CHAPTER: 6
WORK AND ENERGY

Work or Work Done:-

When a force acts on a body and the body covers some distance in the direction of force then the work is said to be done.

The product it is defined as **"The product of force and displacement is called work or work done"**

Formula:-

Work = (Force) (Displacement)

W = (f) (d)

Unit:-

The unit of force is joule.

Unit:-

Work is a scalar quantity.

Joule:-

We know

W.D = (F) (D)

1 joule = (1 Newtron) (1 metre)

If a force of one newtron acts a body and the body covers a distance of one metre in the direction of force then work will be one joule.

Special Case:-

Some times force and displacement are not in the same direction then in such cases the force is resolved in to its rectangular components.

Fx and fy

Fx = F cos θ

And

Fy = F sin θ

In this cases the body moves due to x-component of force.

W = (f) (d)

W = (Fx) (d)

W = (F cos θ) (d)

W = Fd cos θ

Energy:-

The ability of a body to do work is called energy.

Types of energy:-

There are two types of energy.

1. Kinetic energy
2. Potential energy

1. Kinetic Energy:-

The energy of the body due to its motion is called kinetic energy. It is represented by K.E and its formula is

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

Question

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

Consider a body of mass 'm' is placed at point 'A' at rest (vi=o) we apply some force 'F' and move the body from point 'A' to point 'B'. The body cover's distance 'd' with velocity (vf=v) and acceleration 'a'.

We know

$$W.D = (f)(d) \longrightarrow (1)$$

Now we will find values of 'F' and 'd'

According to second law of motion

$$F = ma$$

Now we find 'd' by using following data

Initial velocity = v_i = 0 (Rest)

Final velocity = v_f = v

Acceleration = a

Distance = d

Using 3rd eq of motion

$$2ad = v_f^2 - v_i^2$$

Putting values

$$2ad = v^2$$

$$d = \frac{v^2}{2a}$$

Putting values of 'F' and 'd' equation (1)

W.D (F) (d)

$$W.D = (ma)\frac{(v^2)}{2a}$$

$$W.D = (m\cancel{a})\frac{(v^2)}{2\cancel{a}}$$

$$W.D = \frac{1}{2} mv^2$$

Since this work is done due to motion of the body. Therefore this work is equal to K.G.

Potential Energy:-

The energy of a body due to its position is called potential energy. It is represented by P.E and its formula is P.E = mgh

Question

Prove That

P.E = mgh

Consider a body of mass ‘m’ is lifted to a height ‘h’ from surface of earth.

We know that

W.D = (F) (d) ⟶ (1)

Here

F = Weight = mg

And

d = Height = h

Now eq (1) becomes

W.D = (F) (d)

W.D = (mg) (h)

W. D = mgh

Since this work is done due to change in position of the body, so this work will be equal to potential energy.

W. D = P.E

And

P. E = mgh

Forms of Energy:-

There are different form of energy seven main forms of energy are given as.

1. Mechanical energy
2. Heat energy
3. Electrical energy
4. Sound energy
5. Light energy
6. Chemical energy
7. Nuclear energy

Intercoversion of Energy:-

Energy can be converted from one form to another form but total energy remains the same.

Major Sources of Energy:-

The energy we use comes from the sun wind and water. These are the major sources of energy some other major sources of energy are given as.

1. Fossil Fuels 2. Nuclear fuels

1. Fossil Fuels:-

Fossil fuels are the hydrocarbons that contains coal, oil and gas. All these sources burn and produce energy which can be used for different purposes. When fossil fuels are burnt then they combine with oxygen as a result carbon becomes carbon dioxide and hydrogen becomes hydrogen oxide water and energy is released in the form of heat.

Fossil fuels are formed inside the earth and take million of years in their formation fossil fuels are known as no-renewable resources.

Renewable Sources of Energy:-

Those sources of energy which can be used again and again are called renewable sources of energy.

Example:-

Sun light and water are renewable sources of energy.

Non renewable Sources of Energy:-

Those sources of energy which cannot be used again and again are called non-renewable sources of energy. These sources can only be used once.

Example:-

Coal, oil and gas are non-renewable sources of energy.

2. Nuclear Fuels:-

In nuclear power plants the energy is obtained by nuclear fission reaction. In this reaction breaking of a heavy nucleus takes place with the release of large of large amount of heat. This heat energy is used to run electro power station.

Energy From Water:-

Water stored in a high dam at a certain height from earth has gravitational potential energy. This gravitational potential energy is used to run a turbine and power generator's energy by running these power generators.

Energy From Sun:-

Energy coming out from the sun is called solar energy. The sun energy can be used directly and indirectly. Sun light is very big source of energy.

Einstein's Mass Energy Equation:-

Einstein gave a theory according to this theory mass and energy are interconvertable. It means that.

"Energy can be converted in to mass and mass can be converted into energy"

The relation between mass and energy is given by Einsteins mass energy equation.

E = mc2

Where

m = energy

m = mass

c = speed of light

c = 3×10^8 m/sec

Efficiency:-

The ratio of output of a machine to its input is called efficiency.

$$\text{Efficiency} = \frac{\text{output}}{\text{Input}}$$

Percentage Efficiency:-

Percentage efficiency = out put × 100

Power:-

The rate of doing work with respect to time is called power.

Formula:-

$$\text{Power} = \frac{\text{work}}{\text{Time}}$$

$$P = \frac{w}{t}$$

Quantity:-

Power is a scalar quantity.

Watt:-

$$P = \frac{w}{T}$$

$$1 \text{ watt} = \frac{1 \text{ joule}}{1 \text{ second}}$$

If a body does a work of power will be one watt.

Numerical Problems

6.1

Distance = d = 35m

Force = F = 300 N

P.E = 120 J

Solution:

We know

W.D = (f) (d)

= (300) (35)

= 10500 J

6.2

Weight = w = 20 N
Height = h = 6 m
P.E = ?

Solution:

We know

Weight = w – mg
w = mg
20 = mg

Now

P.E = mgh
P.E = (20) (6)
P.E = 120 J

6.3

Weight = w = 12 kN
w = 12 × 1000 N
w = 12000 N

Solution:

We know

w = mg
12000 = mg
Mg = 12000
M = $\frac{12000}{g}$
M = $\frac{1200\not{0}}{1\not{0}}$
M = 1200kg

Now

K.E = $\frac{1}{2}$ mv2
K.E = $\frac{1}{2}(1200)(20)^2$
K.E = $\frac{1}{\not{2}}$ ($\not{1200}$ 600) (400)
K.E = (600) (400)
K.E = 24000J

6.4

Mass = 500g
m = $\frac{500}{1000}$ = 0.5 kg
Velocity = v = 15 m/sec
P.E at maximum height = ?
K.E when it hits the ground = ?

Solution:

We know

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

$$K.E = \frac{1}{2} (0.5) (15)^2$$

$$= \frac{1}{2} (0.5) (225)$$

$$= \frac{1}{2} (112.5)$$

$$= \frac{112.5}{2}$$

$$K.E = 56.25 \text{ j}$$

P.E at the top = k Eat ground

P.E at top = 56.25 j

6.5

Height	=	h	=	6m
Speed	=	V	=	6m
Kinetic energy	=	K.E	=	?
Potential energy	=	P.E	=	?
Mass	=	m	=	40kg

Solution:

We know

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

$$K.E = \frac{1}{2} (40) (1.5)^2$$

$$K.E = \frac{1}{2} (40) (2.25)$$

20

$$K.E = \frac{1}{\not{2}} (\not{40}) (2.25)$$

$$K.E = (20) (2.25)$$

$$K.E = 45J$$

Now

$$P.E = m\,g\,h$$

$$P.E = (40) (10) (6)$$

$$P.E = 24000J$$

6.6

Speed	=	V	=	4m/sec
Force	=	F	=	4000N
Power	=	P	=	?

Solution:

We know that power is the product of force and velocity

So

Power = (Force) (Velocity)

P = (F) (V)

P = (4000) (4)

P = 16000watt

6.7

Force = F = 300N

Distance = d = 50m

Time = t = 60sec

Power = P = ?

Solution:

We know that

$$\text{Power} = \frac{\text{W.D}}{\text{Time}}$$

And

W.D = (F) (d)

W.D = (300) (50)

W.D = 15000J

Now

$$P = \frac{\text{W. D}}{T}$$

$$P = \frac{15000}{60}$$

P = 250 watt

6.8

Mass = m = 50kg

Time = t = 20 sec

Height of one step = 16cm

= 16 = 0.16m

Power = ?

Solution:

Height of one step = 0.16m

Height of 25 step = 25×0.16

h = 4 m

We know

W.D = P. E

W.D = mgh

W.D = (50) (10) (4)

W. D = 2000j

Now

$$P = \frac{W.D}{Time}$$

$$P = \frac{2000}{20}$$

$$P = 100 \text{ watt}$$

6.9

Power = p = ?

Mass = m = 200 kg

Height = h = 6 m

Time = t = 10 sec

Solution:

We know

$$Power = \frac{W.D}{Time}$$

W.D = mgh

W.D = (200) (10) (6)

W. D = 12000j

Now

$$Power = \frac{W.D}{Time}$$

$$P = \frac{12000}{10}$$

P = 1200 watt

6.10

Power = 1 hp

= 746 watt

Time = t = 10 min

t = 10×60

t = 600 sec

Height = h = 15m

Actual W.D = ?

Efficiency = ?

Solution:

It is given that mass of

1 litre = 1 kg

So,

Mass of 1 litre = 1 x 800

We know that

$$\text{Power} = \frac{\text{W.D}}{\text{Time}}$$

$$746 = \frac{\text{W.D}}{600}$$

$$746 \times 600 = \text{W.D}$$

$$\text{W.D} = 447600 \text{ j}$$

This work is called actual work done and it is equal to output of the motor.

So

$$\text{Out put} = 447600 \text{ j}$$

Now we find input

$$\text{Input} = \text{P. E}$$

$$\text{Input} = mgh$$

$$= (800)(10)(15)$$

$$= 120000 \text{ j}$$

Now

$$\text{Efficiency} = \frac{\text{Input}}{\text{Output}} \times 100$$

$$= \frac{120000}{447600} \times 100$$

$$= 26.80$$

$$= 26.801$$

Page No. 141Exercise Question

Question no. 6.2

Define work what is its SI unit?

Ans. When a force acts on a body and the body cover's some distance in the direction of force then work is said to be done.

Mathematically it is defined as

"The product of force and displacement is called work"

Formula:-

W. D = (Force) (Displacement)

$$W = Fd$$

Quantity:-

Work is a scalar quantity.

Unit:-

The unit of work is joule.

Joule:-

W.D = Fd

1 joule = (1 Newton) (1 metre)

If a force of one newton acts on o body and the body covers a distance of one metre in the direction of force then work will be one joule.

Question no. 6.3

When does a force do work Explain?

Ans. When a force acts on a body and the body cover's some distance in the direction of force then work is said to be done.

Formula:-

Work = (Force) (Displacement)

Question no. 6.4

Why do we need energy?

Ans. When a force acts on a body and the body cover's some distance in the direction of force then work is said to be done.

Question no. 6.5

Define energy. Give two types of mechanical energy?

Ans. The ability of a body to do work is called energy. There are two types of mechanical energy.

1. Kinetic energy
2. Potential energy

Question no. 6.8

Why fossils fuels are called non-renewable form of energy?

Ans. Fossils fuels are the hydro carbons formed under the earth crust. They take million of years in their formation fossils fuels can only be used once to get energy. They cannot be used again and again. Therefore they are called non-renewable source of energy.

Question no. 6.10

How energy is converted from one form to another? Explain?

Ans. Energy cannot be created or destroyed but it can be converted from one form another form.

Example:-

1. The energy of running water is converted in to electronic energy.

2. The electrical energy is converted in to mechanical energy by electric motor.

3. Heat energy is also converted into mechanical energy to run different types of engines.

Question no. 6.11

Name the five devices that covert electrical energy into mechanical energy?

Ans. The electrical energy is converted into mechanical energy by

1. Electrical motor
2. Electric fan
3. Drill machine
4. Electric grinder
5. Electric spinner

Question no. 6.12

Name a device that converts mechanical energy into electrical energy?

Ans. The electrical generators convers mechanical energy in to electrical energy.

Question no. 6.13

What is meant by efficiency of a system?

Ans. The ratio of output of a machine to its input is called efficiency.

OR

The ratio of required form of energy obtained from a system as output to the total energy given to it as input.

$$\text{Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}} \times 100$$

Question no. 6.14

How can you find the efficiency of a system?

Ans. We can find efficiency of a system by using the formula

$$\text{Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}}$$

$$\%\ \text{Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}} \times 100$$