Homework Exercise #8 is due today.

**Correction** to sample exam 1A, #33, page 248:

\[ 4.6 \times 10^8 \] should be \[ 1.59 \times 10^8 \]

**Midterm 1 Drop-In:** Weds, 4:00 – 5:45 pm 2005 Smith

**Midterm 1:** Wednesday 6:30 – 7:40 pm in 1009 Smith for the T/R 9:35 and W/F 9:35 sections and in 1153 Smith for all other sections.

- See the Midterm 1 handout for more details.
• How do levers reduce the force to lift a load?
• How are lever arm length and lever distance moved related?
• What makes a lever balance?

• Remember to put away your phone. No calls or texting during class.
Levers

Machines, such as levers, allow you to lift heavy objects more easily.

A small force in applied over a long lever arm produces a large force out over a short load arm.
Examples of levers

Pliers

Load Arms

Lever Arms

Fulcrum

Scissors

Lever Arms

Variable Length

Load Arms

Fulcrum
Examples of levers

Human Arm

- Fulcrum
- Lever Arm
- Load Arm
What is the relationship between

- the length of a lever arm and the distance the end of the lever arm moves?
- the length of the load arm and the distance the end of the load arm moves?

Make measurements and form ratios
Lever arms: length and distance moved

Use your measurements to form two ratios:

\[
\frac{D_{in}}{D_{out}} \quad \text{and} \quad \frac{\text{lever arm}}{\text{load arm}} = \frac{L_{lever}}{L_{load}}
\]

What is the relationship between these ratios?
Levers: lever arm and load arm

The relationship between the lever arm lengths and the distances each end of the lever moves:

\[ \frac{D_{\text{in}}}{D_{\text{out}}} = \frac{L_{\text{lever}}}{L_{\text{load}}} \]
Example

Solve \( \frac{D_{in}}{D_{out}} = \frac{L_{lever}}{L_{load}} \) for the variable \( D_{out} \)

1) Multiply both sides by \( D_{out} \)
\[
\frac{D_{out} D_{in}}{D_{out}} = \frac{L_{lever} D_{out}}{L_{load}}
\]

2) Multiply both side by \( L_{load} \)
\[
\frac{D_{in} L_{load}}{L_{load}} = \frac{L_{lever} D_{out} L_{load}}{L_{load}}
\]

3) Divide both sides by \( L_{lever} \)
\[
\frac{D_{in} L_{load}}{L_{lever}} = \frac{L_{lever} D_{out} L_{load}}{L_{lever}}
\]

\[
\frac{D_{in} L_{load}}{L_{lever}} = D_{out}
\]
Levers: force in and force out

The relationship between the force in and out and the distances each end of the lever moves:

\[ F_{in} \cdot D_{in} = F_{out} \cdot D_{out} \]
Example

Using a lever, you lift a 20 kg box a distance of 0.5 meters. If you apply a force of 50 newtons to the lever, over what distance must the lever move?

\[ F_{in} D_{in} = F_{out} D_{out} \]

Solve the equation for \( D_{in} \) by dividing both sides by \( F_{in} \)

\[ \frac{F_{in} D_{in}}{F_{in}} = \frac{F_{out} D_{out}}{F_{in}} \]

\[ D_{in} = \frac{20 \text{ kg} \times 9.8 \text{ m/s}^2 \times 0.5 \text{ m}}{50 \text{ kg m/s}^2} = 2.0 \text{ m} \]
Balancing a lever

To balance, the same amount of work must be done on each side of the fulcrum.

\[ \text{Work} = \text{Force} \times \text{Distance} \]

10 N at 6 cm from fulcrum

? N at 12 cm from fulcrum
BEFORE THE NEXT CLASS…

✓ Read textbook chapter 10
✓ Complete Homework Exercise 9
✓ Bring a blank Activity Sheet 10 to class.

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