

## 4 Fundamental Forces

- **Electromagnetic Force**
  - Everyday contact forces: push, pull, friction, etc.
  - Also causes electrical fields and magnetism
- **Gravity Force**
  - Masses attract each other: We fall to the Earth
- **Strong Nuclear Forces**
  - Holds the nucleus of an atom
- **Weak Nuclear Forces**
  - Involved with nuclear reactions

## Forces

- Measured in Newtons  $1 \text{ N} = \frac{\text{Kg m}}{\text{s}^2}$

1 Newton is about the weight of an apple

### Contact Forces

Push and Pull  
Frictional Force  
Wind Resistance  
Spring Force

### Field Forces

Gravitational Force  
Electrical Force  
Magnetic Force

- Any of these forces can move or stop an object

## Displaying Forces with Vectors

**Vectors** are arrows used to show force

Vectors point the direction a force is applied

The amount of force is shown by length

Labels for force are  $F_{\text{something}}$

$F_{\text{pull}}$   
20 N

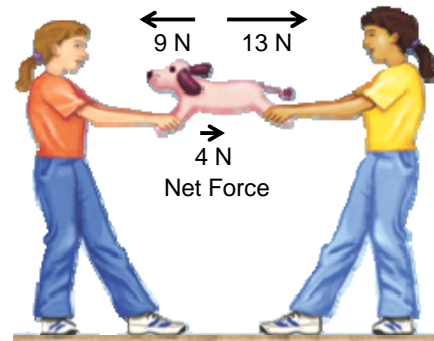
$F_{\text{friction}}$   
10 N

$F_{\text{gravity}}$   
7.5 N

$F_{\text{wind}}$   
5 N

## Net Force

**Net Force** - sum of all forces acting on an object



## Balanced Vs Unbalanced Forces

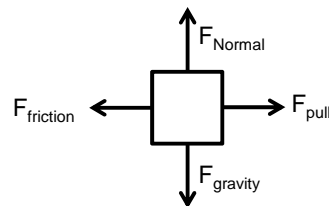
**Balanced** forces occur when the net force is 0 N  
This is when all forces cancel each other out

**Unbalanced** forces occur when the net force is greater than 0 N

Unbalanced forces will cause an object to accelerate in the direction of the net force.  
This is how motion happens!!

## Free Body Diagrams

- Shows all forces as vectors acting on an object
- Vectors always point away from object
- Used to help find net force



### Find the unknown force!!

Ex. 1

$$F_{net} = 100\text{N} - 75\text{N}$$

$$F_{net} = 25\text{ N Upward}$$

$F_{net} = ?$

The net force is the amount of arrow that doesn't "cancel"

### Combining Forces

$F_2 = 100\text{ N}$ $F_1 = 100\text{ N}$ $F_{net} = 0\text{ N}$ Equal forces Opposite directions	$F_1 = 100\text{ N}$ $F_2 = 100\text{ N}$ $F_{net} = 200\text{ N}$ Equal forces Same direction	$F_2 = 200\text{ N}$ $F_1 = 100\text{ N}$ $F_{net} = 100\text{ N}$ Unequal forces Opposite directions
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### Newton's First Law

Law of Inertia – Resistance to change motion

- Objects in motion stay in motion
- Objects at rest stay at rest

**Equilibrium** – balanced forces, net force = 0

**Net force** – sum of all forces

### Newton's Second Law

A net force will cause acceleration

$$F = ma$$

force                      mass                      acceleration

Gravity force →  $F = mg$

Mass and gravity are not the same!!!

### Newton's Third Law

- Each action has an opposite and equal reaction
- Interaction Pair – action / reaction forces

### Normal Force

(a)  $F_N = mg$

(b)  $F_N = mg + F_{hand}$

(c)  $F_N = mg - F_{string}$

## Drag Force

- “friction” force from a fluid (gases and liquids)

**Terminal Velocity** – constant velocity of falling

This occurs when the force of air resistance is equal to the force of gravity

