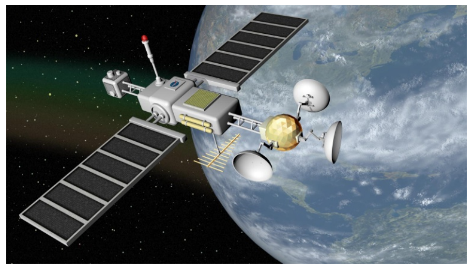
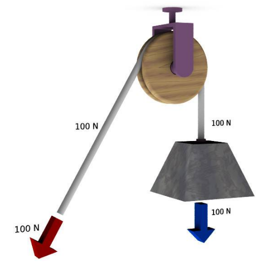
ECOR 1101 - Lecture Notes

Lecture #1 - Introduction (Chapter 1)

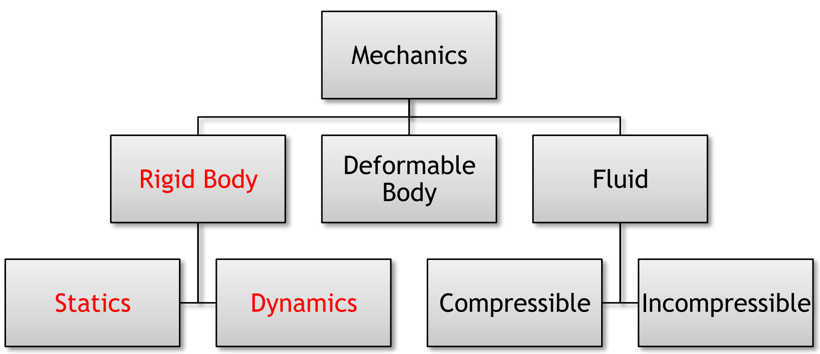
What is Mechanics?

- Study of bodies when acted by forces. The body is at rest or in motion
- Either the bodies or the forces can be large





Branches of Mechanics



Fundamental Units (Dimensions)

- Four fundamental physical quantities (dimensions)
  - Length: Used to locate a body in space and to measure the size of boides (m, ft)
  - Mass: Used to measure the quantity of matter in a bidy (kg, slugs)
  - Time: Used to measure the succession of event (s)
  - Force: Used to measure a “push” or “pull” exerted by one body on another (lb, N)

Systems of Units

- We work with two systems of units in mechanics
  - SI - Système International d'Unités
  - US Customary System (Imperial Units)
- Both systems have three base units and one derived unit

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.

TABLE 1–2 Conversion Factors

Quantity	Unit of Measurement (FPS)	Equals	Unit of Measurement (SI)
Force	lb		4.448 N
Mass	slug		14.59 kg
Length	ft		0.304 8 m

Dimensional Homogeneity

- In Mechanics, the terms of all equations must be dimensionally homogenous
  - In other words
  - Dimension of LHS = Dimension of RHS
- Consider the kinematic equation:

$$v_f = v_i + at$$

$$\frac{m}{s} = \frac{m}{s} + \frac{m}{s^2} \cdot s$$

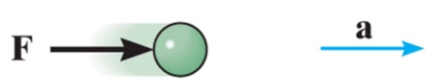
Models and Idealizations in Mechanics

Models and idealizations are often used in mechanics to simply problems

- Particle: A particle has mass but negligible size. Can the earth be considered a particle?
- Rigid Body: A rigid body can be considered as a collection of particles but all particles remain fixed with respect to one another under load
- Concentrated Force: When the area of load application is small relative to the size of the body

Newton's Laws of Motion

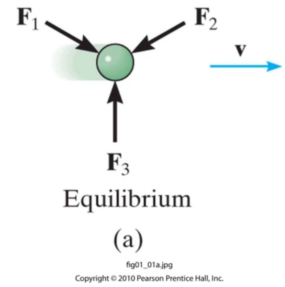
- Engineering mechanics is formulated on Newton's Laws of Motion
  - The laws were postulated based on experimental observation
  - The laws apply to the motion of a particle with reference to a non-accelerating reference path
- 2nd Law: A particle of mass (m) acted upon by an unbalanced system of Forces (F) experiences an acceleration (a) in the same direction as the force and with a magnitude proportional to the force.
- F= m a



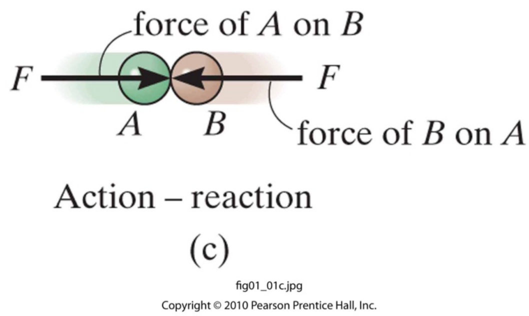
Accelerated motion

(b)

- 1st Law: A particle at rest or in motion will continue in its state of rest or motion unless acted upon by an unbalanced system of forces.



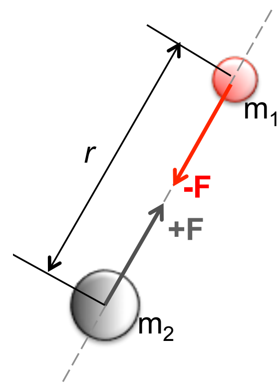
- 3rd Law: For every action, there is an equal and opposite reaction



Newton's Law of Gravitational Attraction

- States that two bodies are attracted by a force of gravity
  - F = force of gravity between the two particles
  - m1, m2 = mass of each particles
  - R = distance between the two particles
  - G = universal constant of Gravitation (G = 66.73 x 10^12 m^3/(kg.s^2)

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



Weight of a Body

- Consider an object of mass (m) on the surface of the earth
- The force exerted between the body and the earth, i.e., The body's weight (W) is give as:

$$W = mg = G\frac{M_e m}{r^2}$$

Accuracy of Numerical Calculations

- Depends on:
  - Accuracy of the data provided; and,
  - Accuracy of computations.
- Solution of computations cannot be more accurate than the least accurate of the given data

Significant Figures

- The number of significant figures conveys the accuracy of a number.
- Number of significant figures?
  - 4903
  - 23,500
  - 0.00356
- Use Engineering notation (not the same as scientific notation)
- 4.903×10^3
- 23.5×10^3 or 23.50×10^3
- 3.56×10^{-3}

Calculations

- Round-off only your final answer.
- Calculations should be to 4 significant figures and your answers rounded off to 3
- In mechanics, geometries, accuracy of measurements, and determining actual forces means it is rarely possible to obtain more than 3 significant figures
- Keep your units in your calculations and final answers
  - Marks will be deducted for not using appropriate units
- No Plurals (e.g., m=5 kg not kgs)

- Separate Units with a . (dot)
  - meter * second = m . s not ms (millisecond)
- Most symbols are in lowercase (m, km, s, kg, etc) (Except for N, Pa, M and G)
- Exponential powers apply to units,
  - E.g., cm . cm = cm^2
- Compound prefixes should not be used
- Other rules are given in the textbook

Sample Problem

- If a car is travelling at 55.0 mi/hr, determine its speed in:
  - A) km/hr and;
  - B) m/s.

A)

$$55.0\,\frac{\mathbf{mi}}{\mathbf{h}} = 55.0\,\frac{\mathbf{mi}}{\mathbf{h}}\,\frac{5280\,\mathbf{ft}}{1\,\mathbf{mi}}\,\frac{0.3048\,\mathbf{m}}{1\,\mathbf{ft}}\,\frac{0.001\,\mathbf{km}}{1\,\mathbf{m}} = 88.51392\,\frac{\mathbf{km}}{\mathbf{h}} = 88.5\,\frac{\mathbf{km}}{\mathbf{h}}$$

B)

$$55.0\,\frac{\mathrm{mi}}{\mathrm{h}} = 55.0\,\frac{\mathrm{mi}}{\mathrm{h}}\,\frac{5280\,\mathrm{ft}}{1\,\mathrm{mi}}\,\frac{0.3048\,\mathrm{m}}{1\,\mathrm{ft}}\,\frac{1\,\mathrm{h}}{60\,\mathrm{min}}\,\frac{1\,\mathrm{min}}{60\,\mathrm{s}} = 24.5872\,\frac{\mathrm{m}}{\mathrm{s}} = 24.6\,\frac{\mathrm{m}}{\mathrm{s}}$$

Important - Reminder

- Try to develop a 'sense' for the numbers
- Always use appropriate terms - Use 'engineering' language
  - Become familiar and get 'comfortable' with engineering terminology
- Understand how loads travel from one body to another (load path)
- Always use appropriate units
- Use four sig figs in your calc and round-off to three sig figs for final answer
- Always use Engineering Notation
- Marks will be deducted if you don't follow these basic rules! Sorry but that's how it works!