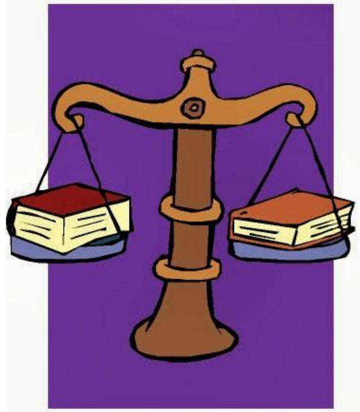
Simple machines are used to make work easier. They are used in various places and times in our lives. They include: the pulley, screw, wheel and axle, wedge, lever, and the inclined plane.

The simple machines are the **inclined plane**, lever, wedge, **wheel and axle**, pulley, and screw

Simple Machines

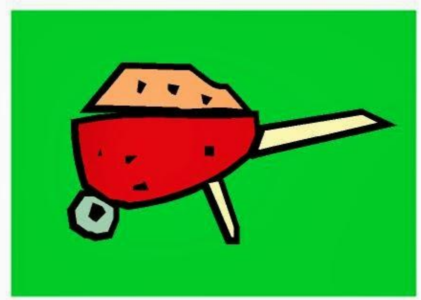


Lever

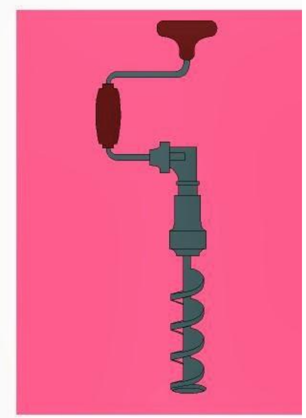
Inclined Plane

Wedge

Pulley



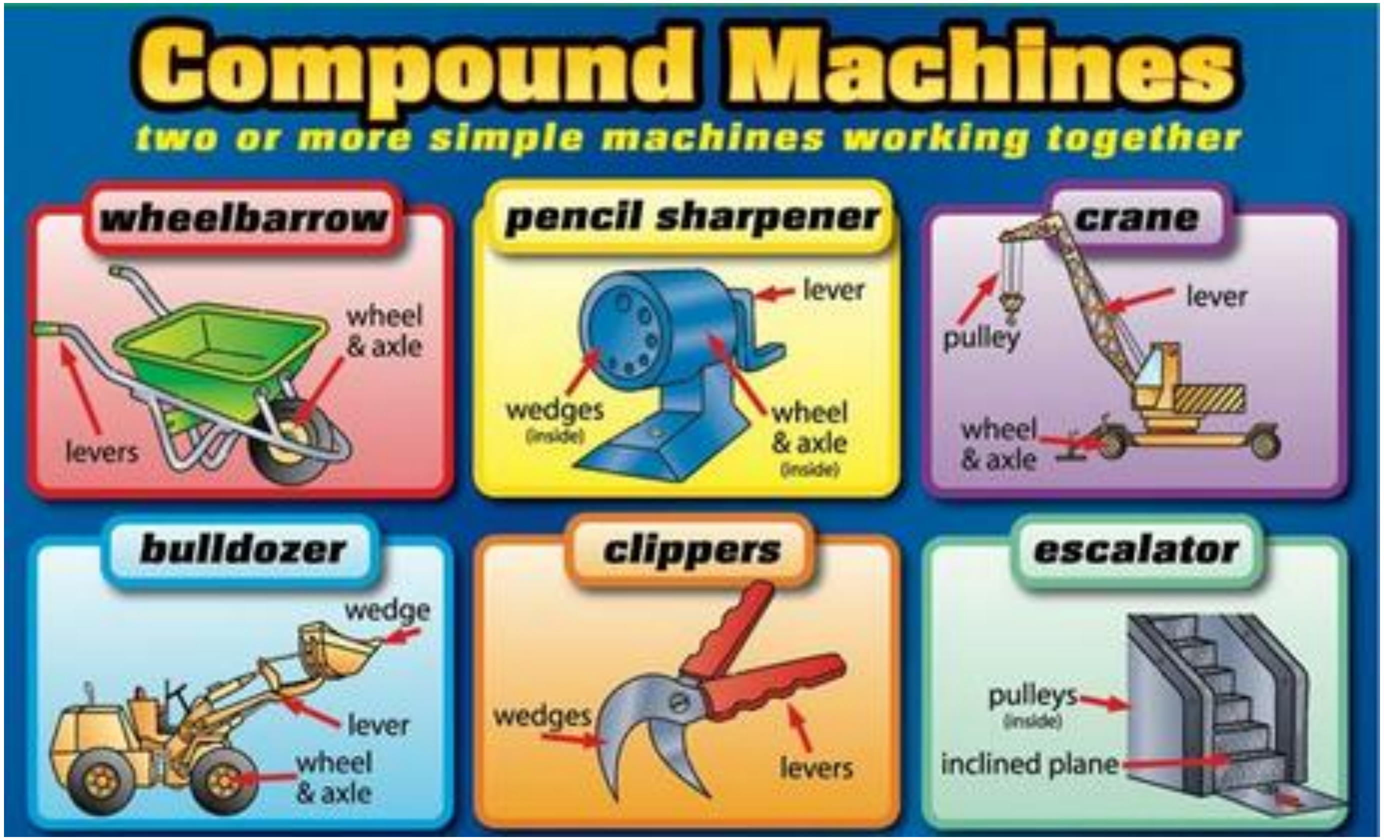
Wheel and Axle



Screw

Compound machines are made up of two or more **simple machines**.

When we group two or more simple **machines** together, it becomes a **compound machine**. When we combine a lever, wheels and axles, and screws together, they make a **compound machine**, like a **car**. **Cars** have hundreds of simple **machines** inside them to put them in motion.


Compound Machines
two or more simple machines working together
wheelbarrow
wheel & axle
levers
pencil sharpener
lever
wedges (inside)
wheel & axle (inside)
crane
pulley
lever
wheel & axle
bulldozer
wedge
lever
wheel & axle
clippers
wedges
levers
escalator
pulleys (inside)
inclined plane

Load is a heavy or a bulky object that requires **effort** to move or lift the **load**.

Effort is an applied force to bring desired Change to the position (push or lift) of the **load**.

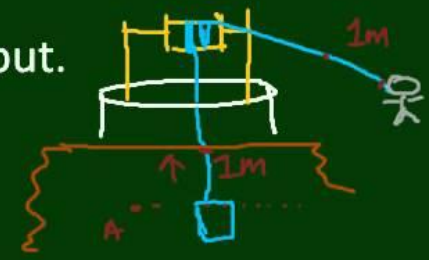
SIMPLE MACHINE

INPUT

Work done by force applied on the machine is called input.

work = Force x distance

effort x



OUTPUT

Useful work done by machine is called output.

EFFICIENCY

Its a ratio of usefull work done by the machine to the work done on the machine.

EFFICIENCY= OUTPUT/INPUT

Technical terms Related to Simple Machines

- **Mechanical advantage (MA) :**
- The ratio of load lifted (W) and effort required (P) is called Mechanical advantage.

$$MA = \frac{\textit{Load Lifted}}{\textit{Effort required}} \quad \therefore MA = \frac{W}{P}$$

Where, W= Load and P= Effort

- **Velocity ratio (VR) :**
- The ratio of distance moved by effort and the distance moved by load is called velocity ratio.

$$VR = \frac{\text{Distance moved by effort}}{\text{Distance moved by load}} \quad \therefore VR = \frac{y}{x}$$

We can classify machines in two different ways:

Simple machines	Complex machines
• A simple machine has few or no moving parts.	• A complex machine is compound by simple machines.
• They require energy	• They require electrical energy.

Law Of Machine

- Machines which are used to lift a load are governed by the "Law of machines", which states that the effort to be applied on the machine (p) is related to the weight (w) which it can lift as –

$$p = mw + c$$

- Where m and c are positive constants which are characteristics of the machine.

Ideal Machines

- In an ideal machine, work going in is equal to the work going out, this means it has 100% efficiency. We will talk about this more in a moment.

- Mechanical advantage is the ratio of the output force to the input force.

- MA = F out/F in   How can mechanical advantage be increased?

IDEAL MACHINE

An ideal machine is a hypothetical machine whose output is equal to its input.
For an ideal machine

- **output = input**
- Efficiency of an ideal machine
is 100% because there is no loss of energy in an ideal machine due to friction or any other means that can waste useful energy.
- M.A of an ideal machine is **d / h.**

11.12 Reversibility

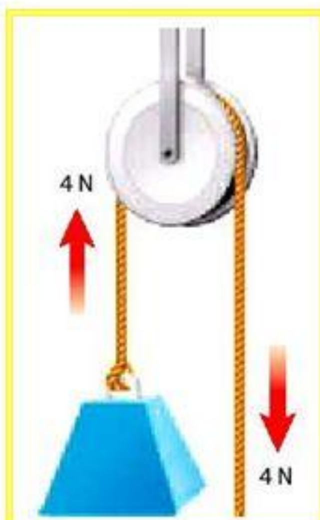
- **Reversibility** is the ability to run a process back and forth infinitely without losses.
- Reversible Process
  - Example: Perfect Pendulum
- Irreversible Process
  - Example: Dropping a ball of clay

- **Reversible machine :**
  - If a machine is capable of doing some work in the reverse direction, after the effort is removed is called reversible machine.
  - For reversible machine, $\eta \geq 50\%$

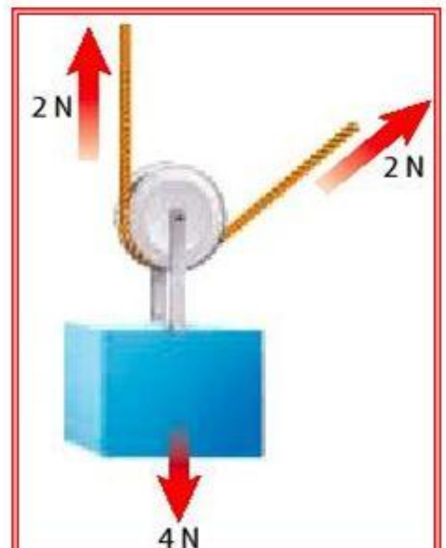
- **Non-reversible machine or self-locking machine**
  - If a machine is not capable of doing some work in the reverse direction, after the effort is removed, is called non-reversible machine or self-locking machine.
  - For non-reversible machine, $\eta < 50\%$
  - A car resting on a screw jack does not come down on the removal of the effort. It is an example of non-reversible machine.

3 Types of Pulleys

- Fixed: wheel attached to a fixed location
- Movable: wheel attached to object
- Pulley System: combination of fixed & movable pulleys



Fixed pulley

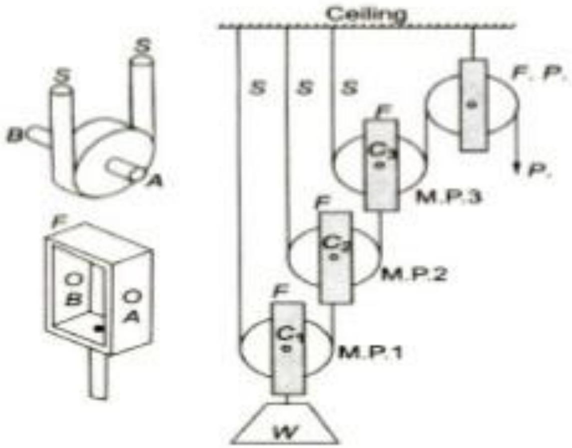


Movable pulley

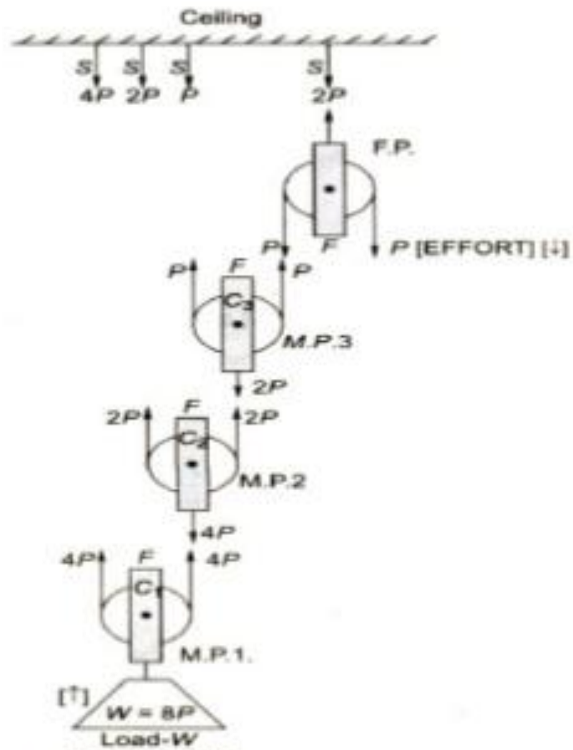
System OF PULLEYS

- First system of pulleys
- Second system of pulleys
- Third system of pulleys

First system of pulleys



Details:-
1. S - String
2. F - Frame
3. F.P. - Fixed Pulley
4. M.P. - Movable Pulleys
   1, 2 & 3, i.e., $n = 3$
5. P - Effort
6. W - Load
7. A & B Bearings
8. Velocity Ratio $= 2^n$
9. V.R. = M.A. $= \frac{W}{P} = 8$
   $= 2^3 = 2^n$

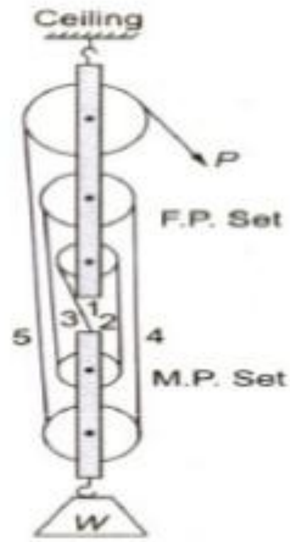


F.B.D. of First System of Pulleys

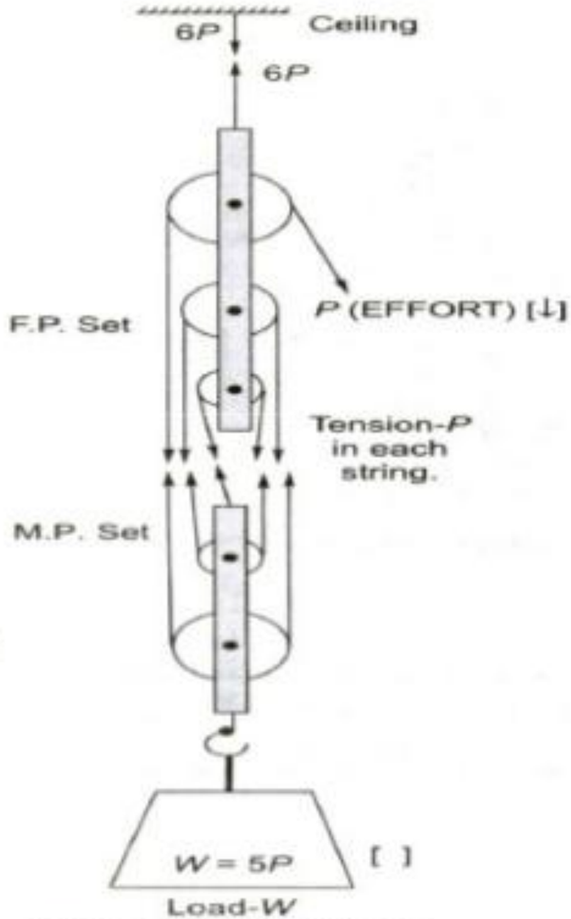
First system of pulley : VR $= 2^n$

Where, n = no. of moving Pulley

Second system of pulleys



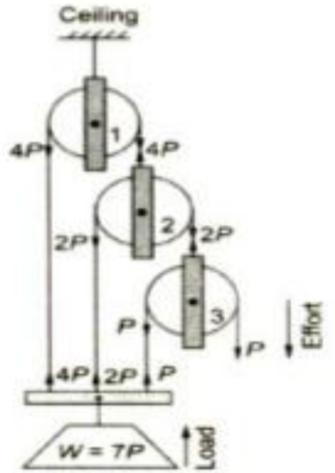
Details:-
1. F.P. Set - Fixed Pulley Set
2. M.P. Set - Movable Pulley Set
3. P - Effort
4. W - Load = $5P$
5. V.R. = M.A. = $\frac{W}{P} = 5$
6. V.R. = n [Number of String between F.P. & M.P. Sets]



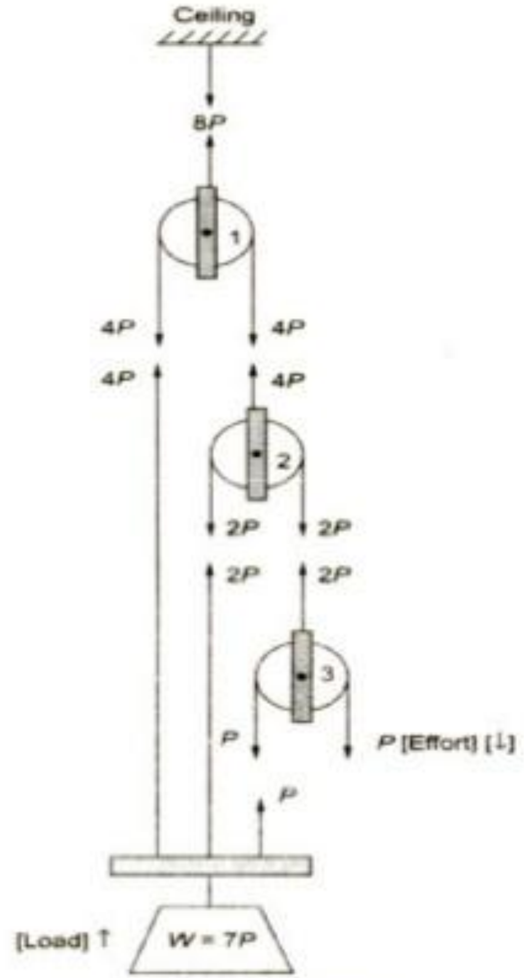
F.B.D. of F.P. & M.P. sets
Self Explanatory

Second system of pulley: VR = n
Where, n =total no. of Pullies.

Third system of pulleys



3rd System of Pulleys



F. B. D. of 3rd System of Pulleys.
It is self-explanatory.

Third system of pulley : VR = 2^n - 1
Where, n = total no. of Pullies.

$$V.R. = M.A. = \frac{W}{P} = 7 = [2^3 - 1]$$
$$= [2^n - 1]$$

Fixed (Single)Pulley

A fixed (single) pulley is attached to a stationary object like a wall or ceiling.

It acts as a first-class lever having the fulcrum at the axis and the rope acting as the bar.

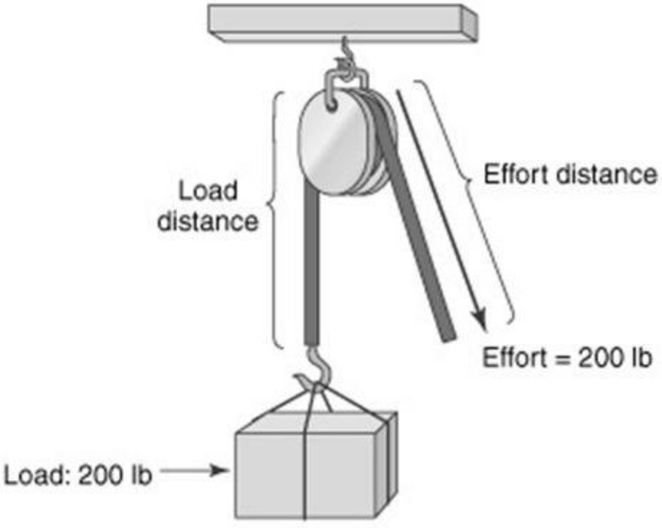
Fixed (single) pulleys only change effort (force) direction (you can pull down on the rope to lift the load instead of pushing up on it).

They do not enhance the effort (force).

- Effort (force) distance equals resistance force (load) distance and, therefore, each foot of pull on the rope will lift the load one foot.

It provides no mechanical advantage (MA = 1).

- Example: The fixed (single) pulley has a resistance force (load) at one end of the rope. The other end must have effort (force) applied downward to raise the load. The effort (force) is equal to the load in this pulley system and there is no mechanical advantage, with the MA equal to 1.



FIXED PULLY