

## Relative Position Vector

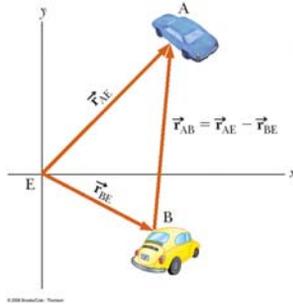
- Position of car A relative to car B is given by the vector subtraction equation

- $\vec{r}_{AE}$  is the position of car A as measured by E

- $\vec{r}_{BE}$  is the position of car B as measured by E

- $\vec{r}_{AB}$  is the position of car A as measured by car B

$$\vec{r}_{AB} = \vec{r}_{AE} - \vec{r}_{BE}$$



## Relative Velocity

$$\vec{v}_{AB} = \vec{v}_{AE} - \vec{v}_{BE}$$

$$\vec{v}_{AB} = -\vec{v}_{BA}$$

True for any set of indices

## Classical Mechanics

- Describes the relationship between the motion of objects in our everyday world and the forces acting on them
- Conditions when Classical Mechanics does not apply
  - very tiny objects (< atomic sizes)
  - objects moving near the speed of light

## Newton's First Law

- An object moves with a velocity that is constant in magnitude and direction, unless acted on by a nonzero net force
  - The net force is defined as the vector sum of all the external forces exerted on the object

## Inertia

- Is the tendency of an object to continue in its original motion

## Mass

- A measure of the resistance of an object to changes in its motion due to a force
- Scalar quantity
- SI units are kg

## Newton's Second Law

- The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass.

$$\vec{a} \propto \frac{\sum \vec{F}}{m} \text{ or } \sum \vec{F} = m\vec{a}$$

- F and a are both vectors

## Units of Force

- SI unit of force is a Newton (N)

$$1\text{N} \equiv 1 \frac{\text{kg m}}{\text{s}^2}$$

- US Customary unit of force is a pound (lb)
  - 1 N = 0.225 lb

## Gravitational Force

- Mutual force of attraction between any two objects
- Expressed by Newton's Law of Universal Gravitation:

$$F_g = G \frac{m_1 m_2}{r^2}$$

## Weight

- The magnitude of the gravitational force acting on an object of mass  $m$  near the Earth's surface is called the weight  $w$  of the object
  - $w = m g$  is a special case of Newton's Second Law
    - $g$  is the acceleration due to gravity
- $g$  can also be found from the Law of Universal Gravitation