

Vocabulary

- **Mass** – A measure of the amount of _____.
- **Inertia** – The tendency of an object to _____ change in motion
 - More specifically... to *resist* _____.

Newton's First Law of Motion

- Objects at _____ stay at _____ until acted upon by an outside force.
- Objects in _____ will stay in *straight line* _____ until acted upon by an outside force.
 - Both statements are only true if the object is acted upon by forces that are _____ or _____.

Force

- A force is a _____ or a _____ on an object.
- There are two general kinds of forces.
 - _____ Force - requires two objects to touch each other
 - Pushing a sled, kicking a ball
 - _____ Force - does not require contact
 - Gravity
- **Types of Forces**
 - Force of Gravity
 - Symbol:
 - _____ present
 - Points _____
 - Measurement of the _____ of an object
 - Normal Force
 - Symbol:
 - Need contact with a _____
 - Points _____ to the surface
 - Force of Friction
 - Symbol:
 - _____ motion or an _____ at motion
 - Points _____ to the surface
 - Applied Force
 - Symbol:
 - A push or a pull
 - Specific examples: Tension, Spring, Thrust

- **Representing Forces with Freebody (Force) Diagrams**

- The _____ is represented by a small _____.
- The dots are surrounded by _____ that represent all of the _____ that act on a given object.
- The _____ of the arrow represents the _____ of the force.
 - *A long arrow would have a larger force than a small arrow*
- The _____ of the arrow shows force is a _____!

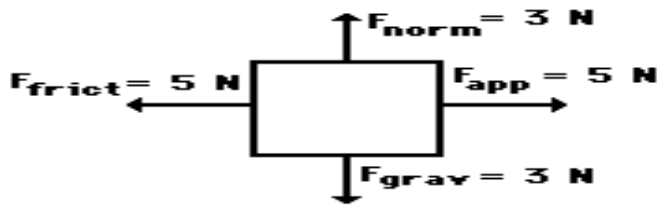
- **Examples:**

- A book held in your hand at rest.
- A book pushed at a constant velocity across the desk by your hand.
Assume friction.
- A book is sliding across the desk at a constant velocity. *Assume **no** friction.*
- A book at rest on a desk when your hand is pushing down on it.
- A book just after you removed your hand from underneath.
- Bob pushes a crate with a 10 N force to the right while Mark pushes to the left with a 5 N force. Draw a free body diagram for the crate.
- A boy is standing on the playground pulling a sled with 2 more boys on it. The weight of the sled is 200 N and the boy pulls with 100 N of force. Draw a free body diagram for the sled.

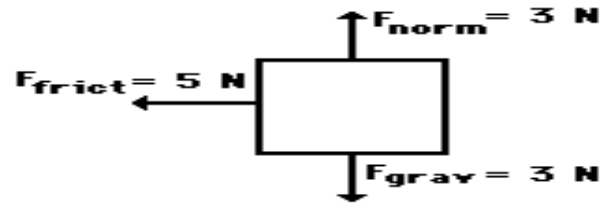
Net Force

- If the forces up/down (y-direction) & left/right (x-direction) _____...
 - net $F =$
 - This is an example of _____ or _____
- If the forces up/down (y-direction) & left/right (x-direction) _____...
 - net $F =$
 - This is an example of _____
- **Examples:**

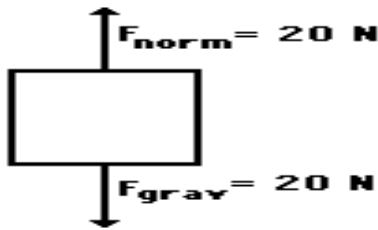
Situation A



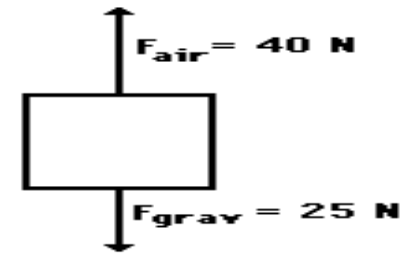
Situation B



Situation C



Situation D



Mass & Weight

- **Mass**
 - symbol:
 - units:
 - An intrinsic property of matter that _____ as an object is moved from one location to another.
- **Weight**
 - symbol:
 - units:
 - The force of gravity acting on the object and _____ from one location to another.
- **Example:**
 - A rightward force of 60 N is applied to a book so that it moves with a constant velocity. Friction is present.
 - Draw the freebody diagram.
 - If the book has a mass of 45 kg, calculate its weight.
 - What is the normal force?
 - What is the frictional force?

Friction

- **Static Friction**

- Symbol:
- The friction that exists when a force is applied to an object, but it is _____ to _____ between the 2 surfaces in contact.
- Equation:

- **Kinetic Friction**

- Symbol:
- The friction that exists once 2 surfaces _____ (moving) over one another.
- Equation:

- **Examples:**

- A 120-kg crate is being pushed at a constant velocity. If the coefficient of kinetic friction is 0.2, what is the frictional force exerted on this object?

- A 59-kg skier is standing motionless on a horizontal patch of snow. She is holding onto a horizontal tow rope, which is about to pull her forward. The coefficient of static friction between the skis and snow is 0.14. What is the magnitude of the maximum force that the tow rope can apply to the skier without causing her to move?

Forces and Angles

- *See worksheets for FBD diagrams and work related to solving problems involving angles and inclines.*

Newton's Second Law of Motion

- Acceleration is _____ to net force.
 - *If you double net force, acceleration will _____.*
 - *If you cut net force in 1/3, acceleration will _____.*

- Acceleration is _____ to mass.
 - *If you double mass, acceleration will _____.*
 - *If you cut mass in 1/4, acceleration will _____.*

- Equation:

- **Examples:**

- A bike has a mass of 18 kg. Someone pushes sideways with a force of 20 N to cause the bike to move to the left. The frictional force along the floor is 12 N. What is the acceleration of the bike? *Draw a FBD.*
- An applied force of 30 N is used to accelerate an object that weighs 60 N to the right across a frictional surface. If the coefficient of kinetic friction is 0.25, what is the object's acceleration? *Draw a FBD.*
- A 1225 kg car can accelerate from rest to 30.0 m/s in 6.50 s. How much net force does it take to cause this acceleration? *Draw a FBD.*
- A tow rope is used to pull a 1750-kg car, giving it an acceleration of $+1.35 \text{ m/s}^2$. If the frictional force is 600 N, what force does the rope exert? *Draw a FBD.*
- A 50-kg bucket is being lifted by a rope. The rope is guaranteed not to break if the tension is 500 N or less. The bucket started at rest, and after being lifted +3.0 m, it is moving at 3.0 m/s. Assume the acceleration is constant. Determine the tension (F_A) in the rope and if the rope is in danger of breaking. *Draw a FBD.*
- The Rock 'n Roller Coaster at Disney's Hollywood Studios has a mass of 1800 kg. It starts from rest and travels 110.0 m in 7.0 s. An applied force of 8744 N is required to accelerate the coaster during this time. *Draw a FBD.*
 - What is the force of friction the car experiences from the track?
 - What is the coefficient of friction?

Newton's Third Law of Motion

- **Initial Thoughts...*Imagine a bug getting hit by a car...***
 - If the car is moving with some velocity v_C , and hits a bug that is stationary (at rest), who feels more force, the bug, the car, both are the same, both feel nothing?
 - If the car is at rest and the bug has velocity v_B , who feels more force, the bug, the car, both are the same, both feel nothing?
 - If they both have velocity towards each other, who feels more force, the bug, the car, both are the same, both feel nothing?

- Involves the interaction of _____ and _____.

- For two objects in contact with each other, when object A acts on B with a force, object B acts on A with an _____ (in size) and _____ (in direction) force.
 - *For every action there is an equal and opposite reaction!*