wc02lect

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wc02lect

Announcements

- ❑ Go through course website (schedule & lectures)
- ❑ Register i>clicker (Compass)
- ❑ MATLAB Clinics Wed/Fri 9am-6pm MEL1001
- ❑ Special ME Office Hours (Grainger Library room 429):
  Wednesday (8/30) and Thursday (8/31), 4-6 pm
- ❑ Upcoming deadlines:
  - Friday (9/1)
    - Prairie Learn HW0
  - Sunday (9/3)
    - Mastering Engineering HW1
  - Tuesday (9/5)
    - Prairie Learn HW1

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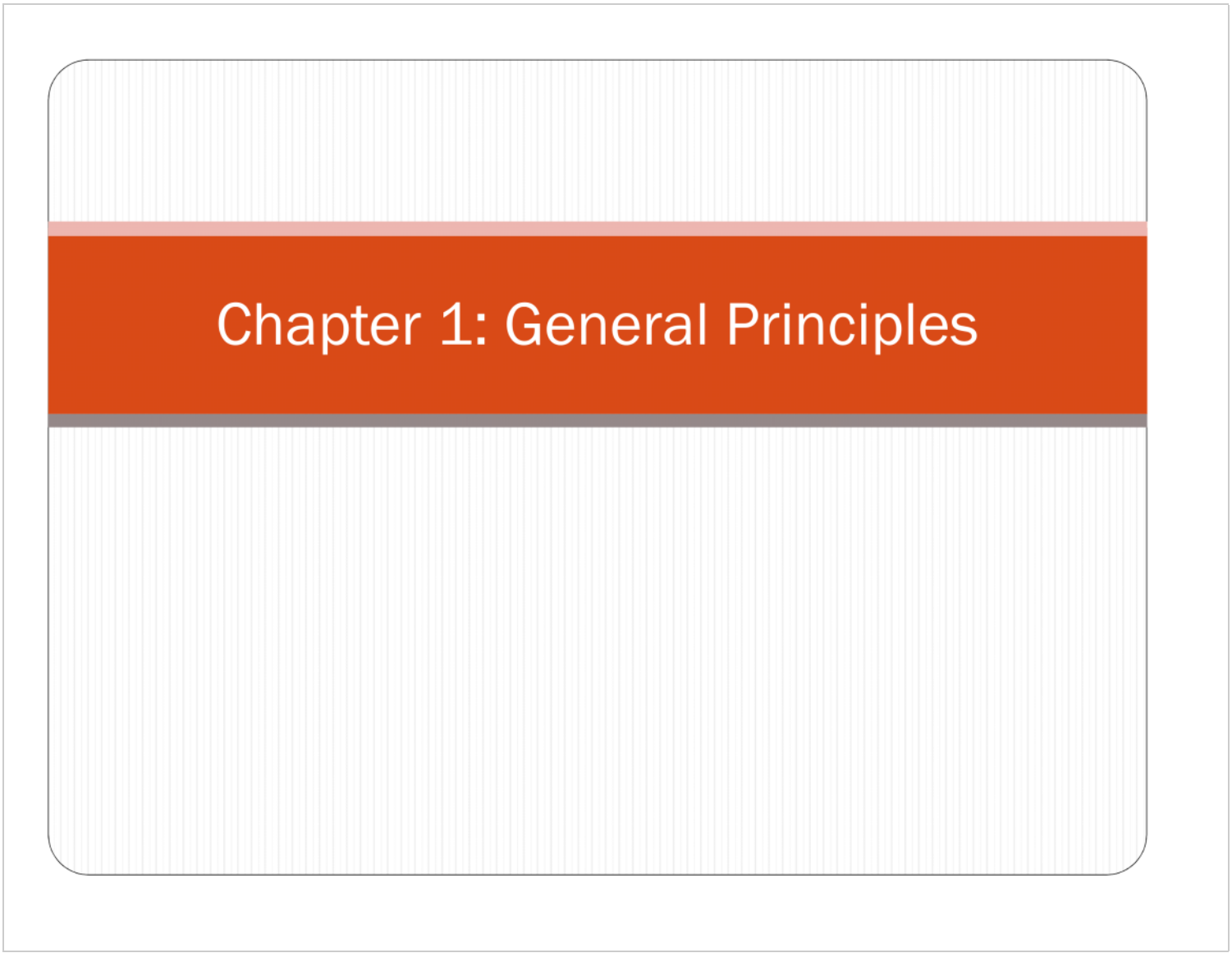

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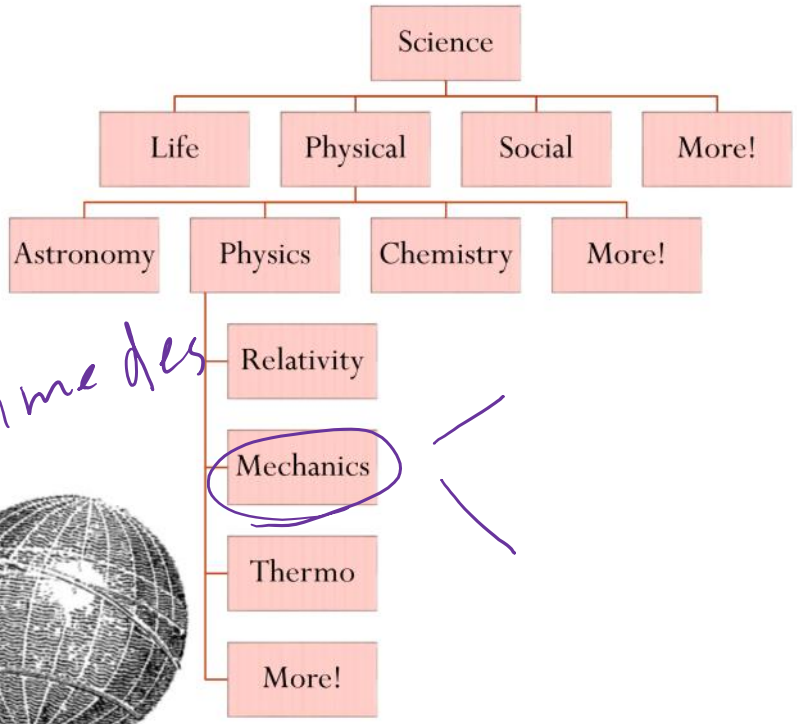
What is "statics"?



Archimedes

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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

4 L2 - Gen Principles & Force Vectors

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victorstuff.com

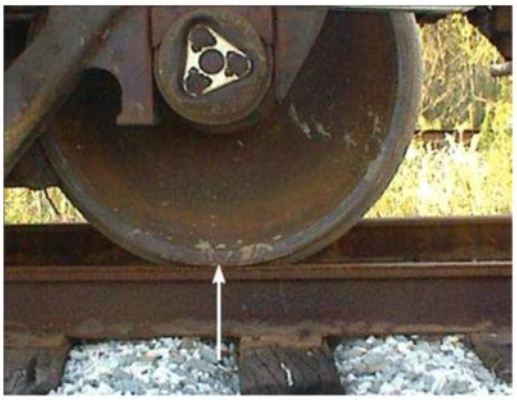
state of rest or motion of bodies that are subjected to the action of forces

www.ashvegas.com

Which forces?

- gravity ✓
- electrical
- magnetic
- ⋮

Fundamental concepts



Basic quantities:

- length
- mass
- time
- force

Idealizations:

- Particle: has mass, but not size.
- Rigid Body: has mass and size (system of particles) no deformation
- Concentrated Force: it is applied at a point.

Understanding and applying these things allows for amazing achievements in engineering!

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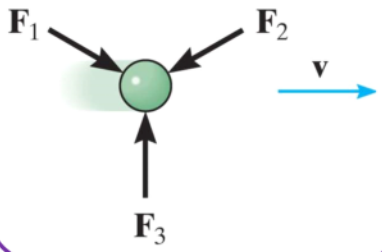
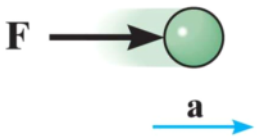
Newton's laws of motion

First law: Object in motion will remain so until acted upon by a net force. (constant velocity in straight line or at rest)

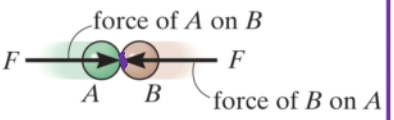


Second law: a particle acted upon by an unbalanced force **F** experiences an acceleration **a** that is proportional to the particle mass *m*:

$$F = ma$$



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



F F - non-collinear

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:

$$F = G\frac{m_1 m_2}{r^2}$$

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:

$$W = m\left(\frac{Gm_e}{r_e^2}\right) = mg$$

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

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

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

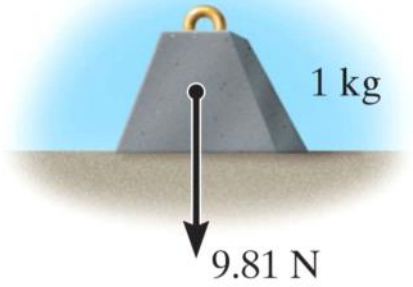
M_e is the mass of the earth
r_e is the distance between the earth's center and the particle near the surface
g is the acceleration due to the gravity

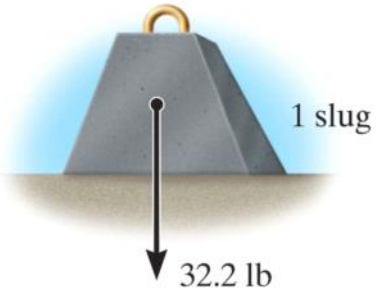
Units

TABLE 1–1 Systems of Units

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

*Derived unit.





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

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

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

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Numerical Calculations

Dimensional Homogeneity

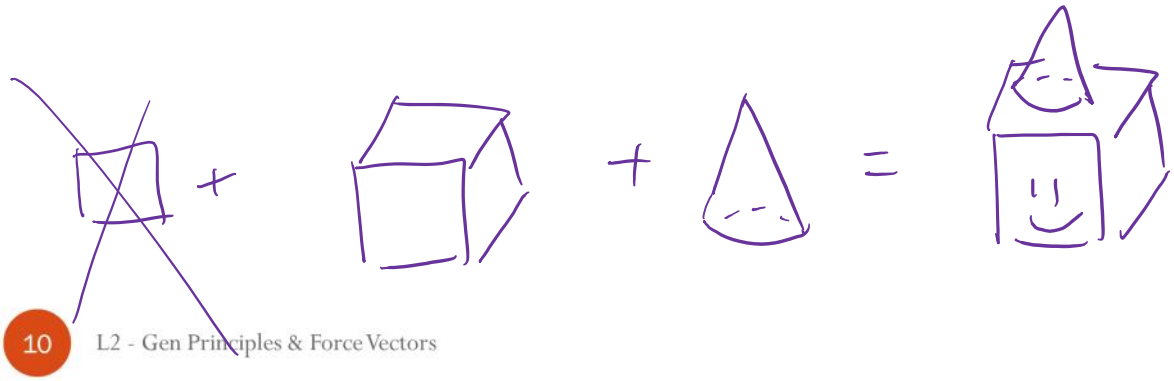
Equations ***must*** be dimensionally homogeneous, i.e., each term must be expressed in the same units.

Work problems in the units given unless otherwise instructed!

$$mg = [kg]\left[\frac{m}{s^2}\right] = \frac{kg \cdot m}{s^2} = [N]$$

$$\Sigma F = F_1 + F_2 + W = F_R$$

$$[N] + [N] + [N] = [N]$$



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Numerical Calculations

Significant figures

The number of significant figures contained in any number determines the accuracy of the number. Use 3 or > 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.

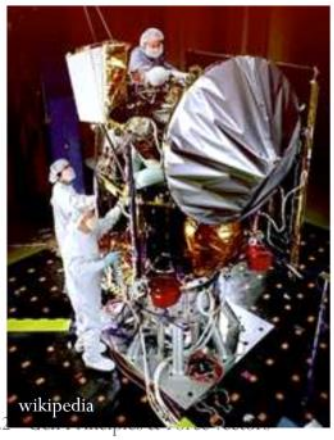
134.76 ⇒ 130 :(

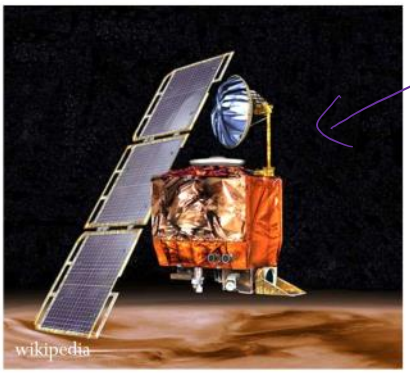
↓

135.

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
- take sat. photo
- weather
- 193.1 million USD!!!
NASA
Lockheed
FPS.
83

12

http://www.planetseed.com/sciencearticle/importance-units

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.

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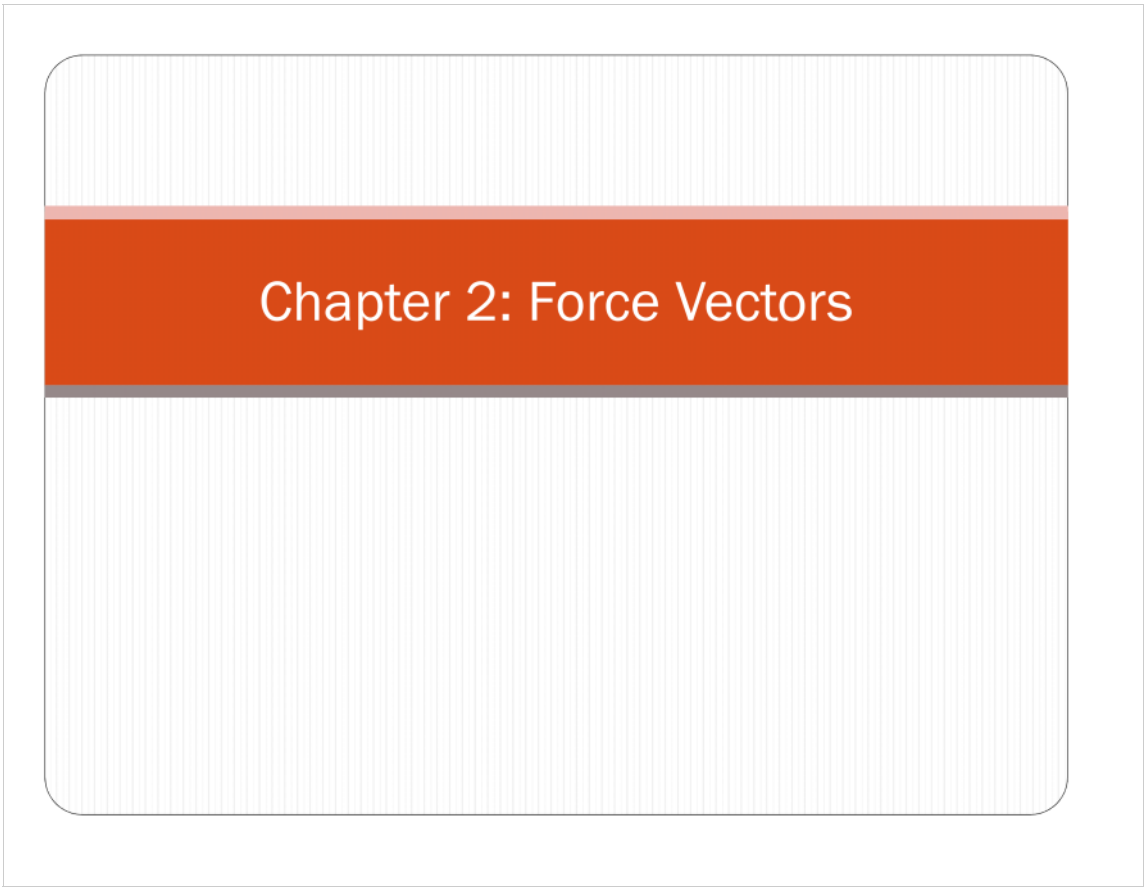

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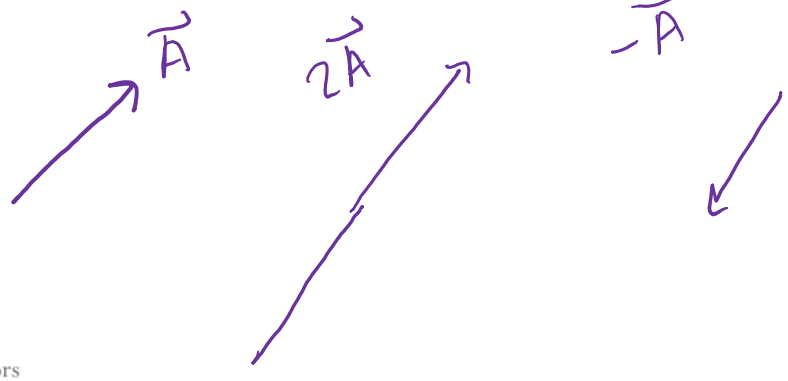
Scalars and vectors

	Scalar	Vector
Examples	Mass, Volume, Time	Force, Velocity
Characteristics	It has a magnitude	It has a magnitude and direction
Special notation used in TAM 210/211	None	Bold font or symbols ("~" or "→") Ex:

A, S $\underset{\sim}{A}$ $\vec{A}$ $\tilde{A}$ **A**

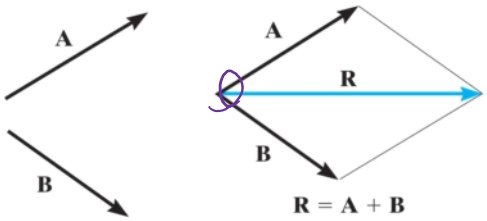
Multiplication or division of a vector by a scalar

$$\boldsymbol{B} = \alpha \boldsymbol{A}$$

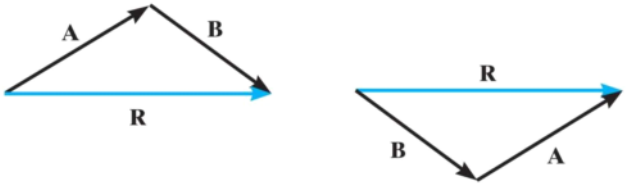


Vector addition

$$\boldsymbol{R} = \boldsymbol{A} + \boldsymbol{B}$$



R = A + B
Parallelogram law

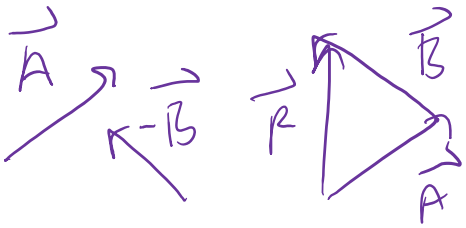


R = A + B
Triangle rule

R = B + A
Triangle rule

Vector subtraction:

$$\boldsymbol{R} = \boldsymbol{A} - \boldsymbol{B} = \boldsymbol{A} + (-\boldsymbol{B})$$



Commutative law:

$$\boldsymbol{R} = \boldsymbol{A} + \boldsymbol{B} = \boldsymbol{B} + \boldsymbol{A}$$

Associative law:

$$\boldsymbol{A} + (\boldsymbol{B} + \boldsymbol{C}) = (\boldsymbol{A} + \boldsymbol{B}) + \boldsymbol{C}$$

Scalar/Vector multiplication:

$$\alpha(\boldsymbol{A} + \boldsymbol{B}) \qquad (\alpha + \beta)\boldsymbol{A}$$