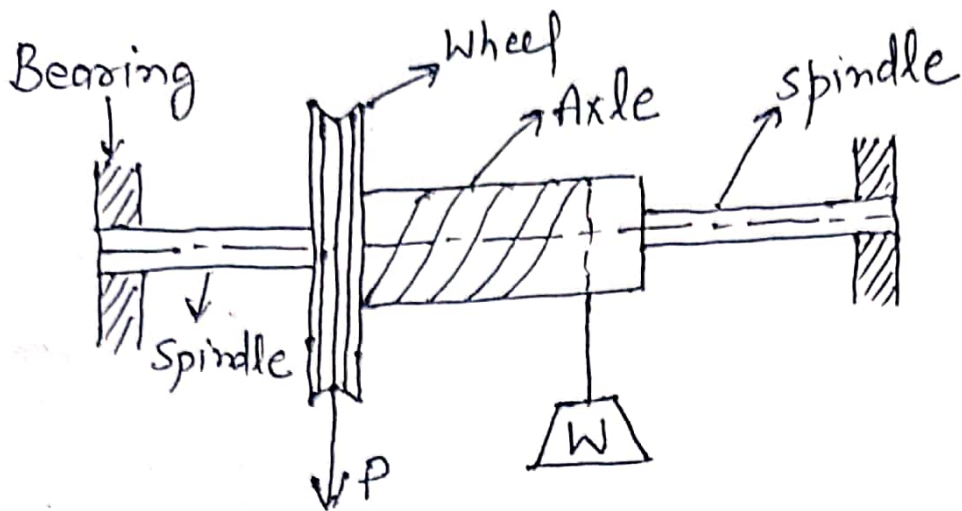


Simple Wheel and Axle

①



It consists of a wheel and axle fixed to the a common spindle as shown in figure.

- * Spindle is supported in bearing at both ends.
- * Diameter of wheel is greater than diameter of axle to obtain more velocity ratio, more mechanical advantage.
- * A rope is wound on axle with one end fixed and other end carries a load W to be lifted.
- ⇒ A second rope is wound on the wheel in a direction opposite to that on axle.
- * One end of this rope is fixed to the wheel while other end carries the effort P .
- * Since both the ropes are wound in opposite direction, so a down ward

motion of effort P will raise the load W

Let, $D =$ diameter of wheel

$d =$ diameter of axle.

\Rightarrow For one revolution of wheel, the axle will also make one revolution.

\therefore Distance moved by effort $= \pi D$.

Distance moved by load $= \pi d$.

$$V.R. = \frac{\text{Distance moved by effort } P}{\text{Distance moved by load } W}$$

$$V.R. = \frac{\pi D}{\pi d} = \frac{D}{d}$$

\Rightarrow If diameter of ropes is also considered

then,

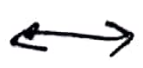
$$V.R. = \frac{D+d_1}{d+d_2}$$

Where $d_1 =$ diameter of rope on wheel

$d_2 =$ diameter of rope on axle.

$$M.A. = \frac{W}{P}$$

Efficiency,
$$\eta = \frac{M.A. \times 100}{V.R}$$



Problem:- The diameter in a wheel and axle machine are 45 cm and 15 cm. A load of 1600 N is raised by applying an effort of 600 N. Find the efficiency of machine. What additional load could have been raised if the machine is frictionless.

Solution:- Given,
 $D = 45 \text{ cm}$
 $d = 15 \text{ cm}$
 $W = 1600 \text{ N}$
 $P = 600 \text{ N}$

$$V.R. = \frac{D}{d} = \frac{45}{15} = 3 \checkmark$$

$$M.A. = \frac{W}{P} = \frac{1600}{600} = 2.66 \checkmark$$

$$\text{Efficiency } \eta = \frac{M.A.}{V.R.} \times 100$$

$$= \frac{2.66 \times 100}{3} = \boxed{88.88\%} \text{ Ans.}$$

⇒ For a frictionless machine ∴ -

$$\text{Efficiency} = 100\%$$

or $M.A. = V.R.$

$$\frac{W}{P} = V.R.$$

$$W = V.R. \times P = \cancel{2.66} \times 600 \times 3$$

$$\boxed{W = 1800 \text{ N}}$$

$$\text{Additional Load} = 1800 - 1600 = \boxed{200 \text{ N}} \text{ Ans}$$