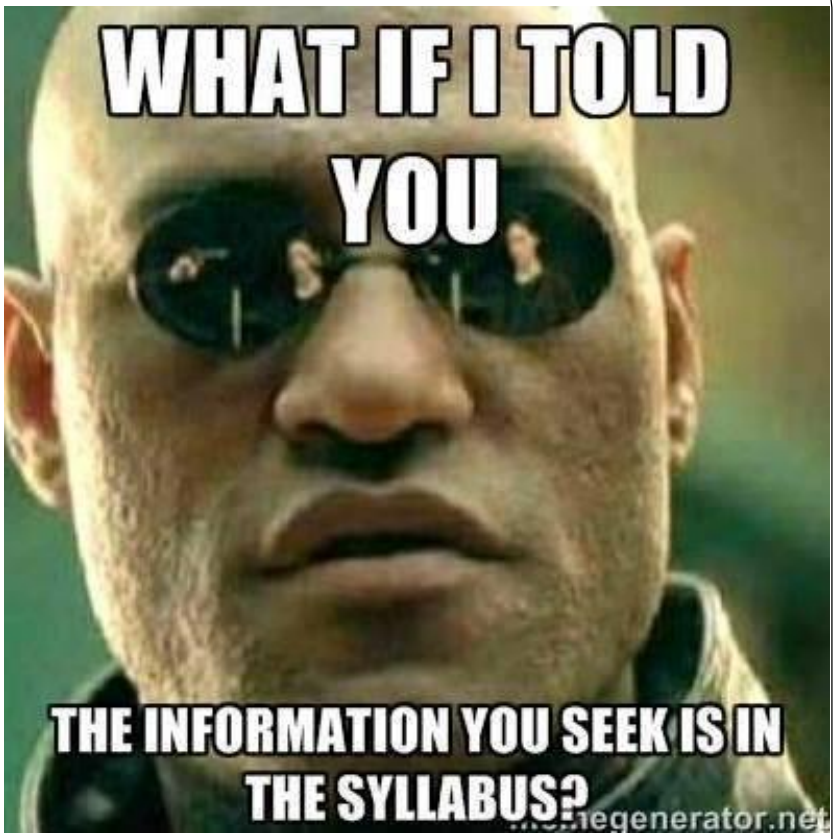
To do...

- Register i>clicker (Compass)
- MATLAB office hours
  - WED/FRI 9-5 pm in MEL 1001
- Mastering Engineering office hours
  - WED/THURS
  - 4-6 pm in Grainger 429



- HW 0 (PrairieLearn) due FRI
- HW 1 (Mastering Engineering) due SUN
- HW 2 (PL) due TUES

- Use Illinois netid/email

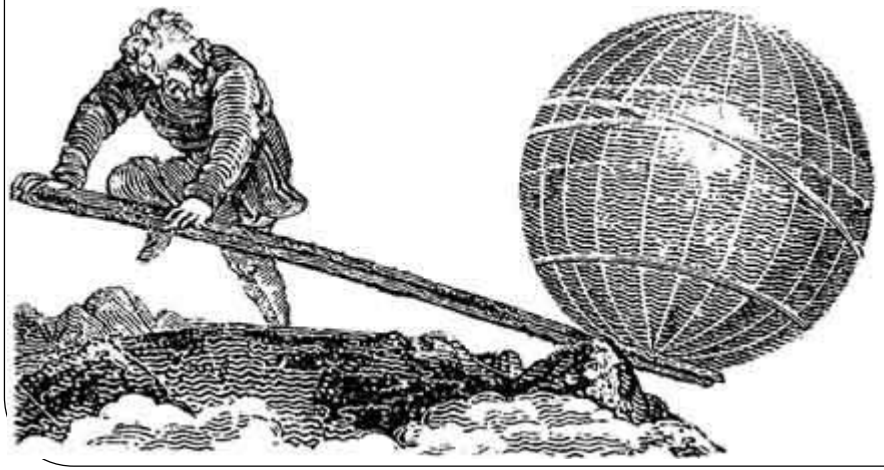
Chapter 1: General Principles
Main goals and learning objectives

- Introduce the basic ideas of *Mechanics*
- Give a concise statement of Newton's laws of motion and gravitation
- Review the principles for applying the SI system of units
- Examine standard procedures for performing numerical calculations
- Outline a general guide for solving problems

What is “statics”?

- Science
  - Life
  - Physical
    - Astronomy
    - Physics
      - Relativity
      - Mechanics
      - Thermo
      - More!
    - Chemistry
    - More!
  - Social
  - More!

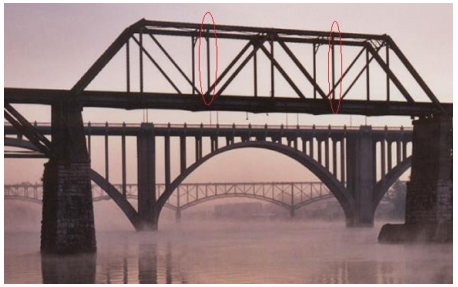
- Mechanics: State of rest or motion of bodies subjected to forces



Mechanics

Mechanics is a branch of the physical sciences that is concerned with the **state of rest or motion of bodies that are subjected to the action of forces**

Rigid Bodies



Statics

Dynamics

Deformable Bodies

Solid Mechanics

Fluids

Compressible and incompressible

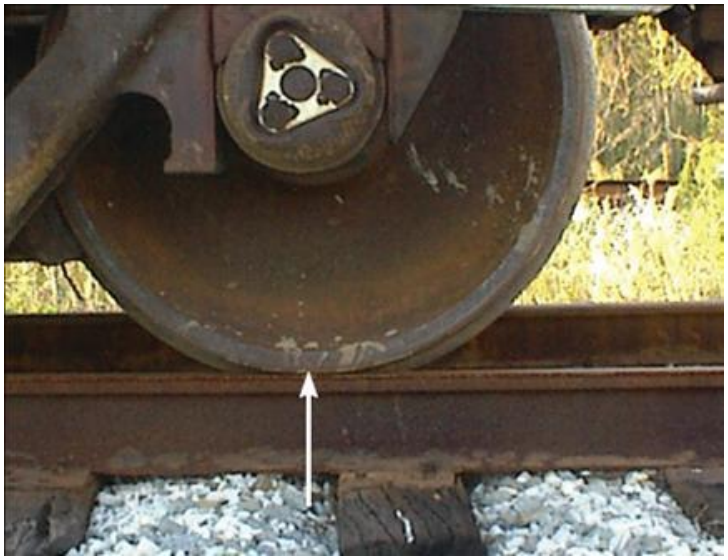
victorstuff.com

Which forces?

www.ashvegas.com

- Mechanics: State of rest or motion of bodies subjected **to forces**

Fundamental concepts



Basic quantities:

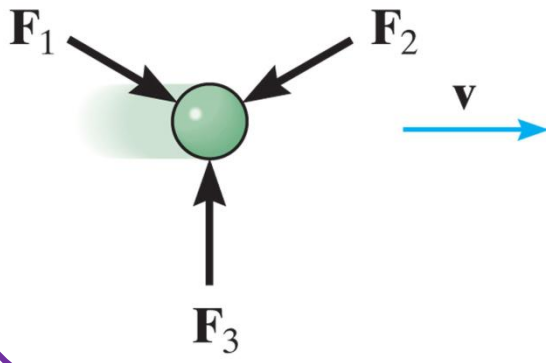
Idealizations:

- Particle:
- Rigid Body:
- Concentrated Force:

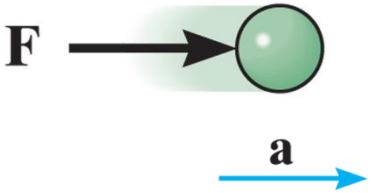
Understanding and applying these things allows for amazing achievements in engineering! (planes, robotics, etc)

Newton's laws of motion

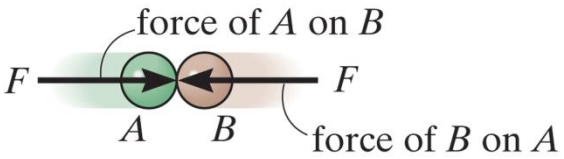
First law:



Second law: a particle acted upon by an unbalanced force **F** experiences an acceleration **a** that is proportional to the particle mass *m*:



Third law: the mutual forces of action and reaction between two particles are _____, _____ and _____.



Newton's law of gravitational attraction

The mutual **force F of gravitation** between two particles of mass m_1 and m_2 is given by:

G is the universal constant of gravitation (small number)
r is the distance between the two particles

Weight is the force exerted by the earth on a particle at the earth's surface:

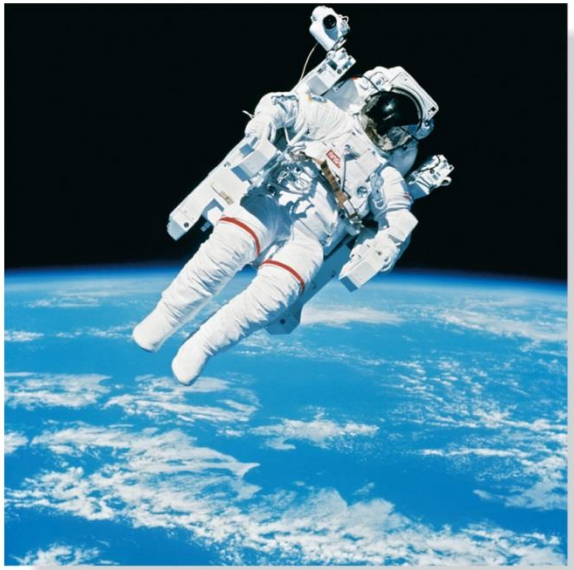


Figure: 01_PH003
The astronaut's weight is diminished, since she is far removed from the gravitational field of the earth.

M_e is the mass of the earth
r_e is the distance between the earth's center and the particle near the surface
g is the acceleration due to the gravity

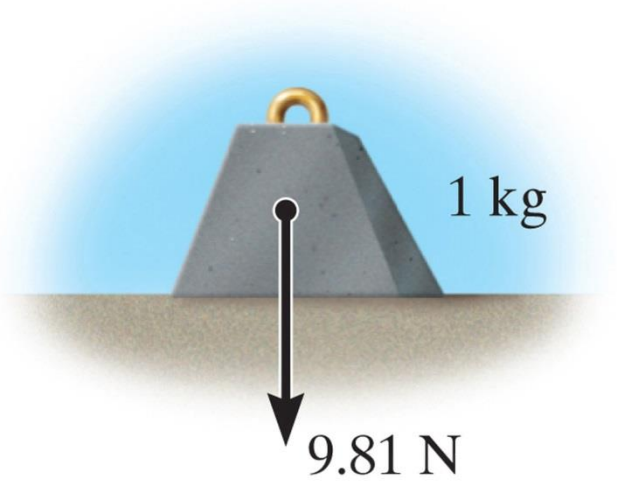
Castells of Catalonia

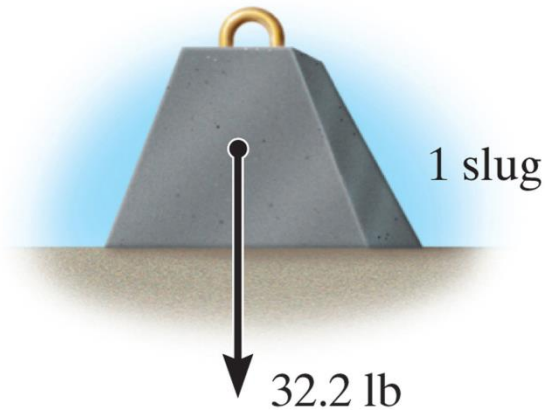
Units

TABLE 1–1 Systems of Units

Name	Length	Time	Mass	Force
International System of Units SI	meter m	second s	kilogram kg	newton* $\left(\frac{\text{kg}\cdot\text{m}}{\text{s}^2}\right)$
U.S. Customary FPS	foot ft	second s	slug* $\left(\frac{\text{lb}\cdot\text{s}^2}{\text{ft}}\right)$	pound lb

*Derived unit.





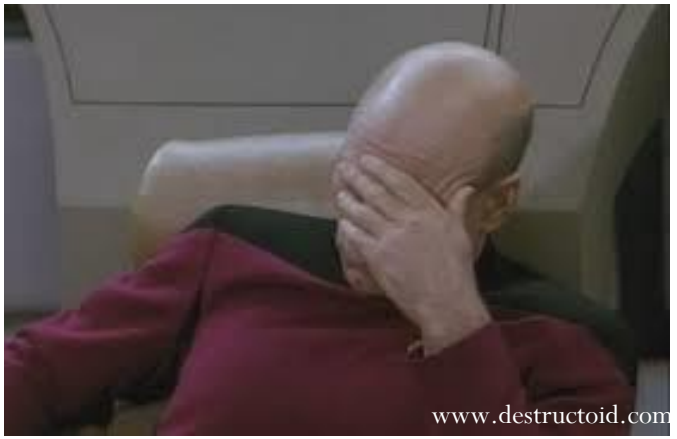
$$G = 66.73 \times 10^{-12} \frac{m^3}{kg \cdot s^2}$$

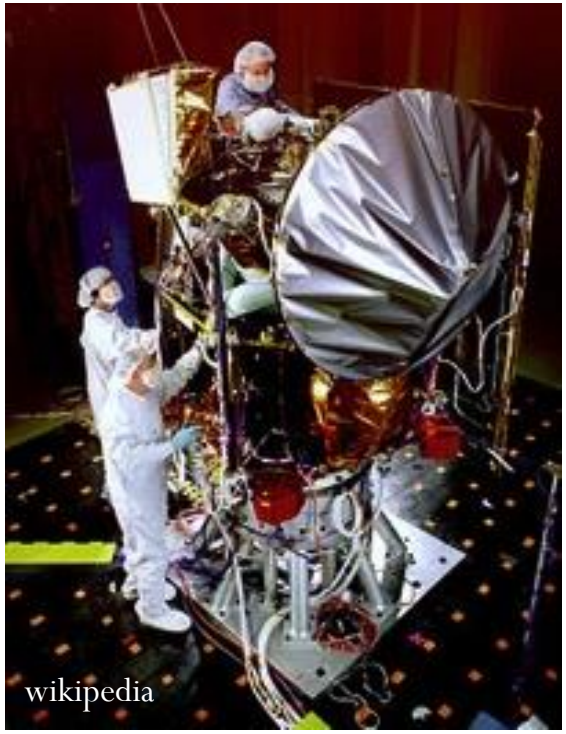
$$g = 9.81 \frac{m}{s^2}$$

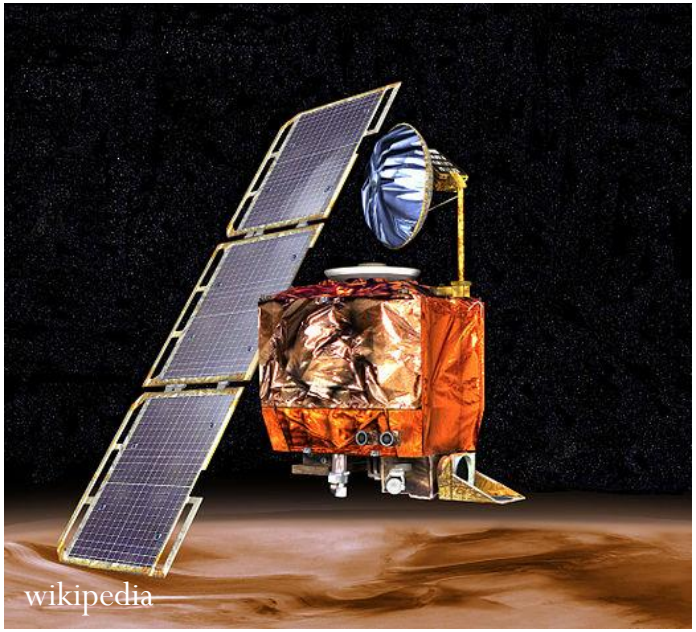
$$g = 32.2 \frac{ft}{s^2}$$

Why so picky? Units matter…

- A national power company mixed up prices quoted in kilo-Watt-hour (kWh) and therms.
  - Actual price = $50,000
  - Paid while trading on the market: $800,000
- In Canada, a plane ran out of fuel because the pilot mistook liters for gallons!. He landed the plane safely without power on an emergency airstrip.







Mars climate orbiter – $327.6 million

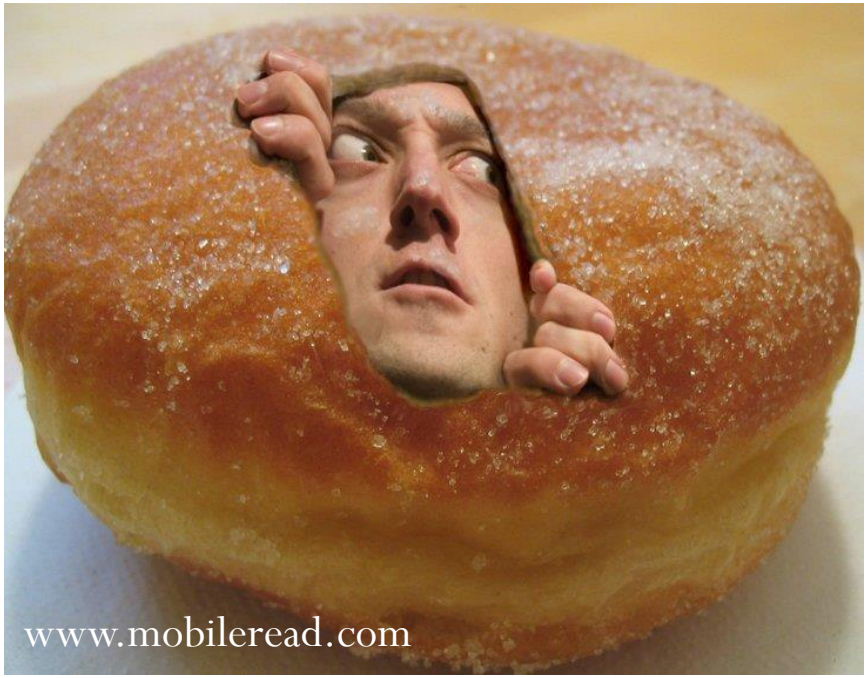
The 'super-tall' age is here: World welcomes 100th mammoth skyscraper

Could this detachable plane cabin really save lives?

Numerical Calculations

Dimensional Homogeneity

Equations ***must*** be dimensionally homogeneous, i.e., each term must be expressed in the same units. Consider the following example:



Numerical Calculations

Significant figures

The number of significant figures contained in any number determines the accuracy of the number. Use 3 significant figures for final answers. For intermediate steps, use symbolic notation, store numbers in calculators or use more significant figures, in order to maintain precision.

Example 1: If d = 3.2 in., w = 1.413 in., and h = 2.7 in., then

General procedure for analysis

1. Read the problem carefully; write it down carefully.

2. Model the problem: Draw given diagrams neatly and construct additional figures as necessary.

3. Apply principles needed.

4. Solve problem symbolically. Make sure equations are dimensionally homogeneous

5. Substitute numbers. Provide proper units *throughout*. Check significant figures. Box the final answer(s).

6. See if answer is reasonable.

Most effective way to learn engineering mechanics is to ***solve problems!***