Chapter 1: The Fundamentals of Statics

Fundamental Principles (1.4)

Base definitions

Mass: *amount of matter in an object*

Force: *an agency that can produce motion of an object*

Particle/point mass: *object whose mass in concentrated at one point*

Rigid body: *a body that is not deformable*

- The distance between any two points never changes
- No true rigid bodies exist in nature

Vector: *entity with both magnitude and direction*

- Represented like $\vec{v}$ or $\boldsymbol{v}$

Scalar: *quantity complete characterized by a single number*

- Represented like s

Review of position, velocity, and acceleration

Consider position $\vec{r}$ relative to some location

It has velocity $\vec{v} = \frac{d\vec{r}}{dt}$ and acceleration $\vec{a} = \frac{d\vec{v}}{dt}$

Fundamental applications to statics

$\vec{a} = \vec{0}$

Constant velocity can imply either a zero or nonzero velocity

Newton's laws

(1) A particle remains at rest, or continues to move with uniform velocity if no unbalanced force acts upon it

(2) The acceleration of a particle is proportional to the resulting force acting the particle and is in the direction of the force

$$\vec{F} = m\vec{a}$$

- m is the constant of proportionality
- When $\vec{F} = \vec{0} \Rightarrow \vec{a} = \vec{0}$, which implies constant velocity

(3) Action/reaction forces between interacting bodies are equal I magnitude, opposite direction, and collinear

Units & Conversions (1.7)

U.S. to metric

Length	$1\ in$	$0.0254\ m$
	$1\ ft$	$0.3048\ m$
	$1\ mi = 5280\ ft$	$1.609\ km$
Force	$1\ lb$	$4.448\ N$
	$1\ kip = 1000\ lb$	$4.448\ kN$
Mass	$1\ slug = 1\ lb \cdot s/ft$	$14.59\ kg$

Small angle approximations

If $\theta \ll 1\ rad$ ($\approx 57°$), can use Taylor approximation (first term in series)

$\sin\theta = \theta$

$\cos\theta = 1$

Newton's Laws of Gravitation (1.8)

Acceleration due to gravity

$W = mg$ where $g = Gm_{Earth}/r^2$

$g = 9.81\ m/s^2 = 32.2\ ft/s^2$

Specific weight and density

Specific weight: *weight on Earth of a unit volume of a material*

$$\gamma = \frac{W}{V} = \frac{m}{V}g = \rho g$$

Density: *mass on Earth of a unit volume of a material*

$$\rho = \frac{m}{V} = \frac{\gamma}{g}$$