Chapter Seven: Work and Energy

- 7.1 Force, Work, and Machines
- 7.2 Energy and the Conservation of Energy
- 7.3 Efficiency and Power

7.1 Learning Goals

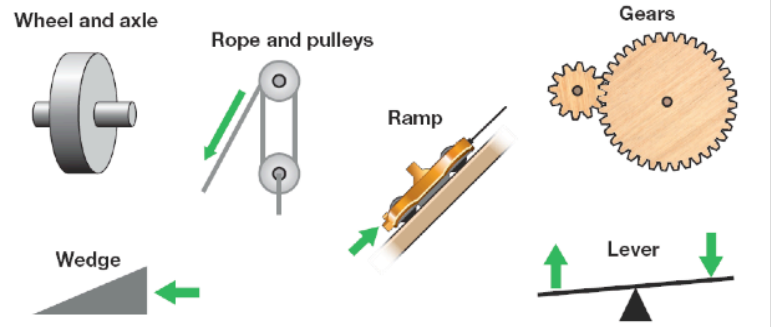
- Identify examples of simple machines.
- Evaluate the mechanical advantage of simple machines.
- Tell what it means to “do work” in a scientific sense.

7.1 Using Machines

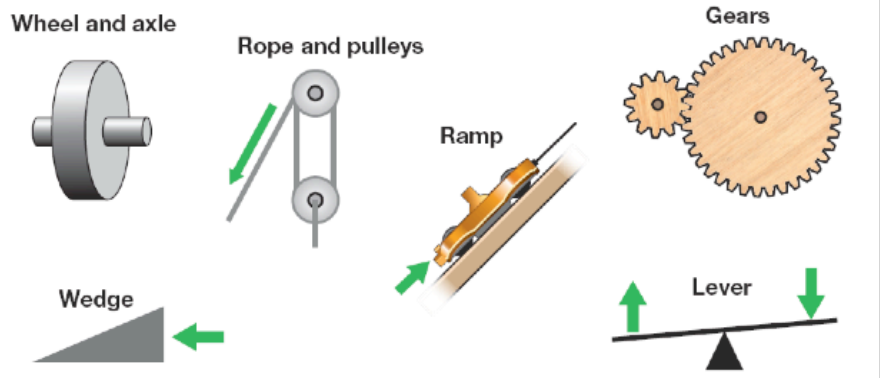
- The input includes everything you do to make the machine accomplish a task, like pushing on the bicycle pedals.
- The output is what the machine does for you, like going fast or climbing a steep hill.

7.1 Forces in Machines

- A simple machine is an unpowered mechanical device that accomplishes a task in one movement.



Simple Machines



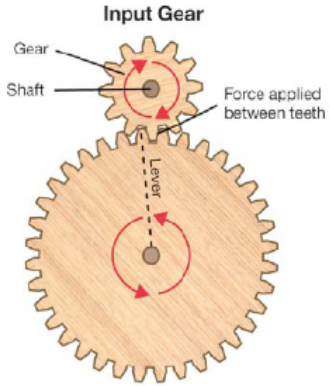
7.1 Simple Machines

Can you spot the simple machines?

- The lever, wheel and axle, rope and pulleys, screw, ramp, and gears are the most common types of simple machines.
- A bicycle is a complex machine made up of simple machines.

7.1 Gears

- A gear is a rotating wheel with teeth that receives or transfers motion and forces to other gears or objects.

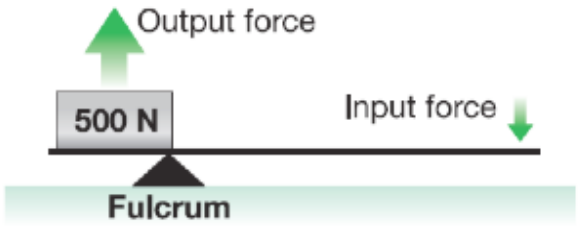


- Gears are found in all types of complex machines.

Can you names some complex machines?

7.1 The Lever

- A lever includes a stiff structure (the lever) that rotates around a fixed point called the fulcrum.



7.1 The Lever

- Levers are useful because you can arrange the fulcrum and the input arm and output arm to adjust the mechanical advantage of the lever.

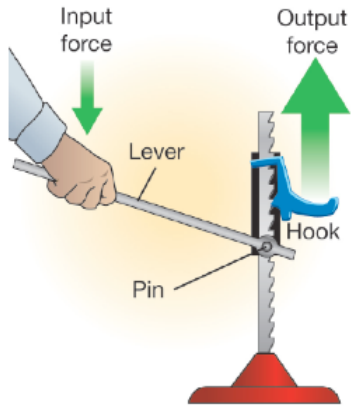
7.1 Mechanical advantage

- Mechanical advantage is the ratio of output force to input force.

Output force (N)

mechanical advantage → $MA = \frac{F_o}{F_i}$

Input force (N)



Solving Problems: Mechanical Advantage

MECHANICAL ADVANTAGE

Mechanical advantage — $MA = \frac{F_o}{F_i}$

F_o — Output force (N)

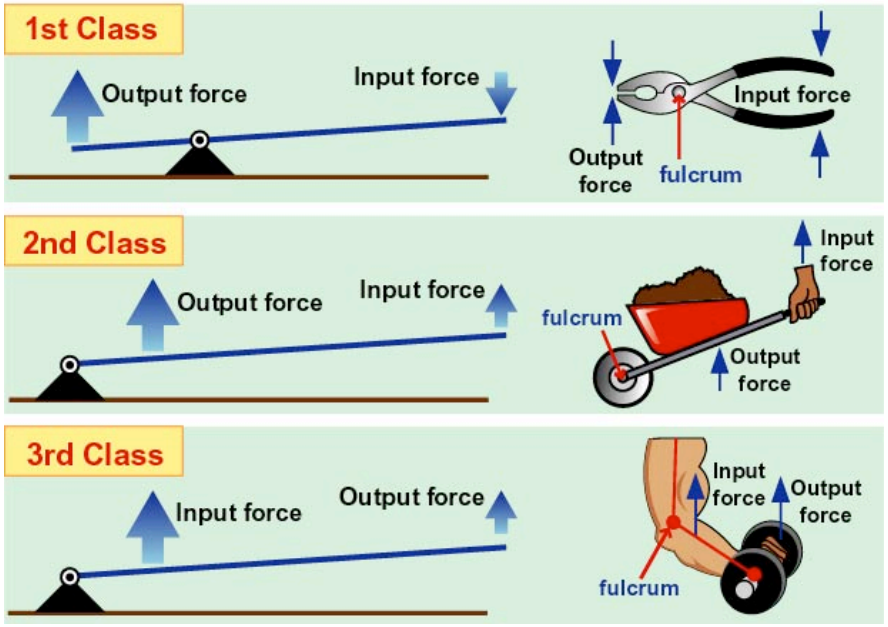
F_i — Input force (N)

7.1 Three classes of levers

- Pliers, a wheelbarrow, and your arm each represent one of the three classes of levers.
- Each class of levers is defined by the location of the input and output forces relative to the fulcrum.

Class of Lever	Fulcrum	Force	Length of Arms
1st	Between input and output forces	Vary in magnitude	Vary in length
2nd	One end of lever	Output > input	Input > output
3rd	One end of lever	Input > output	Output > input

The 3 Classes of Levers



7.1 Work and machines

- In science, work is the transfer of energy that results from applying a force over a distance.
- You do 1 joule of work if you push with a force of 1 newton for a distance of 1 meter.

7.1 Work

Force (N)

Work (joules) → $W = F \times d$

Distance (m)

is the amount of work done by pushing with a force of 1 newton for a distance of 1 meter.

7.1 Work

- When thinking about work, remember that work is done by forces that cause movement.
- If nothing moves (distance is zero), then no work is done.

Solving Problems: Work

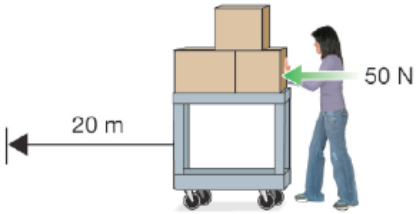
WORK

Force (newtons)

Work (joules) $W = Fd$

Distance in the direction of the force (meters)

Solving Problems



How much work is done by a person who pulls a cart with a force of 50 newtons if the cart moves 20 meters in the direction of the force?

Solving Problems

1. **Looking for:**
   - …work done by person
2. **Given:**
   - …force = 50 N (forward);
   - …distance = 20 m
3. **Relationships:**
   - Work = force x distance
4. **Solution**
   - 50 N × 20 m = **1,000 joules.**