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Ch-3 (Machines) 3(a)

Machines, technical terms and levers

⇒ **Machine :→** It is a device that performs work.

OR

⇒ **Simple Machine :→** It is a device with the help of which a force applied at one point is transmitted to another point with a convenient change of magnitude or direction.

Examples of simple machines :→ The lever, pulley, inclined plane, screw, wedge and wheel and axle etc.

Functions of a simple machine :→

(a) In lifting a heavy load by applying less effort ie as a force multiplier. for e.g A jack is used to lift a car.

(b) In changing the point of application of effort to convenient direction. for eg; The rear wheel of a cycle is rotated by applying effort on the pedal attached to the toothed wheel.

(c) In changing the direction of effort to a convenient direction. for eg, a single fixed pulley and levers.

(d) For obtaining gain in speed ie to increase the speed. for e.g when a pair of scissors is used to cut a cloth, its blades move longer on cloth, while its handles move a little.

⇒ Technical terms related to a machine :→

(1) **Load** :→ It is the resistive or opposing force to be overcome by a machine. It is denoted by the letter 'L'.

(2) **Effort (E)**:→ The external force applied on the machine to overcome the load is called effort (E).

(3) **Mechanical Advantage (M.A)** :→ The ratio of load to the Effort (E) is called the mechanical advantage of the machine

i.e $$M.A = \frac{\text{Load (L)}}{\text{Effort (E)}}$$

M.A is mechanical Advantage. It is a pure ratio ∴ It has not no units.

⇒ **Importance of mechanical Advantage** :→

⇒ If MA > 1, then a machine can be used as a force multiplier. In this case Effort < Load for e.g crowbar

⇒ If MA < 1, then a machine can be used as a speed multiplier here Effort > Load for e.g scissor.

⇒ If MA = 1; then a machine can be used to change the direction of effort as there is no gain in force or speed.

⇒ A machine has two sides :— (a) The input side, where energy is supplied

(b) The output side; where useful work is done by machine.

Velocity Ratio :→ (VR):→ It is the ratio of the distance traversed by the effort to the distance traversed by the load in the same given time.

VR is a pure ratio; hence it has no unit

$$VR = \frac{d_E}{d_L}$$

d_E – distance moved by effort

d_L – " " by the load.

* If $VR > 1$ → Force multiplier
  $VR < 1$ → Speed multiplier
  $VR = 1$ → to change the direction

(Note) → VR will not change once the machine is designed OR value of VR of all type of machine; Ideal or practical is the same and is not affected by the friction.

⇒ **Work Input :→** The energy supplied to machine or work done by the effort

⇒ **Work output :→** Useful work done by the machine is called the work output or work done on the load.

⇒ **Efficiency :→** It is denoted by η (eta)

$$\eta = \frac{\text{Work output}}{\text{Work Input}} = \frac{W_{output}}{W_{input}}$$

In percentage; Efficiency is

$$\text{or } \eta = \frac{W_{output}}{W_{input}} \times 100$$

Teacher's Signature .....

⇒ **Principle of a machine** :→

for an ideal machine ; work output = work input

Ideal Machine :— In this machine, there is no loss of energy and Work output = Work input and efficiency of an ideal machine is 100 %.

[* In practical, no machine is ideal because there will always be a loss of energy in a machine due to
→ (a) friction between the moving parts of machine
→ (b) certain parts are not perfectly rigid

Actual or a practical Machine :→ In this machine W output is always less than W input because there is always a loss of energy during operation of a machine.

* Efficiency of a practical machine is always less than 100 %.

⇒ **for an Ideal Machine** :→ $MA = VR$

η = Efficiency = 100 %.

W output = W input

⇒ Relationship between Efficiency (η) , mechanical advantage (MA) and Velocity ratio (VR)

$$M.A = V.R \times \eta$$

⇒ **for a Practical Machine**

↓

$MA < VR$

(∵ W output < W input)

and $\eta < 1$