Basics of Simple Machine (Part II) - Notes for RRB ALP CBT II 2018

Railways RRB ALP Computer Based Test for Stage II will be conducted on 12th December to 14th December 2018. If you are preparing for the upcoming ALP CBT-II, then it is necessary that you are familiar with the ALP CBT II Basics of Simple Machine. Read this article to gear up your preparation. Also, watch the video to clear your doubts on ALP CBT II Basics of Simple Machine.

Basics of Simple Machine - Lever

A lever is a type of simple machine that is used to lift the heavy loads. It consists of three parts, effort arm, fulcrum, and load arm.

Load (or) Weight

The force overcome by the effort is called load or weight (W).

Effort (or) power:

The force applied to lift the load is called effort or power (P).

Fulcrum:

It is a fixed point in the machine around which the machine rotates (F).

Mechanical Advantage

In a simple machine when the effort (P) balances a load (W) the ratio of the load to the effort is called the mechanical advantage of the machine. It is simply expressed in a number.

Mechanical advantage (M.A)

$$MA = \frac{\text{Load}}{\text{Effort}} = \frac{W}{P}$$

Example 1: Mechanical advantage is

1) Input force/ Output force

2) Output force/ Input force

3) Input force x Output force

4) Input force + Output force

Ans: 2

Velocity ratio

It is the ratio between the distances moved by the effort to the distance moved by the load. It is also expressed in a number.

$$\text{Velocity ratio} = \frac{\text{Distance moved by the effort } (d_p)}{\text{Distance moved by the load } (d_w)}$$

Efficiency of machine

The ratio of output to the input of a machine is known as efficiency.

In simple machines, the ratio of mechanical advantage to the velocity ratio is also known as the efficiency of the machine.

Efficiency is generally expressed in percentage.

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

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

Relation between M.A., V.R., and η

$$\text{Efficiency} = \frac{\text{Output}}{\text{Input}} = \frac{\text{Load} \times \text{Distance moved by the load}}{\text{Effort} \times \text{Distance moved by the effort}}$$

$$\text{Efficiency} = \frac{\text{Load}}{\text{Effort}} \times \frac{\text{Distance moved by the load}}{\text{Distance moved by the effort}}$$

$$\text{Efficiency} = \text{Mechanical advantage} \times \frac{1}{\text{Velocity ratio}}$$

$$\text{Efficiency}\ (\eta) = \frac{\text{Mechanical advantage}}{\text{Velocity ratio}} = \frac{\text{M.A.}}{\text{V.R.}}\%$$

Ideal Machine

In an ideal machine, the mechanical advantage is equal to the velocity ratio. So, efficiency is 100% or unity.

Example2:

In a machine of a mass 120 kg is lifted to a height of 5 metre by a force of 60 kg. moving 15 m. Calculate, mechanical advantage, velocity ratio and efficiency.

Solution:

Load (w) = 120 kg

Distance moved by load = (dw) = 5 m

Power (P) = 60 kg

Distance moved by power (dP) = 1.5 m

$$MA = \frac{W}{P} = \frac{120\ kg}{60\ kg} = 2$$

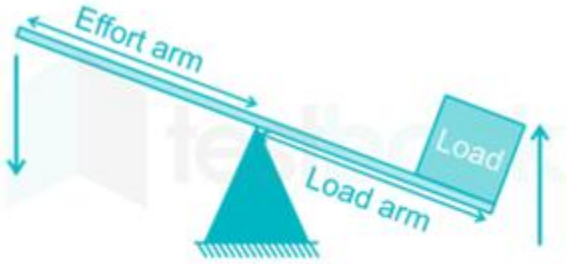
$$VR = \frac{dp}{dw} = \frac{15}{5} = 3$$

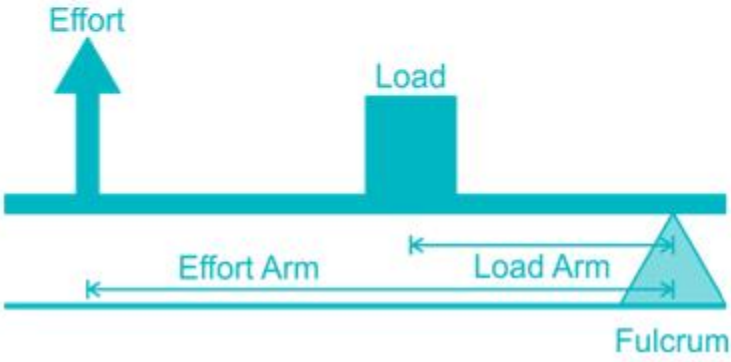
$$\%Efficiency\ (\eta) = \frac{MA}{VR} \times 100\% = 66.99\ \%$$

Load Arm: The distance of the load from the fulcrum is called the load arm

Effort Arm: The distance of the effort from the fulcrum is called the effort arm

Principle of Lever: Load × Load arm = Effort × Effort Arm

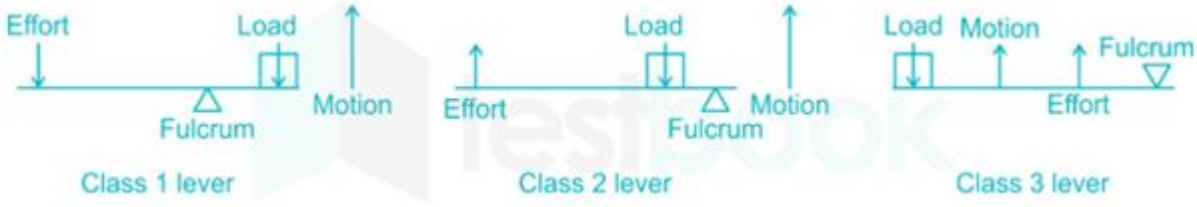




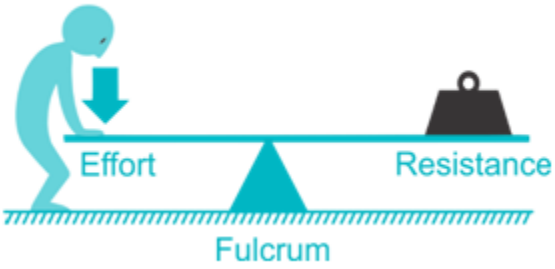
Basics of Simple Machine - Types of Lever

Levers are of three types depending upon the positions of fulcrum with respect to load and effort.

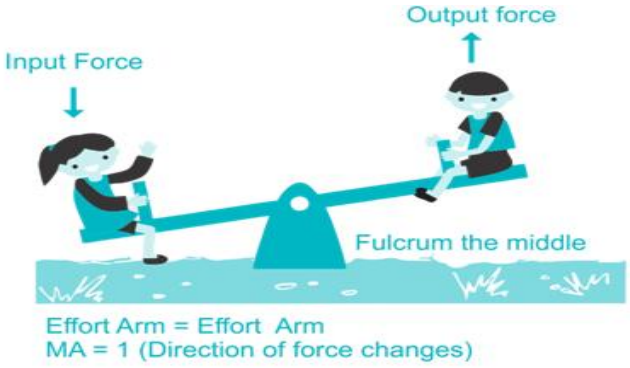
1. First class lever
2. Second class lever
3. Third class lever

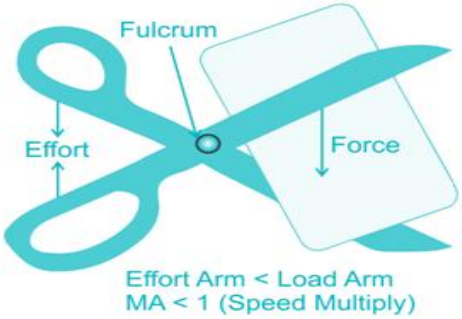


Class 1 Lever



- A **Class 1** lever has the **fulcrum placed between the effort and load.**
- The movement of the load is in the opposite direction of the movement of the effort
- g. A pair of scissors, See – saw, Crow bar, Beam balance, Hand pump etc.
- Mechanical advantage may be greater than, less than, or equal to 1





Effort Arm < Load Arm
MA < 1 (Effort Multiply)

Example 3: Class 1 levers have

1) Fulcrum placed between the effort and load

2) Load in-between the effort and the fulcrum

3) Effort between the load and the fulcrum

4) None of these

Ans: 1

Example 4: What should you do to reduce the amount of effort needed to lift

something using a first class lever?

1) move the fulcrum to the middle of the lever

2) move the fulcrum closer to the load

3) move the fulcrum closer to the effort

4) Any of these

Ans: 2

Class 2 Lever

- A **Class 2**lever has the **load between the effort and the fulcrum.**
- In this type of lever, the movement of the load is in the same direction as that of the effort
- g. Nut crackers, wheel barrows, doors, Lime squeezer and bottle openers etc.
- Mechanical advantage is always greater than 1 (Effort Multiply)

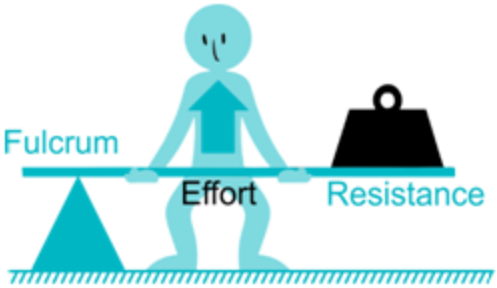
(Effort Arm > Load Arm so MA > 1)

Example 5: Class 2 levers have

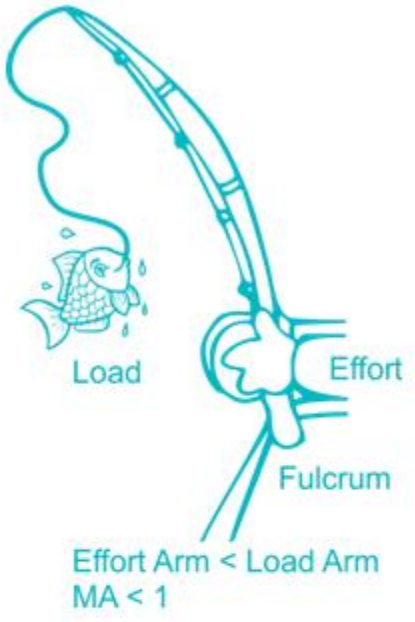
1) Fulcrum placed between the effort and load
2) Load in-between the effort and the fulcrum
3) Effort between the load and the fulcrum
4) None of these

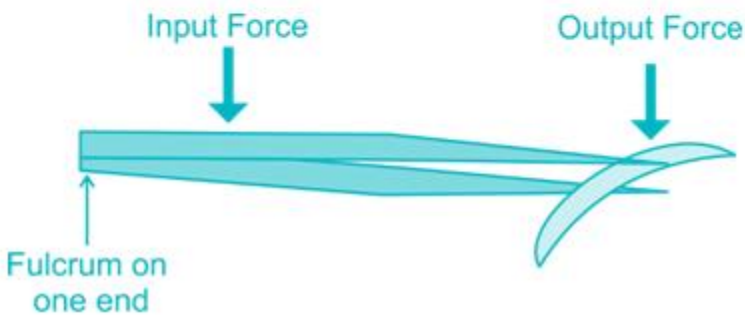
Ans: 2

Class 3 lever



- A **Class 3** lever has the **effort between the load and the fulcrum.**
- Both the effort and load are in the same direction
- Human forearm, forceps, broom, fire tongs, fishing rod, and shovels etc.
- Mechanical advantage is always less than 1


Load
Effort
Fulcrum
Effort Arm < Load Arm
MA < 1


Input Force
Output Force
Fulcrum on one end

Example 6: Class 3 levers have

1) Fulcrum placed between the effort and load

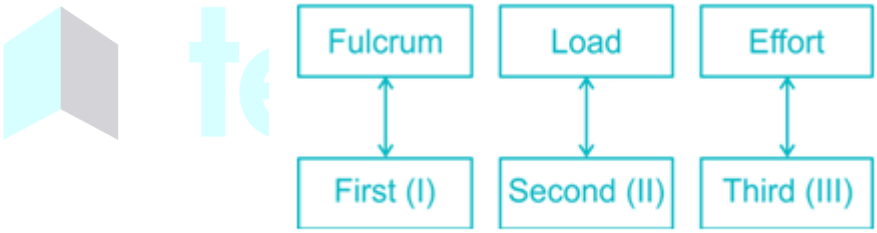
2) Load in-between the effort and the fulcrum

3) Effort between the load and the fulcrum

4) None of these

Ans: 3

Trick to remember types of Lever:



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