

# Simple Machines

## Mechanical Advantage (MA)

$$IMA = \frac{D_E}{D_R} \qquad AMA = \frac{F_R}{F_E}$$

$$\% \text{ Efficiency} = \left( \frac{AMA}{IMA} \right) 100$$

IMA = Ideal Mechanical Advantage

AMA = Actual Mechanical Advantage

$D_E$  = Effort Distance       $D_R$  = Resistance Distance

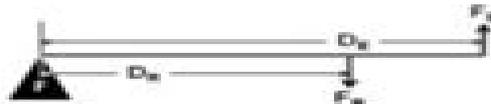
$F_E$  = Effort Force       $F_R$  = Resistance Force

## Lever

1st Class



2nd Class



3rd Class



## Wheel and Axle

Effort at Axle



Effort at Wheel



## Pulley Systems

IMA = Total number of strands of a single string supporting the resistance

$$IMA = \frac{D_E \text{ (string pulled)}}{D_R \text{ (resistance lifted)}}$$

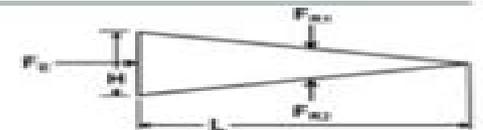
## Inclined Plane

$$IMA = \frac{L \text{ (slope)}}{H}$$



## Wedge

$$IMA = \frac{L \text{ (L to height)}}{H}$$



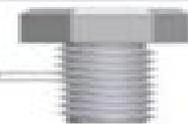
## Screw

$$IMA = \frac{C}{\pi r H}$$

$$\text{Pitch} = \frac{1}{\text{TPI}}$$



Pitch



C = Circumference

r = radius

Pitch = distance between threads

TPI = Threads Per Inch

## Compound Machines

$$MA_{\text{TOTAL}} = (MA_1) (MA_2) (MA_3) \dots$$

## Gears; Sprockets with Chains; and Pulleys with Belts Ratios

$$GR = \frac{N_{\text{out}}}{N_{\text{in}}} = \frac{d_{\text{out}}}{d_{\text{in}}} = \frac{\omega_{\text{in}}}{\omega_{\text{out}}} = \frac{T_{\text{out}}}{T_{\text{in}}}$$

$$\frac{d_{\text{out}}}{d_{\text{in}}} = \frac{\omega_{\text{in}}}{\omega_{\text{out}}} = \frac{T_{\text{out}}}{T_{\text{in}}} \text{ (pulleys)}$$

## Compound Gears

$$GR_{\text{TOTAL}} = \left( \frac{B}{A} \right) \left( \frac{D}{C} \right)$$



GR = Gear Ratio

$\omega_{\text{in}}$  = Angular Velocity - driver

$\omega_{\text{out}}$  = Angular Velocity - driven

$N_{\text{in}}$  = Number of Teeth - driver

$N_{\text{out}}$  = Number of Teeth - driven

$d_{\text{in}}$  = Diameter - driver

$d_{\text{out}}$  = Diameter - driven

$T_{\text{in}}$  = Torque - driver

$T_{\text{out}}$  = Torque - driven

# Civil Engineering Material Quantity Formulas

**C Cleary**



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