth. This energy is called geothermal energy;

A geothermal power plant utilizes geothermal energy to drive an electrical generator.



## WIND ENERGY

The energy obtained from the wind is called wind energy. It is generated by windmills. A windmill consists of a turbine that rotates due to wind. Kinetic energy is produced due to the motion of the turbine. Wind turbines convert this kinetic energy into mechanical power. A generator converts that mechanical power into electricity.



## TIDAL ENERGY

It is a form of hydro power that converts the energy obtained from tides into useful form of power; mainly electricity as the Earth uses the gravitational forces of both the moon and the sun every day to move vast quantities of water around the oceans and seas producing tides and in this way energy is produced called tidal energy.



# RENEWABLE AND NON-RENEWABLE ENERGY SOURCES

## RENEWABLE ENERGY SOURCE

The resources that cannot be exhausted even after continuous utilization are termed renewable resources. Examples of renewable resources are the sun, wind, and tidal energy.

## NON-RENEWABLE SOURCES

Non-renewable resources are limited and will run out once used. Coal, petroleum and natural gases are nonrenewable sources.

## EFFICIENCY

This efficiency is defined as the ratio of output to the input and is called Efficiency.

## FORMULA

$$\text{Efficiency} = \frac{\text{Energy out put } (E_2)}{\text{Energy in put } (E_1)}$$

$$\eta = \frac{E_2}{E_1} \times 100$$

## POWER

### DEFINITION:

**Power is defined as the rate at which the work is done. It is a scalar quantity.**

### FORMULA:

The average power "P<sub>av</sub>" when an amount of work is done in a time interval  $\Delta t$  is

$$P_{av} = \frac{\text{Total work}}{\text{Time interval}}$$

$$P_{av} = \frac{\Delta W}{\Delta t}$$

The work done in the process is equal to the energy transformed from one form to another form. We can say that power is the rate at which energy is transformed.

$$P = \frac{\Delta E}{\Delta t}$$

### UNITS:

$$\therefore P = \frac{\Delta W}{\Delta t} = \frac{J}{\text{Sec}}$$

1. The SI unit of power is (joule per second), called **watt (W)**.
2. The CGS unit of power is **erg/s**
3. The British (F.P.S) unit of power is **ft-lb/Sec**. Another bigger unit in this system is **horse power (hp)**.

$$1 \text{ hp} = 746 \text{ watt}$$

$$1 \text{ hp} = 550 \text{ ft-lb/Sec}$$