Preview of Today’s Class

- Clarifying Newton’s Laws 2 and 3
- Note on Units
- Weight, Apparent Weight, and Gravity
- Sample Problems
Clarifying Newton’s Laws 2 and 3

- **Newton’s Second Law**

  \[ \vec{F} = m\vec{a} \]  
  really means \[ \sum \vec{F} = m\vec{a}, \text{ i.e.,} \]  
  \[ \sum F_x = ma_x, \sum F_y = ma_y, \text{ and } \sum F_z = ma_z \]

- **Newton’s Third Law**

  Force of \( A \) on \( B \) is same magnitude but opposite direction as force of \( B \) on \( A \)
Note on Units

Unit of force in **SI system** – newton (N)

\[ 1 \text{ N} = 1 \text{ kg m/s}^2 \]

Push a mass of 1 kg with net force so it accelerates 1 m/s\(^2\) means the magnitude of force is 1 N.

**Other unit systems**

- **cgs system** – dyne
  \[ 1 \text{ dyne} = 1 \text{ g cm/s}^2 \]

- **BES system** – pound (lb)
  \[ 1 \text{ lb} = 1 \text{ slug ft/s}^2 \rightarrow 1 \text{ slug} = 1 \text{ lb/ft/s}^2 \]
Three astronauts, propelled by jet backpacks, push and guide a 120-kg asteroid toward a processing dock, exerting the forces shown in the diagram.

What is the asteroid’s acceleration expressed (a) in unit vector notation and (b) as magnitude and direction?
Sample Problem

Three blocks are connected and pulled to the left on a horizontal, frictionless table. The blocks accelerate at 2.0 m/s\(^2\). Determine \(F\), \(T_1\), and \(T_2\).

How would results change if there was another force of 10.0 N pulling on the 30.0-kg mass to the right?
Weight and Apparent Weight

- **Weight** = magnitude of force of gravity = $mg$
  \[ \text{weight} \rightarrow F_g = mg \]

- **Weight** is force required to keep an object from accelerating downward due to gravity (inertial frame)
  - Suspend mass from a string $\rightarrow$ Tension in string
  - Stand on a scale $\rightarrow$ Normal force of scale

- **Apparent weight** in non-inertial reference frames
  - Accelerating/decelerating elevators
  - Different parts of a Ferris Wheel

Reference frame not accelerating
What is a 60-kg woman’s:

(a) Real weight in newtons? In pounds?

(b) Apparent weight when accelerating up at 4.0 m/s² on an elevator?

(c) Apparent weight when accelerating down at 4.0 m/s² on an elevator?

Learn to use free-body diagrams!
Sample Problem

A worker drags a crate across a factory floor by pulling on a rope tied to the crate. The worker exerts a force of 450 N on the rope, which is inclined at 38° above the horizontal, and the floor exerts a force of 125 N that opposes the motion.

Draw a free-body diagram that illustrates all forces acting on this crate.

Calculate the magnitude of the acceleration of the crate if (a) its mass is 310 kg and (b) its weight is 310 N.