Date: 17 Feb 2025

Subject:- PHYSICS

TENDER HEART HIGH SCHOOL, SEC 33B, CHD.

CLASS-IX

(Ch-3 (Machines) Continue) 3(a)

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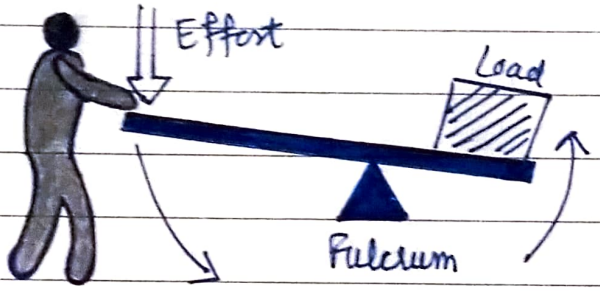
LEVERS

Lever: → Lever is a rigid, straight (or bent) bar which is capable of turning about a fixed axis.

Fulcrum: → Lever is free to turn about a fixed turning point called as fulcrum. It is generally marked by the letter F.



(Lever)

The figure above shows a schematic diagram of a lever. Both the forces, load (L) and effort (E) act on the lever.

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* **Load:** → Object to be moved
* **Effort (E):** → force applied to lift the load.
* **Load arm:** → distance b/w load and fulcrum
* **Effort arm:** → Distance b/w the effort and the fulcrum.

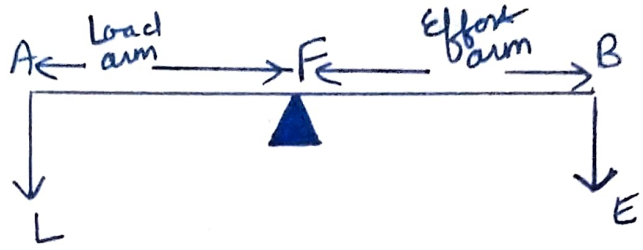
Principle of moments: → A lever works on the principle of moments. When the lever is in equilibrium;

Clockwise moment of Load about the fulcrum = Anticlockwise moment of effort about the fulcrum.

$\therefore$ Load × Load arm = Effort × Effort arm

$L \times FA = E \times FB$

$\frac{L}{E} \Rightarrow \frac{FB}{FA} \Rightarrow M.A \quad \left(\because \frac{L}{E} = M.A\right)$



This relation is called "Law of levers"

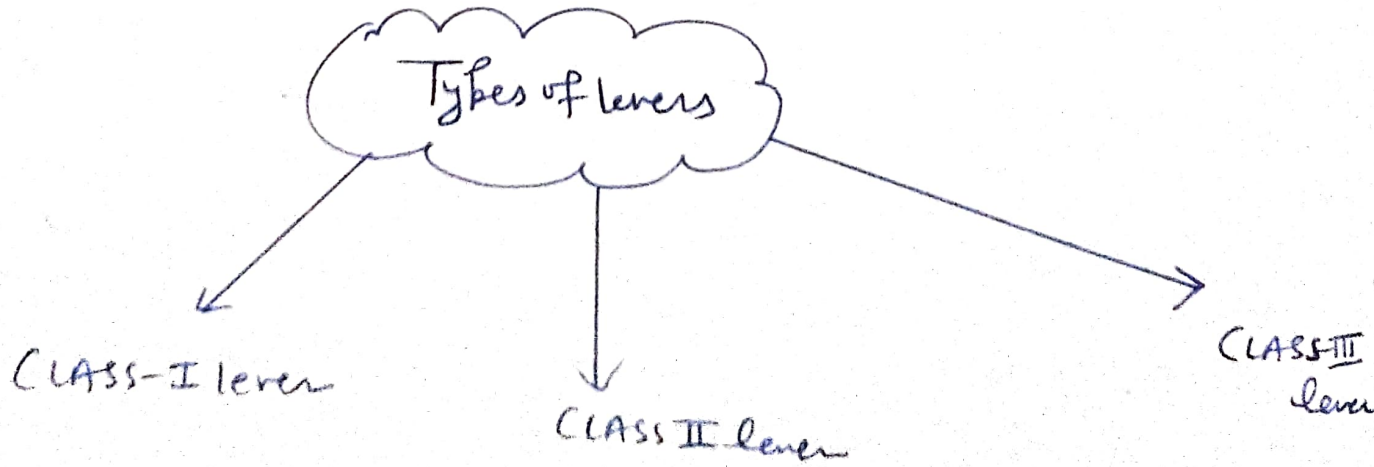
$$\frac{L}{E} \Rightarrow \frac{FB}{FA} = \frac{\text{Effort Arm}}{\text{Load Arm}} = MA \quad \text{---(1)}$$

Case (i) If Effort arm > load arm ; MA > 1

Case (i) If Effort arm < Load arm ; MA < 1

Case iii If Effort arm = Load arm ; MA = 1

* # [the mechanical advantage of a lever can be increased either by increasing its effort arm or by decreasing its load arm (i.e by shifting the fulcrum towards the load)]



for understanding

* Three classes of levers can be remembered through: →

F, L and E

(Fulcrum in centre, Load in centre, Effort in centre)

↓ (CLASS-I lever) ⇓ (CLASS-II lever) (CLASS-III lever)

(i) CLASS-I lever: ↴

In this lever fulcrum is in between load and effort

for class-I lever; the mechanical advantage (MA) may have any value i.e MA=1, MA>1 or MA<1, It depends upon the placement of fulcrum.

(a) When MA=1 (or load arm = effort arm) here (VR=1) then examples are, a physical balance, See Saw.

(b) When MA>1; (or load arm < Effort arm) (VR>1)
for e.g; (Shears, crowbar, Claw hammer, pliers and spoon, nodding of the head.
(Such levers serve as a force multiplier i.e it enables us to overcome a large resistive force (load) by small effort.

(c) When MA<1; (or load arm > Effort arm) (or VR<1)
for eg; a pair of scissors, handle of a water pump.
Such levers serve as a speed multiplier.
In case of pair of scissors, blades are longer than its handles, so that blades move longer on cloth or paper when the handles are moved a little.

(ii) CLASS-II lever :→ In this lever, load is in between the fulcrum and the effort. (In this lever Effort arm > Load arm or MA>1 or VR>1)

In other words; Class-II lever always acts as a force multiplier i.e less effort is needed to overcome a large load. For e.g, in a nut cracker, a hard nut is broken by applying a small effort.

Examples :→ Wheel barrow, Nut cracker, Bottle opener, standing on toes. A paper cutter, Lemon crusher, mango cutter, A bar used to lift a load, opening / shutting a door.

(iii) CLASS-III levers :→ In this lever, Effort is somewhere between the load and the fulcrum. (In this lever, Effort arm < load arm or MA<1 or VR<1)

In other words; Class-III lever always acts as a Speed multiplier i.e we get gain in speed i.e load moves through a large distance than through effort distance

Examples :→ Fire tongs, Sugar tongs, foot treadle, knife, Fishing rod, A Spade used to lift coal (or soil), the forearm used to lift load, Stapler,

⇒ Examples of each Class of levers as found in human body

(i) Class I lever in the action of nodding of head :→

In this action of nodding of head; the spine acts as a fulcrum and load is at its front part and Effort E at its rear part. thus it is an example of CLASS-I lever.

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(ii) Class II lever in raising the weight of the body on toes :→

The fulcrum F is at the toes at one end., the load L (ie the weight of the body) is in the middle and effort E by muscles is at the other end. Thus, it is an example of Class-II lever.

(iii) Class-III lever in raising the Load by fore arm :→

The elbow joint acts as a fulcrum (F) at one end, biceps exerts the force E in the middle and load L on the palm is at the other end. Thus it is an example of Class-III levers.

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