

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 its motion is unchanged (**constant velocity**).
 - Object at rest remains at rest.

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**.
 - Creates 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.

- $F_g = mg = W$

Everyday forces

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

Everyday forces

- **Friction (F_f)** – force that opposes surfaces sliding passed one another.
 - **Static friction** – force that keeps objects at rest from moving
 - **Kinetic friction** – force that resists moving

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)

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?

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?

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 across the countertop.
4. A book slides down a frictionless incline.
5. A book slides down an incline with friction.
6. An elevator is pulled upward by cables.
7. An object in free fall.
8. A skydiver falling at terminal velocity.