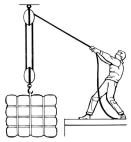
Simple Machines

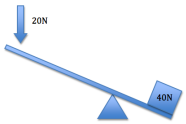
Objectives

Explain pros/cons for doing work with simple machines

Calculate force & distance amounts required to do work on a lever & pulley

Calculate the ideal mechanical advantage for a simple machine

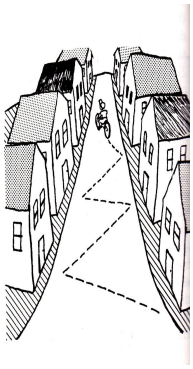




Riding Up Hill

Suppose this block is 300 feet long and quite steep. If I ride my bicycle up the hill along the zigzag path which is 600 feet long, the average force I must exert is:

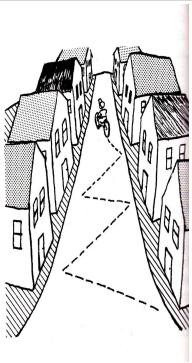
a) 1/4
b) 1/3
c) 1/2
d) equal to the average force I would exert going straight up.



Riding Up Hill

Again, up the same hill along the zigzag path the energy I must expend is:

a) 1/4
b) 1/3
c) 1/2
d) equal to the energy I would spend going straight up.



Simple Machines

it doesn't make work less!

does make work easier

less force → greater distance

TRADE-OFF!

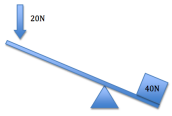
Conservation of Energy - Simple Machines

$$E_{In} = E_{Out}$$

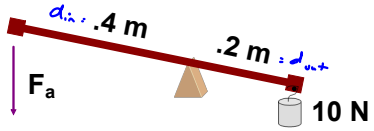
$$W_{In} = W_{Out}$$

$$F_{In} \cdot d_{In} = F_{Out} \cdot d_{Out}$$

(done by the person) (results of lifting object)



Lever



$W_{in} = W_{out}$

$F_{in} \cdot d_{in} = F_{out} \cdot d_{out}$

$F_{in} \cdot .4_m = 10N \cdot .2m$

$F_{in}(.4_m) = 2J$

$F_{in} = 5N$

Mechanical Advantage

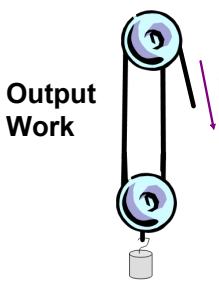
measures how much easier work is

$$MA = \frac{F_{Output}}{F_{Input}}$$

$\frac{10N}{5N} = 2$

no units!

Pulley



Input Work

F_{in} = ?

Output Work

F_{out} = 10 N

MA pulley = # strings

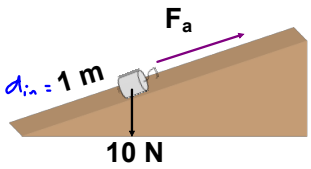
$MA = \frac{F_{out}}{F_{in}}$

$2 = \frac{10N}{F_{in}}$ $F_{in} = 5N$

Incline Plane

length = d_{in}

height = d_{out}



$W_{in} = W_{out}$

$F_{in} \cdot 1m = 10N \cdot .2m$

$F_{in}(1m) = 2J$

$F_{in} = 2N$

$MA = \frac{F_{out}}{F_{in}}$ $\frac{10N}{2N} = 5$

With Friction

$4N \cdot 1m = 10N \cdot .2m$

$4J = 2J$

Mechanical Advantage

$$IMA = \frac{F_{Output}}{\text{Ideal } F_{Input}}$$

w/o Friction

$$AMA = \frac{F_{Output}}{\text{Actual } F_{Input}}$$

w/ friction

$\frac{10N}{4N} = 2.5$

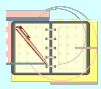
Efficiency

measures work not lost to friction

$$E = \frac{W_{Output}}{W_{Input}} \times 100$$ unit: %

$\frac{2J}{4J} \times 100 = 50\%$

Assignments . . .



- Begin Chapter 7 Homework # 6 - 12

- Quiz on Work/Power and Simple Machines tomorrow!