Simple Machines

Mechanical Advantage (MA)

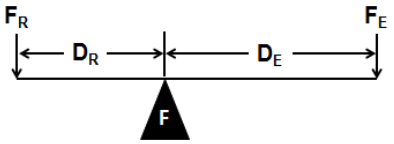
$$IMA = \frac{D_E}{D_R} \qquad AMA = \frac{F_R}{F_E}$$

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

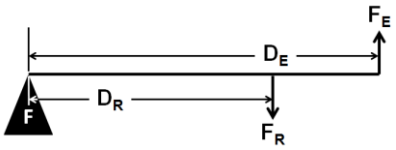
IMA = Ideal Mechanical Advantage
AMA = Actual Mechanical Advantage
D_E = Effort Distance D_R = Resistance Distance
F_E = Effort Force F_R = Resistance Force

Lever

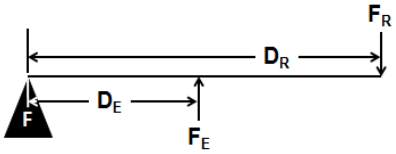
1st Class



2nd Class

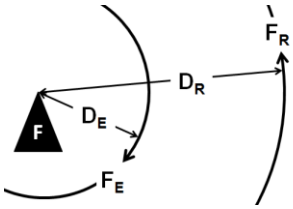


3rd Class

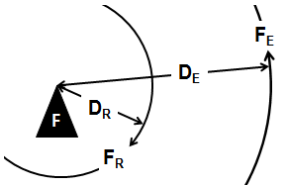


Wheel and Axle

Effort at Axle



Effort at Wheel



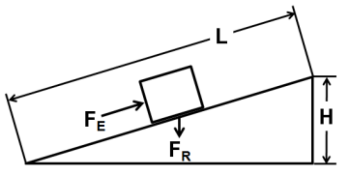
Pulley Systems

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

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

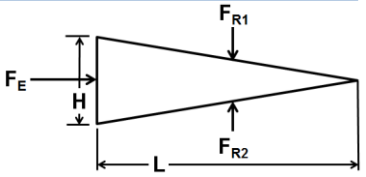
Inclined Plane

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



Wedge

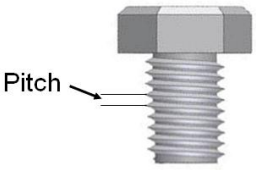
$$IMA = \frac{L\ (\perp \text{ to height})}{H}$$

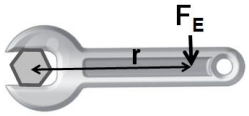


Screw

$$IMA = \frac{C}{Pitch}$$

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





C = Circumference
r = radius
Pitch = distance between threads
TPI = Threads Per Inch

Compound Machines

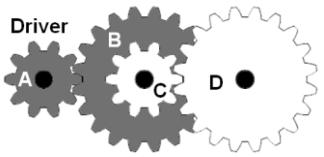
$$MA_{TOTAL} = (MA_1)\ (MA_2)\ (MA_3)\ \ldots$$

Gears; Sprockets with Chains; and Pulleys with Belts Ratios

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

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

Compound Gears



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

GR = Gear Ratio
ω_{in} = Angular Velocity - driver
ω_{out} = Angular Velocity - driven
N_{in} = Number of Teeth - driver
N_{out} = Number of Teeth - driven
d_{in} = Diameter - driver
d_{out} = Diameter - driven
τ_{in} = Torque - driver
τ_{out} = Torque - driven