Physics 161

Lecture 5

Newton's Laws

September 19, 2017

Lecture 5: learning objectives

This lecture

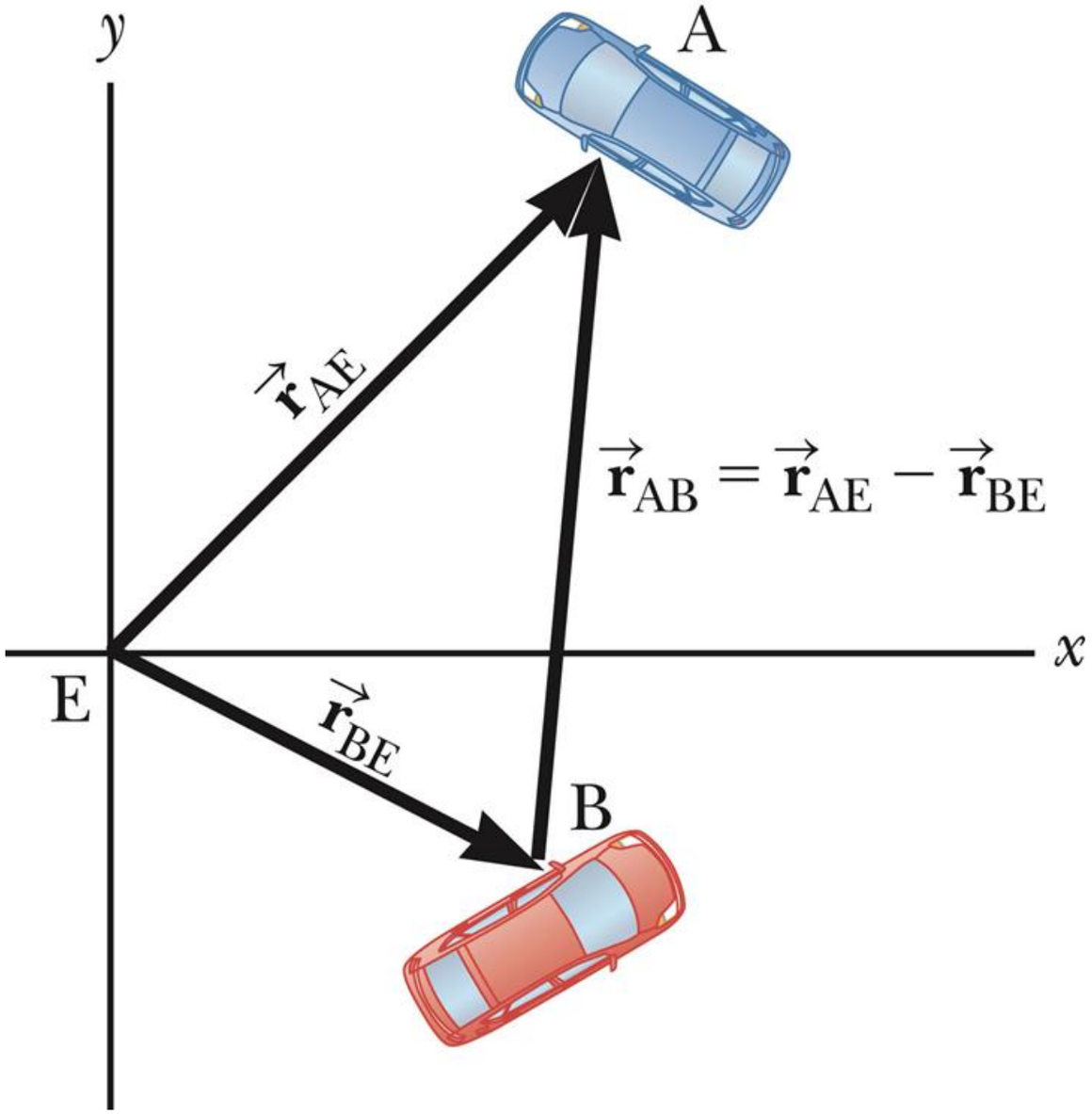
You will be able to solve problems in two dimensions involving relative velocity.

You will be able to explain Newton's three laws of motion and apply them to study the motion of objects in simple applications.

You will be able to explain the relationships between mass, inertia, and weight.

Relative Velocity

The motion of object A may be viewed from two different reference frames. One is from the stationary frame on the Earth (call it E) and the other is from a moving frame (in this example, car B).



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

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

Newton's first law

Newton's first law:
An object moves with constant velocity unless a non-zero net force acts on that object.

Net force:
The vector sum of all forces acting on an object.

$$\vec{\mathbf{F}}_{\text{net}} = \sum_{i=1}^{\text{no. of forces}} \vec{\mathbf{F}}_i$$

Inertia, mass and weight

Inertia (principle of inertia):
Tendency of a body to continue in its original motion in the absence of force.

Mass:
Measures or quantifies a body's resistance to changes in its motion due to a force.

Weight:
The gravitational force acting on an object.

The magnitude of an object's weight is given by

$$W = mg$$

Newton's second law

Newton's second law:
If there is a net force on an object, the object responds by accelerating in the direction of the net force. The magnitude of the acceleration is proportional to the force and inversely proportional to the object's mass.

$$\sum \vec{F}_i = m\vec{a}$$

Newton's third law

Newton's third law:
If two objects A and B interact, the force exerted by object A on B is equal and opposite to the force exerted by B on A.

Normal force:
Contact force exerted by a surface in a direction perpendicular to the surface.