

# Dynamics and Forces

# Force Basics

- Forces fall into one of two categories:
  - **Contact forces**: friction, applied, resistance, normal, etc ..
  - **Field forces**: gravitational, magnetic, electric. No contact required; act over a distance.

# Force Basics

- Forces are responsible for maintaining and/or changing the motion of all objects.
- A combination of forces (**net force**) occurs in most situations.
- A net force is responsible for all changes in motion (acceleration).

# Force Basics

- Force is a vector quantity so vector addition rules must be used to add forces.
  - If forces are in the **same** direction, **add** forces to get net force.
  - If forces are **opposite** in direction, **subtract** to get net force.
  - If forces are on different axes, set up a triangle and solve for resultant.

# Force Basics

- When multiple forces are equal in magnitude and opposite in direction, they are said to be **balanced forces**.
  - Balanced forces result in a **net force of 0**.
  - The object may still move, but it's motion is unchanged (**constant velocity**)

# Force Basics

- When multiple forces do not completely cancel out they are known as **unbalanced forces**.
  - Unbalanced forces result in a **non-zero net force**.
  - Create an **acceleration** in the same direction as the net force.

# Force Basics

- Weight vs Mass

- **Weight** is the force of gravity acting on an object's mass; measured in Newtons.
- **Mass** is a physical property that describes how much matter an object contains; measured in kilograms
- $W = mg$ , where  $g$  is the acceleration of gravity.

# Everyday forces

- **Weight ( $mg$ )** – force due to gravity acting on a mass; also referred to as gravitational force.

- $F_g = mg$

# Everyday forces

- **Normal force ( $F_N$ )** – force due to contact with a surface.
  - $F_N$  is always perpendicular to the surface.

# Everyday forces

- **Friction ( $F_f$ )** – force between two surfaces that resist relative motion between the surfaces
  - **Static friction** – force that keeps objects at rest from moving or sliding
  - **Kinetic friction** – force that resists relative motion between surfaces when in motion.

# Everyday forces

- **Tension ( $F_T$ )** – force that acts through a cable, rope, string, or support that is attached to a mass

# Everyday forces

- **Applied force ( $F_A$ )** – force that is exerted on an object by an outside body. General term for a push or pull not described by other forces.

# Everyday Forces

- **Spring force ( $F_{SP}$ )** – force exerted by a spring that always pushes/pulls a mass towards equilibrium position.

# Everyday forces

- Other terms commonly used include:
  - Resistance
  - Drag (air resistance or force from fluid)
  - Thrust (applied force from an engine or other process)

# Reading Quiz

1. Weight is another name for .....
2. Two things are true if a normal force is present. State one of those truths.
3. When is the static coefficient of friction used?
4. What direction is the frictional force?

# Note Questions

1. What does a net force of zero tell us?
2. 3 forces act on an object. A force of 25 N to the right, a force of 10 N to the right, and a force of 15 N to the left. What is the net force?
3. What else must be true about the object in #2?
4. How are mass and weight different?
5. A force of 6 N acts to the left. A force of 8 N acts downward. What is the net force?

# Free body diagrams

- **Free body diagrams** demonstrate the forces acting on an object at a specific time.
  - What happened before, after, or what you think caused it **DO NOT** matter.
- Forces are drawn **FROM the center of the object; arrows** demonstrate direction of force.
- All forces must be labeled.
- Arrow length represents relative magnitude of forces. (a larger force should have a larger arrow)

# Free body diagram examples

1. A car moves to the right on a level surface with a constant velocity.
2. A car moves to the right on a level surface with a positive acceleration.
3. A book slides down a frictionless incline.
4. A book slides down an incline with friction.
5. An elevator is pulled upward by cables.
6. An object in free fall.