# General Principles

Chapter 1

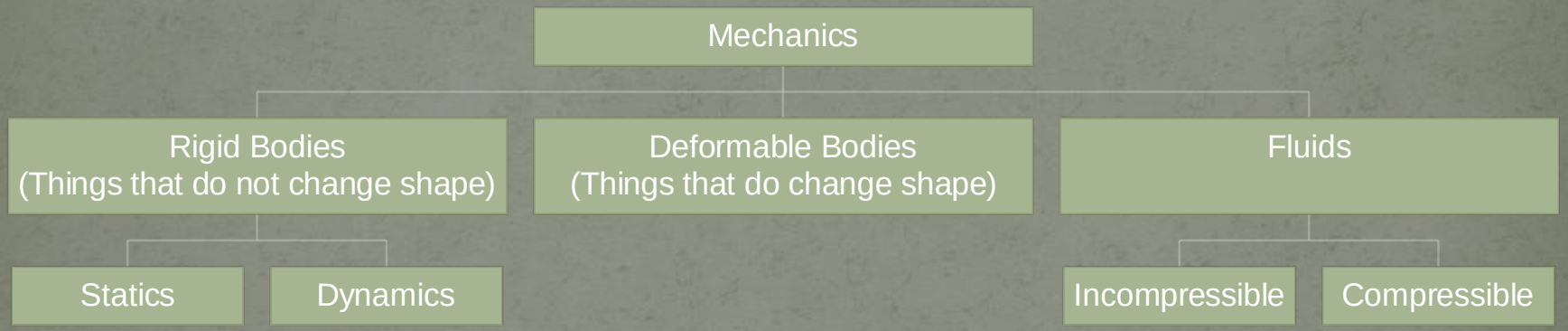
# Overview

- Introduction  to mechanics and statics.
- Units of measure (Dimensional Analysis).
- Numerical calculations.
- Problem-solving strategies

# Definition of Mechanics

- Study of what happens to an "object" (the technical name is "*body*") when *forces* are applied to it.


# Branches of Mechanics



# Models Used in Mechanics

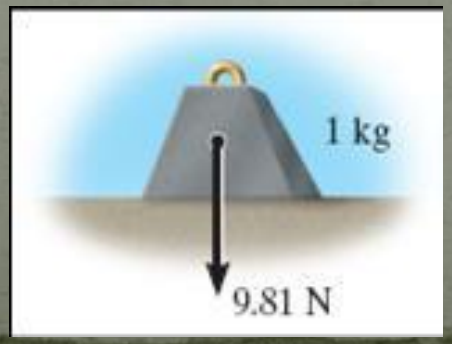
- *Particle*: A particle has mass, but its size is negligible. E.g. Earth is considered a particle when compared to the sun
- *Rigid Body*: This is a combination of a large number of particles in which all particles remain at a fixed distance from one another. E.g. analysis of a vehicle collision
- *Concentrated Force*: This represents the effect of a loading which is assumed to act at a point on a body. E.g. a truck on a bridge

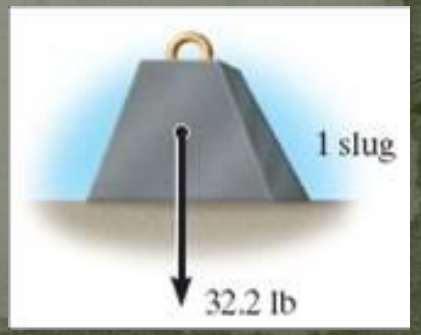
# Units of Measure (Dimensional Analysis)

- Four fundamental physical quantities (or dimensions).
  - Length
  - Mass
  - Time
  - Force
- Newton's 2nd Law relates them: $F = m * a$
- This equation can be used to develop systems of units.
- Units are arbitrary names we give to the physical quantities.

# Unit Systems

- Force, mass, time and acceleration are related by Newton's 2nd law and are considered *base units* and the fourth unit is derived.
- Which unit is derived varies by the system of units.
- Two unit systems in use in statics:
  - International System (SI)
  - U.S. Customary (USCS)



# Unit Systems.

**TABLE 1–1 Systems of Units**

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

*Derived unit.

# Conversion Factors

- Conversion factor enable conversion from unit system to the other.
- Work problems in the units given unless told otherwise!

**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 |

# The International System of Units (SI Units)

- No plurals (e.g., m = 5 kg, not kgs )
- Separate units with a • (e.g., meter second = m • s )
- Typically symbols are in lowercase.
  - Some exceptions include **N**, **Pa**, **M** and **G.**
- Exponential powers apply to units, e.g., cm • cm = $cm^2$
- Compound prefixes should not be used.
- Prefixes: *kilo*meter = $10^3$ m, *mega* Newtons = $10^6$ N, etc

# Numerical Calculations

Some Rules of Thumb

- Dimensions have to be the same on both sides of the equal sign, (e.g. distance = speed × time.) This is called *dimensional homogeneity*
- Use an appropriate number of significant figures. Typically
  - 3 for answer
  - 4 for intermediate calculations
- Rounding off your answers

  - greater than 5, round up (3528 → 3530)
  - smaller than 5, round down (0.03521 → 0.0352)

# Questions & Comments

- Time to solve problems !