



# Mechanical Advantage and Efficiency

SPH4C

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# Mechanical Advantage

- a measure of the force ***amplification*** achieved by using a tool, mechanical device, or machine system

# Actual Mechanical Advantage (AMA)

- the ratio of the load force to the effort force for a machine
- $F_L / F_E$

# Ideal Mechanical Advantage (IMA)

- the ratio of the effort arm (or effort distance) to the load arm (or load distance) for a machine
- $d_E / d_L$

# Calculating AMA and IMA

- In an acrobatic demonstration, one person jumps onto the end of a plank creating an effort force of  $9.2 \times 10^2 \text{ N}$  at the end of the board  $1.7 \text{ m}$  away from the fulcrum. A load force (person) of  $4.6 \times 10^2 \text{ N}$  is  $3.1 \text{ m}$  from the fulcrum.

Calculate:

- A) the AMA of the plank
- B) the IMA of the plank

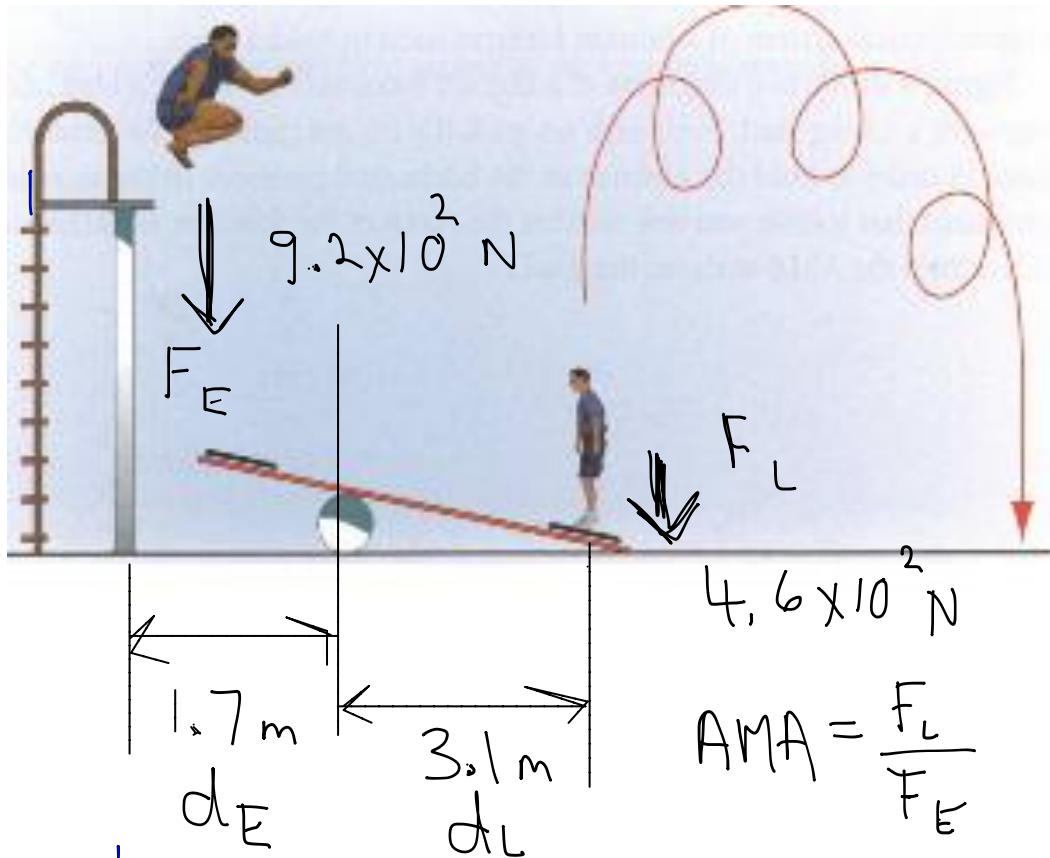
$F_e$

$F_L$

$d_e$

$d_L$

# Calculating AMA and IMA



$$IMA = \frac{d_E}{d_L}$$

$$= \frac{1.7 \text{ m}}{3.1 \text{ m}} = 0.55$$

$$AMA = \frac{F_L}{F_E}$$

$$= \frac{4.6 \times 10^2 \text{ N}}{9.2 \times 10^2 \text{ N}}$$

$$AMA = 0.5$$

# Efficiency of Machines

- **Percent Efficiency**
  - ratio of AMA to IMA of a machine expressed as a percentage
  - $\% \text{ eff} = (\text{AMA} / \text{IMA}) \times 100\%$
  - machines that have a large amount of friction have a low efficiency

# Pg. 94 practice problem 4

- A 14 N cart is pulled 1.2 m along a ramp with an effort force of magnitude 5.0 N parallel to the ramp, raising the cart 0.40 m above its initial level. Calculate:

- A) IMA  $IMA = \frac{d_E}{d_L} = \frac{1.2\text{ m}}{0.4\text{ m}} = 3.0$
- B) AMA  $AMA = \frac{F_L}{F_E} = \frac{14\text{ N}}{5\text{ N}} = 2.8$
- C) Efficiency of the ramp

$$\begin{aligned} \% \text{ eff} &= \frac{AMA}{IMA} \times 100\% \\ &= \frac{2.8}{3} \times 100\% \\ &= 0.93 \times 100\% \end{aligned}$$

$$\begin{aligned} \therefore \% \text{ eff} \\ &= 93\% \end{aligned}$$



# Work

- Pg. 93 # 3, ~~7~~
- Pg. 95 # 9, 10, 12
- Pg. 96 # 3 - 6