

15-394 Intermediate Rapid Prototyping

Spring 2018

Instructor: Dave Touretzky

Your TAs



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What Is This Course About?

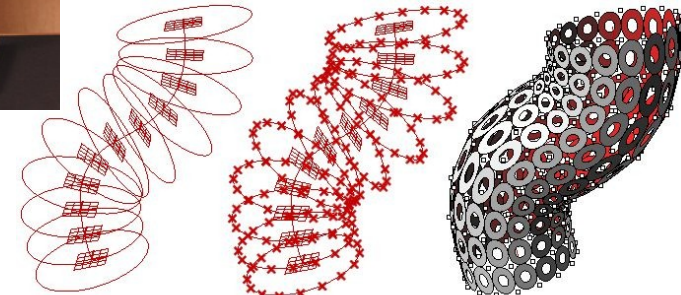
I. Mechanism Design

- Designing with gears, linkages, cams, etc.
- Simulation in SolidWorks
- Assembly of working artifacts



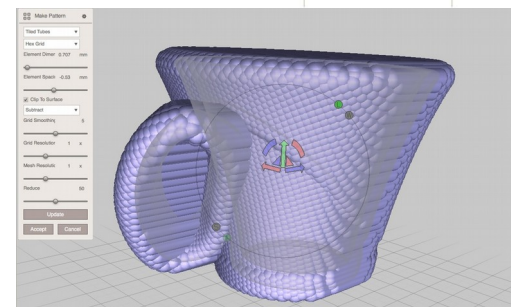
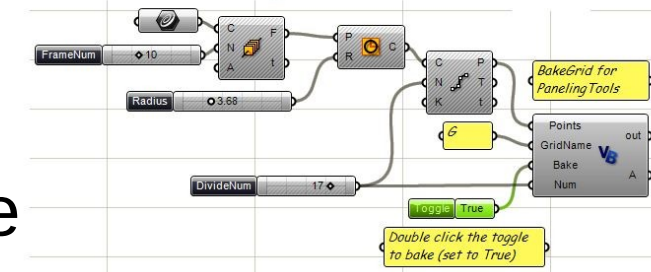
II. Computation With Geometric Primitives

- Grasshopper



III. Capturing and Manipulating 3D Structure

- 3D Scanning
- Mesh manipulation
- 3D printing



Prerequisites

- SolidWorks (comparable to 15-294)
- Fire extinguisher training: sign up today!
- Rabbit Laser checkout

Assignments

- There are four assignments, 10 points each:
 - Automaton
 - Mechanisms
 - Slicer
 - Statue
- There is a final project, for which you'll have a couple of weeks.
 - It's worth 30 points – nearly half your grade.
 - **Don't wait until the last minute!**

Communication

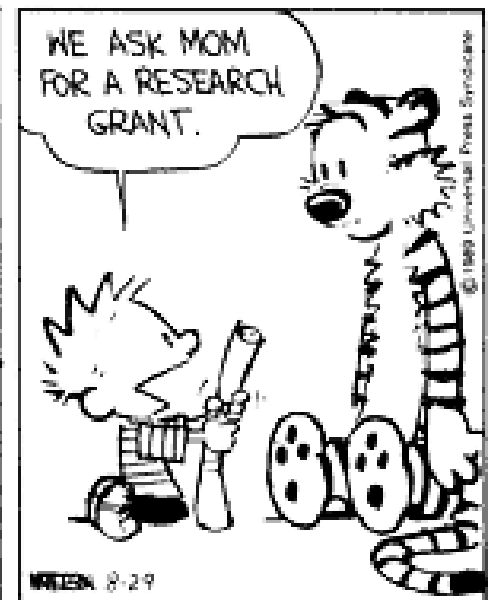
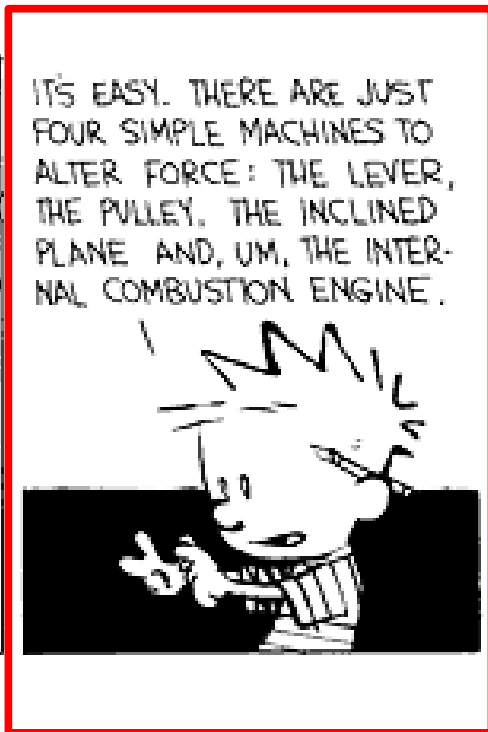
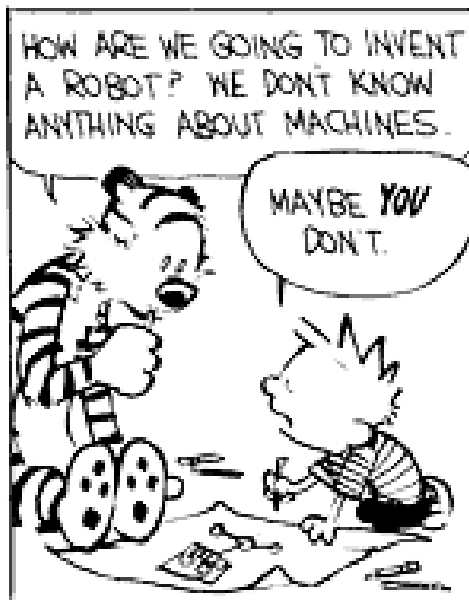
- We'll use Piazza for all class announcements.
- Please ask questions via Piazza, not in private email, unless there is a need to keep something confidential.

Academic Integrity

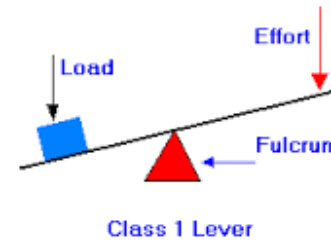
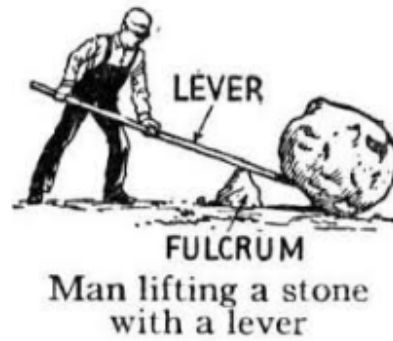
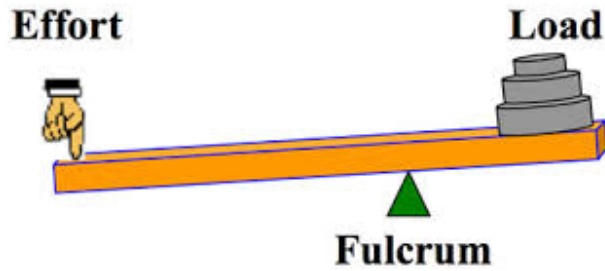
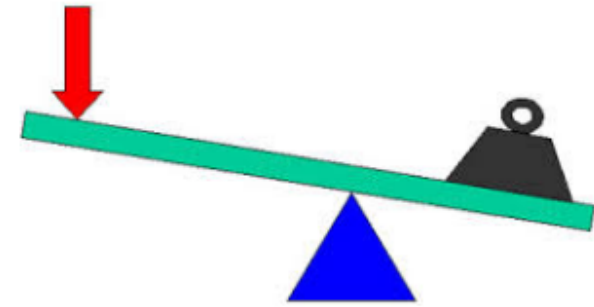
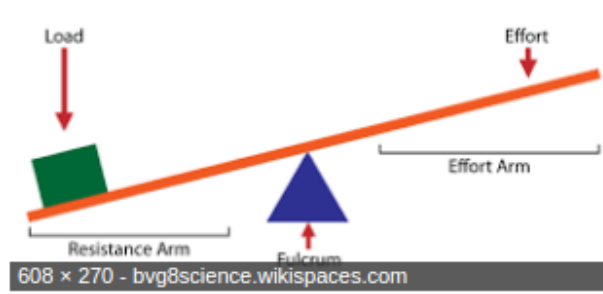
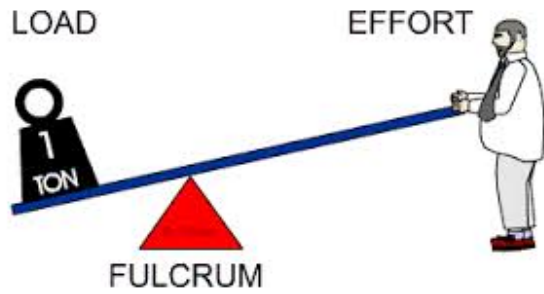
- The work you turn in must be your own.
 - You can help a fellow student with a SolidWorks error, but you can't share your code with them.
 - If you need help with an assignment, ask a TA or the instructor.
- Cite your sources.
 - It's fine for your final project to build on the work of others. Just make sure to cite your sources of inspiration and make clear how you have modified or extended their design.

Six Classical Simple Machines

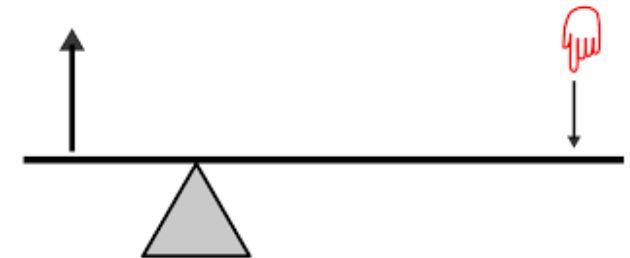
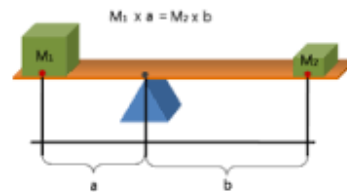
- Lever
- Wheel and axle
- Pulley
- Inclined Plane
- Wedge
- Screw



(1) The Lever

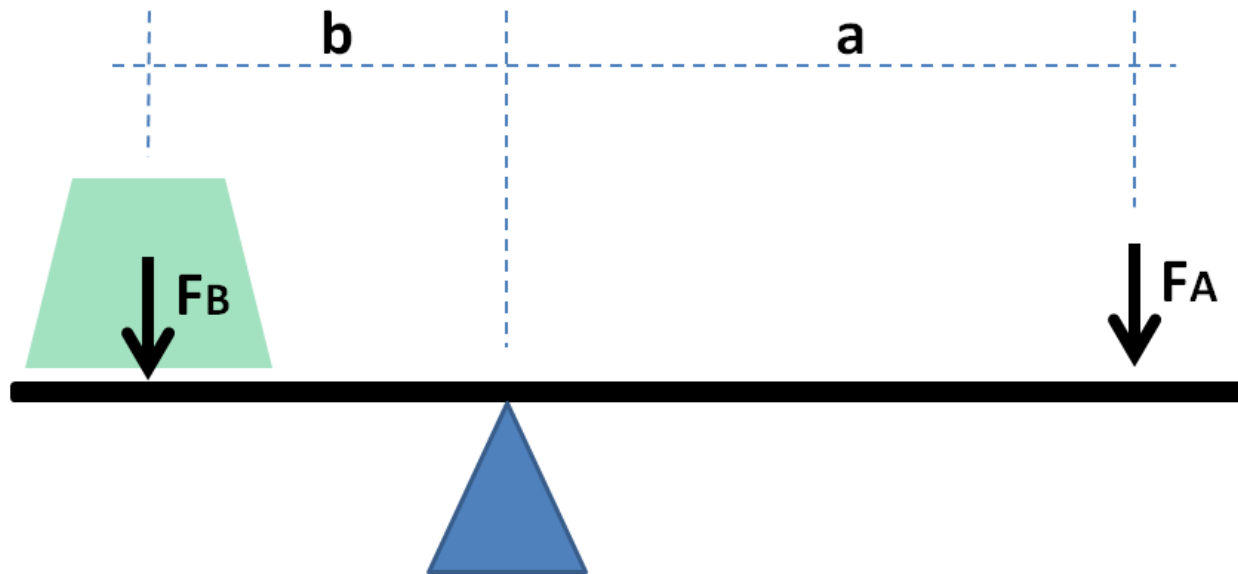


LEVER



Mechanical Advantage

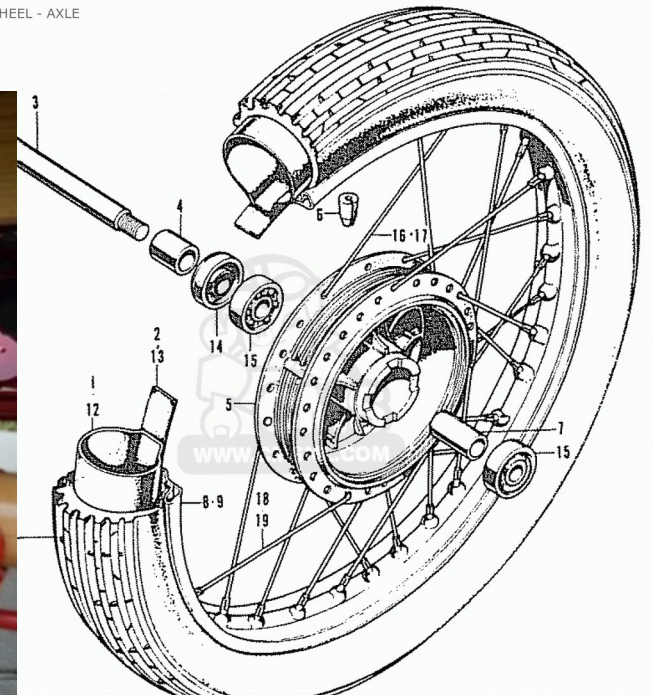
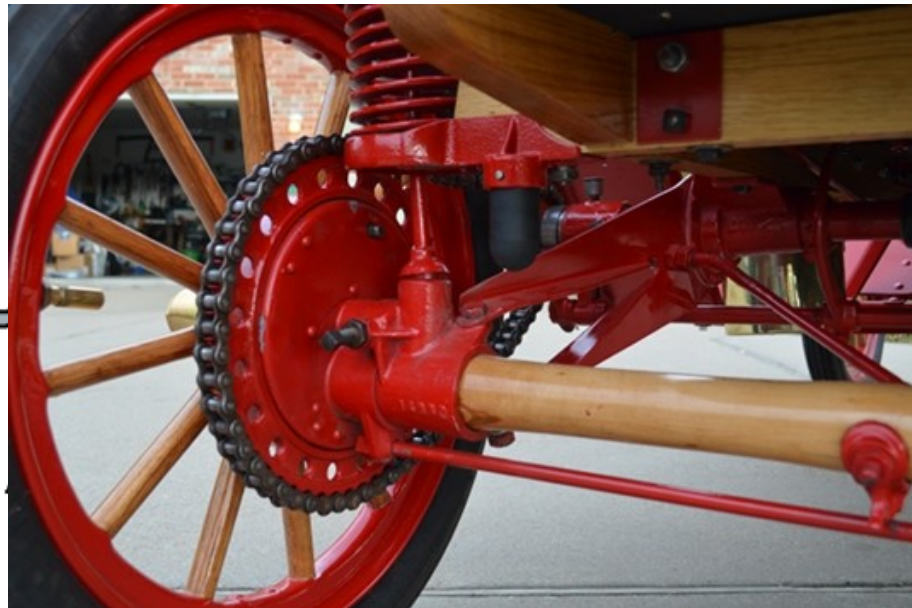
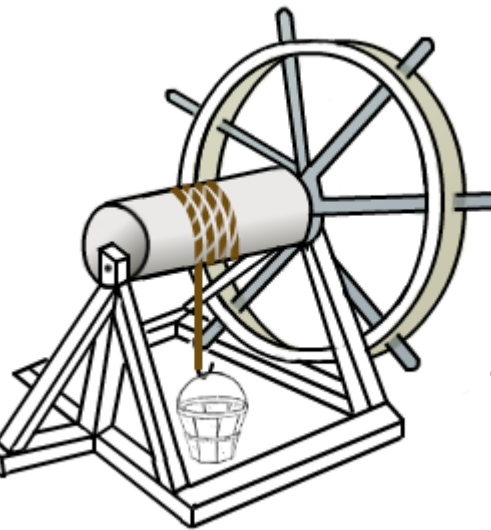
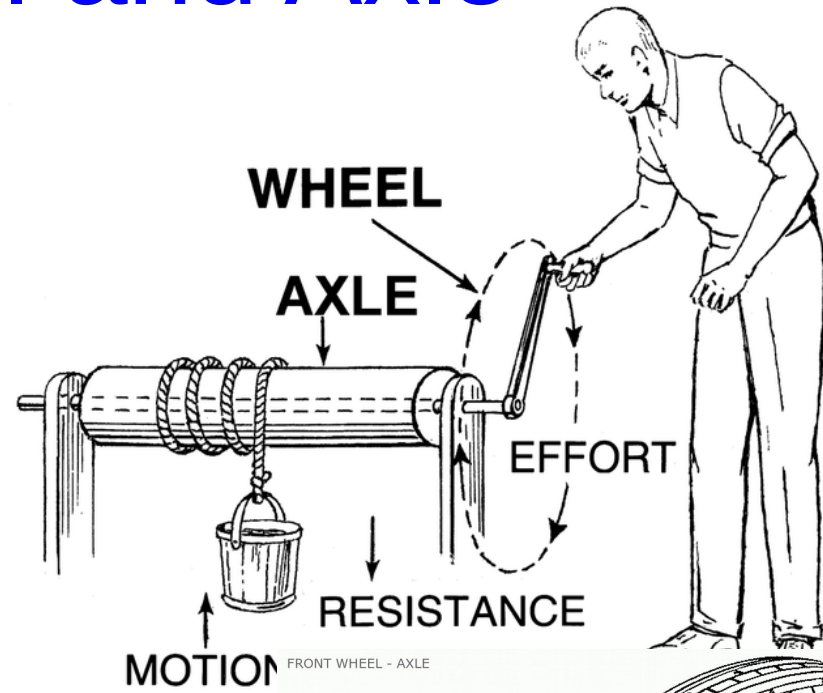
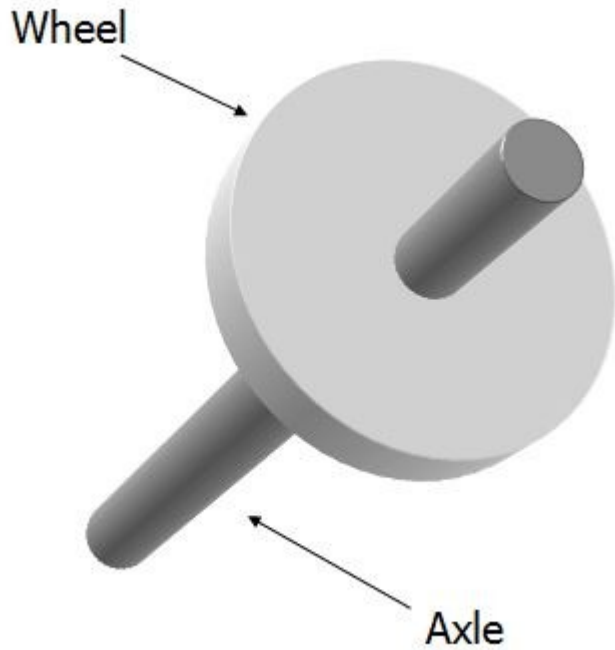
- The ratio of input force to output force.
- Ideal simple machines preserve power while trading force for distance traveled.



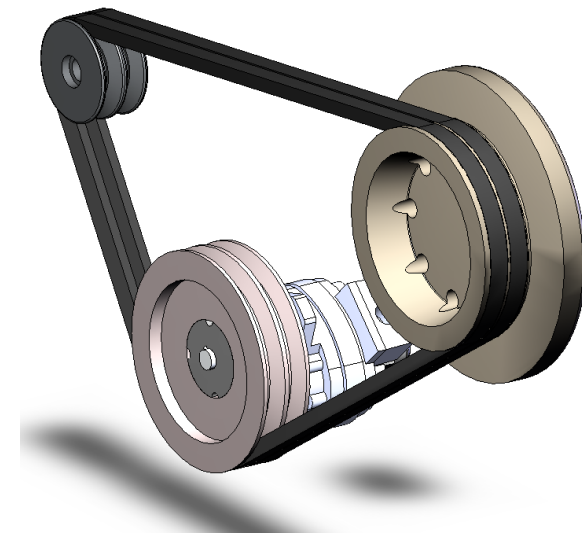
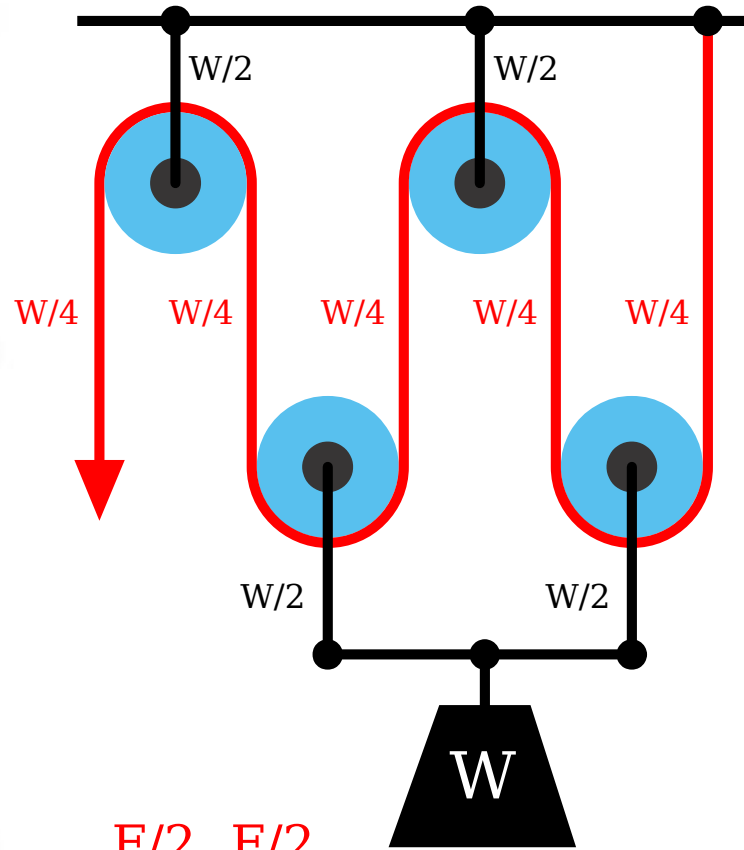
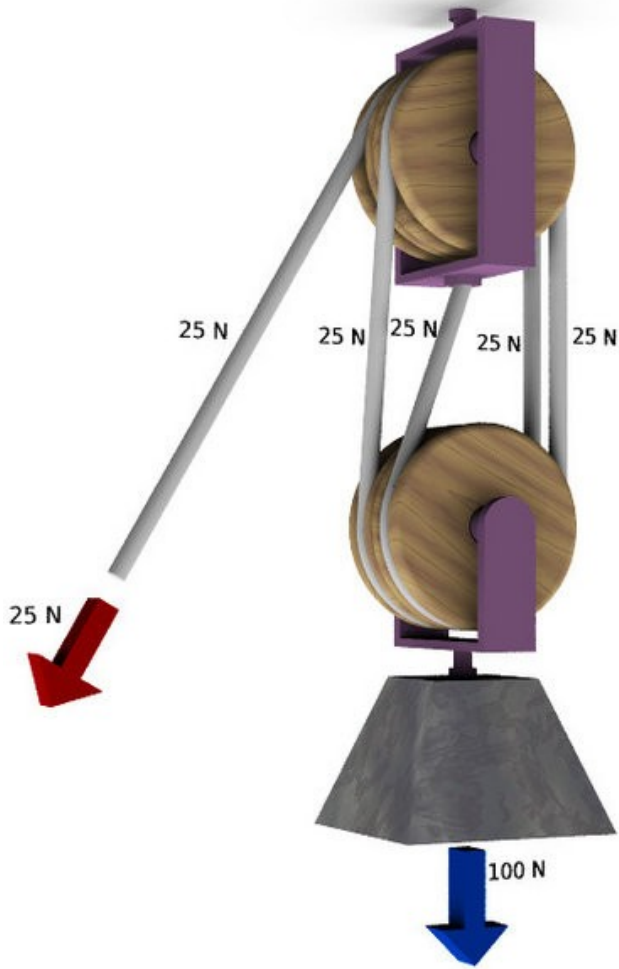
Law of the lever
(Archimedes):

$$a \times F_A = b \times F_B$$

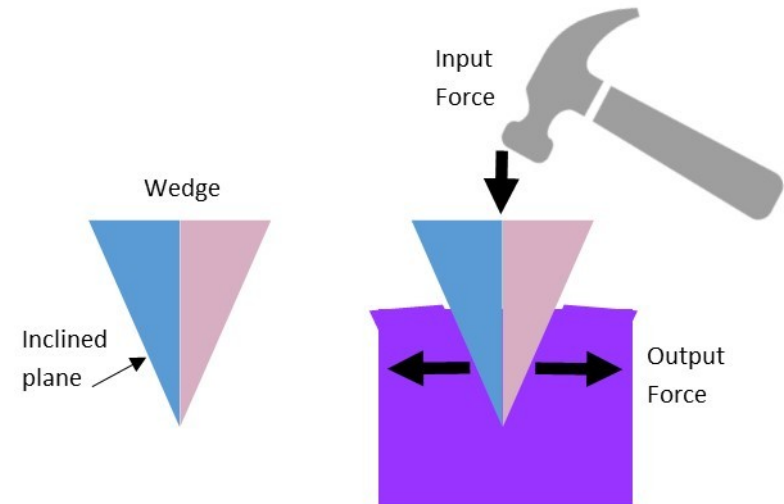
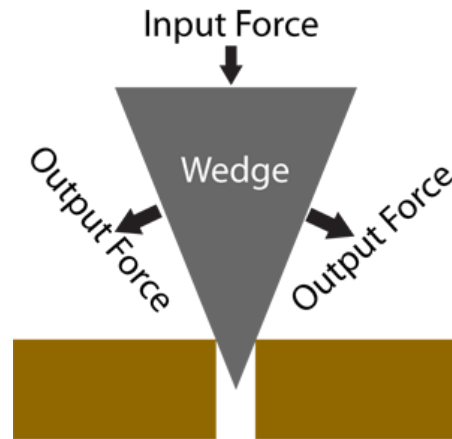
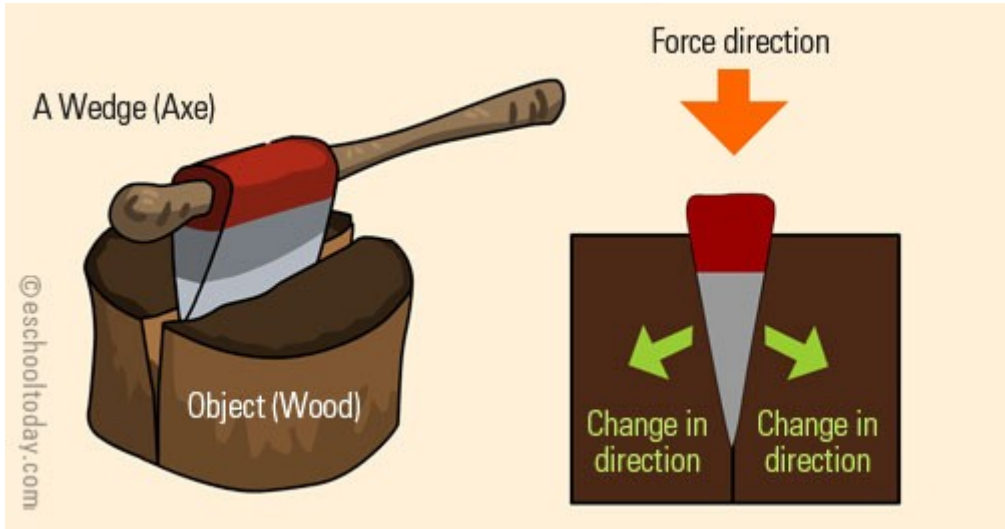
(2) Wheel and Axle



(3) The Pulley

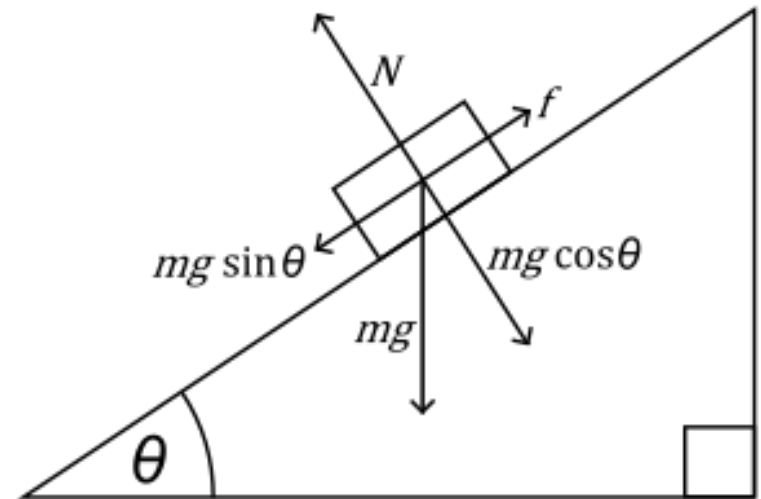
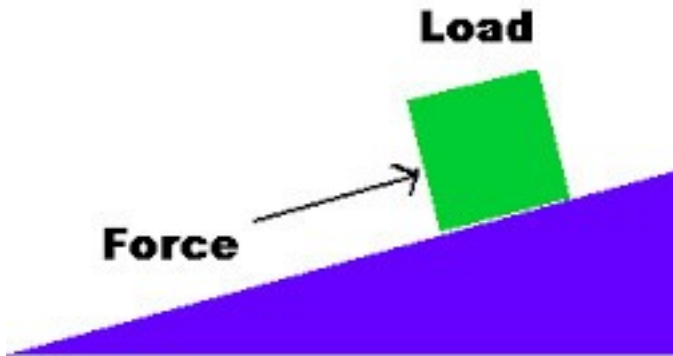


(4) The Wedge

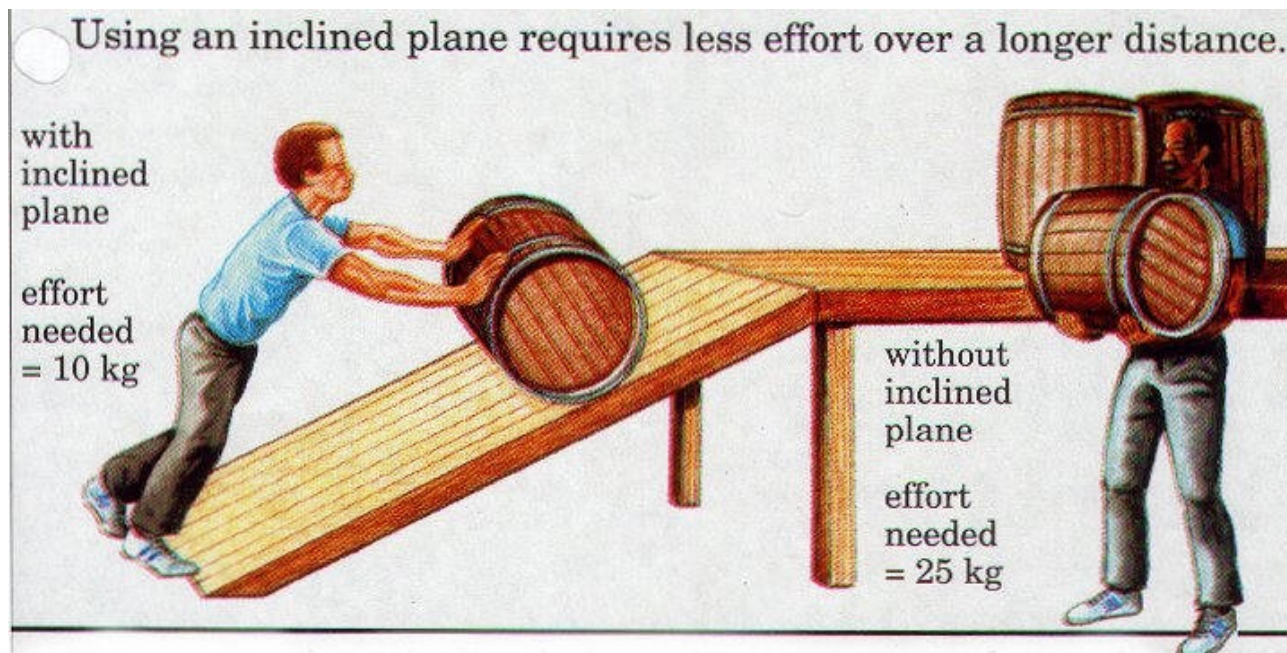


A wedge is a moving *inclined plane*.

(5) The Inclined Plane

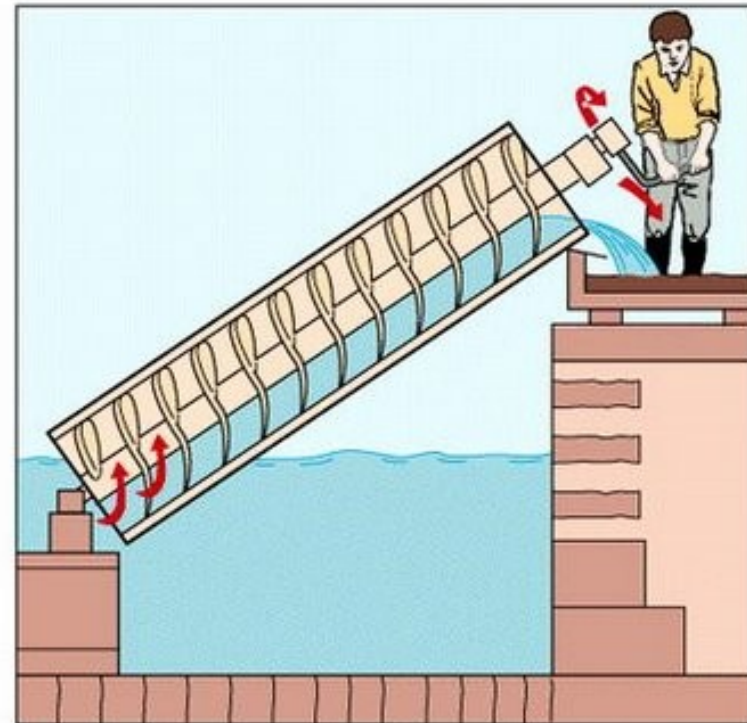
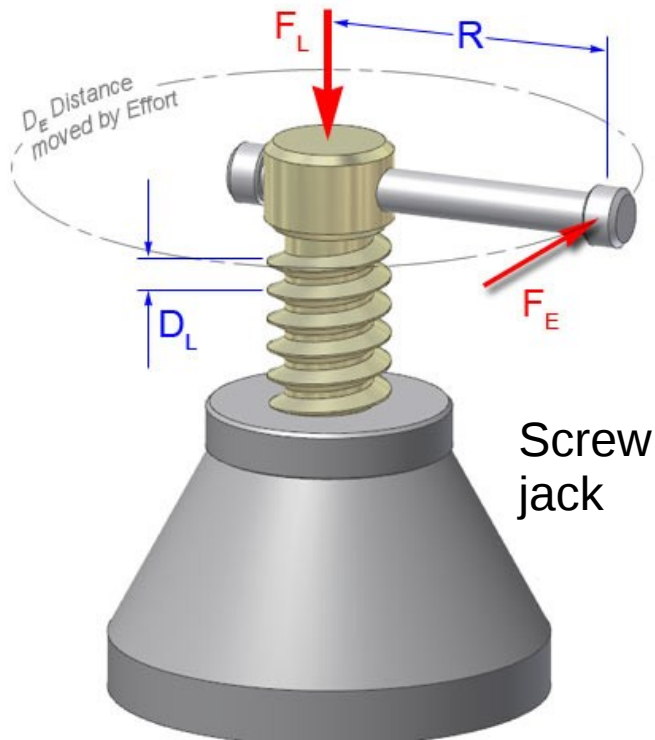
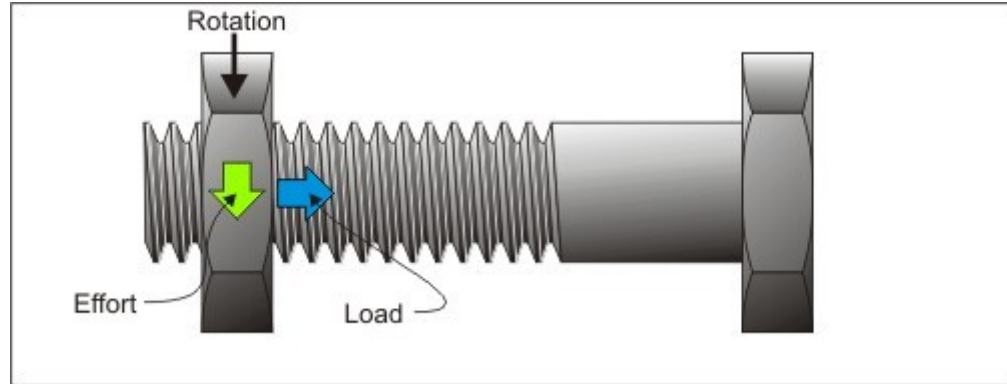
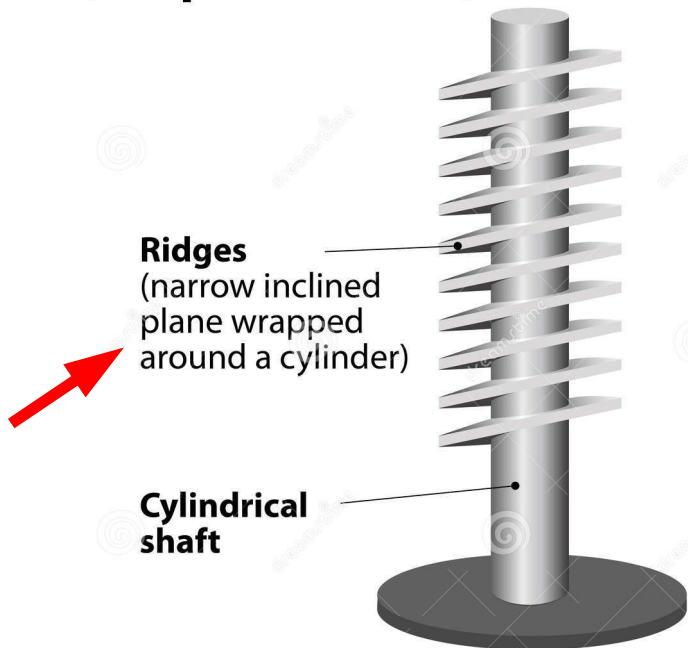


Tradeoff: less force over a longer distance to do the same amount of work.



SCREW (simple machine)

(6) The Screw



Equivalence of Simple Machines

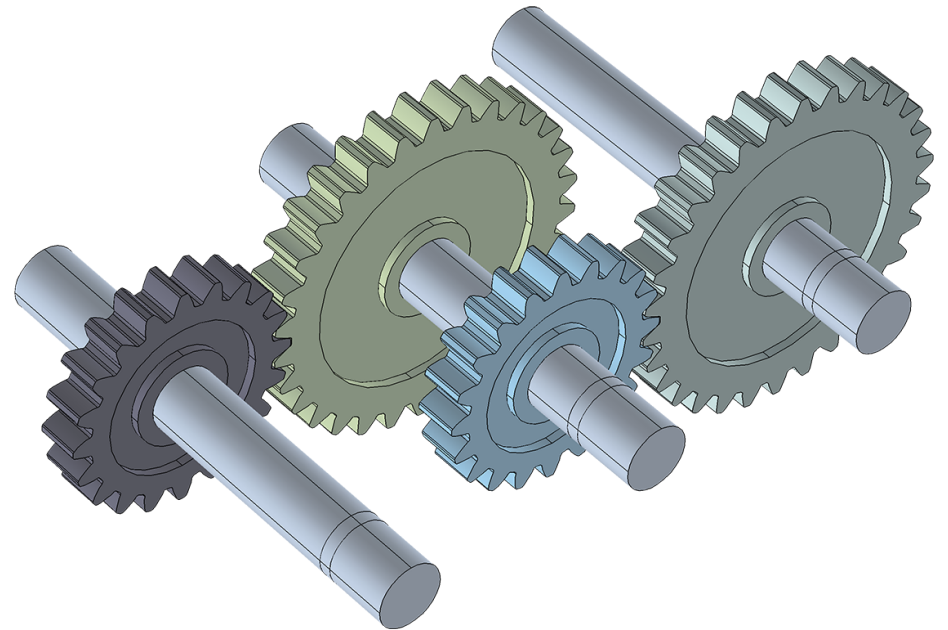
- Reuleaux (19th century mechanical engineer):
 - A lever, pulley, and wheel and axle are the same device: a body rotating about a hinge.
 - An inclined plane, wedge, and screw are the same device: a block sliding on a surface.

Gears Are Meshed Levers

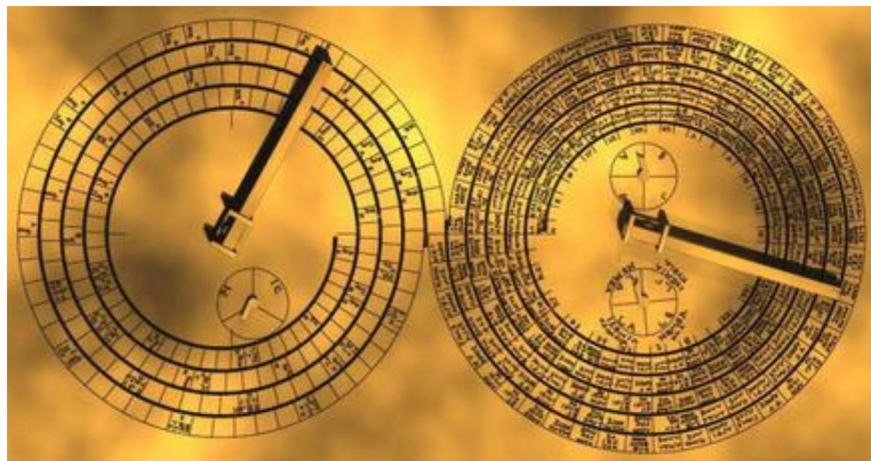
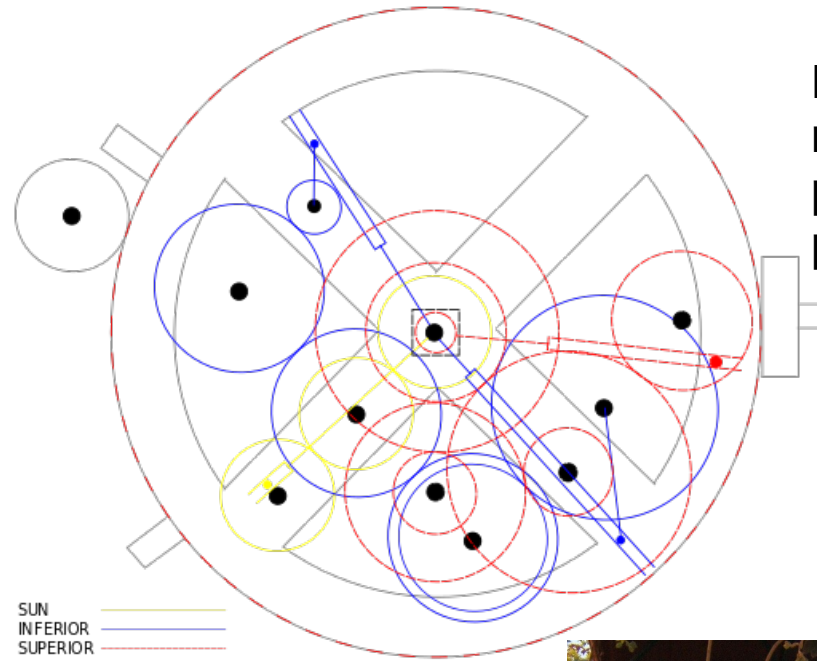


Compound Machines

- Formed from a set of simple machines connected in series.
- The output force of one machine provides the input force to the next.
- Example: a gear train.
- **Linkages** are machines that aren't necessarily connected in series: they can contain branches and loops.



Antikythera Mechanism (205-100 B.C.)



Back: 19 and 76 year cyclic calendars

