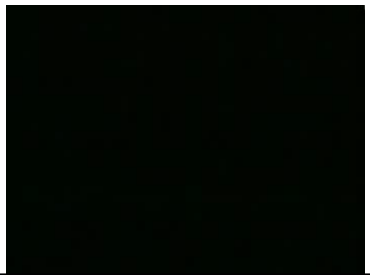
Energy and Motion

Chapter 2

Newton's First Law



Inertia and Mass

- **Inertia** (ih NUR shuh)
  - the tendency of an object to resist any change in its motion.
- Mass is the measure of Inertia
  - Mass is measured in kilograms
- The greater the mass, the more inertia the object has.

Newton's First Law

- also known as the Law of Inertia
- "An object in motion stays in motion or object at rest stays at rest unless acted upon by an outside unbalanced force"
- What keeps this object moving or at rest?
  - Inertia
- http://www.youtube.com/watch?v=QldH0u-VzTg

Section 2.3: Motion and Forces

- Force causes an object to speed up, slow down, start moving or stop moving.
- **Force** can be thought of as a push or pull.
- There are wide range of forces.
  - some forces are not as noticeable as others
  - *LIST A FEW FROM OUR CLASS DISCUSSION IN YOUR NOTES*

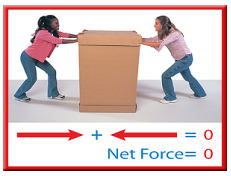
Changing Motion

- More then one force can act on an object at one time
  - Think of your weight pulling you down and the chair pushing you up.
- UNBALANCED FORCE-
  - A force or a set of forces that cause the motion of an object to change
    - **(SPEED UP or SLOW DOWN)**

Changing Motion

- force does not always change the speed of an object.
- when two or more forces act on an object at the same time, the forces combine to form the **NET FORCE**
- If the next force adds up to zero then you have **BALANCED FORCES** and the objects speed does not change.

Balanced Forces



Unbalanced Forces

- Forces are unbalanced when there are unequal forces in opposite directions, a net force occurs in the direction of the larger force.

- They are considered to be unbalanced forces.

Unbalanced Forces

- Forces are combined, or added together, if they are exerted on an object in the same direction.

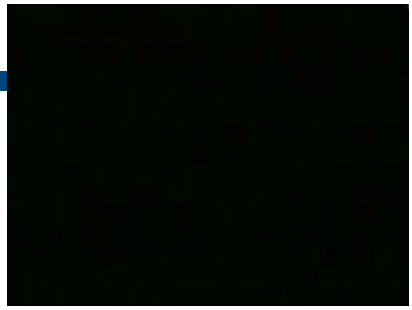
Newton's Second Law of Motion

- The acceleration of an object is in the same direction as the net force on the object.
- The equation for Newton's second law is :
  F = ma

  F=force (N)
  m=mass (kg)
  a=acceleration (m/s^2)

Force, Mass and Acceleration

- Force and motion are connected.
- An object will have greater acceleration if a greater force is applied to it.
- If the same force is applied to 2 objects and the mass of the objects is different, the object with more mass will have a smaller acceleration.



Section 2.1: Describing Motion

- To determine if a force acted on an object you must be able to describe the motion of the object.
- **Position** and **time** are two most important factors in determining motion
- a **reference point** is needed to determine the position of an object

Section 2.1: Describing Motion

- A reference point is location chosen to describe where an object is located.
  - Examples are the a cross street, a start line, the origin on the Cartesian coordinate system, the Sun.
- motion occurs when an object changes its position relative to its reference point

Distance

- **Distance**
  - describes how far an object has moved
    - Direction does not matter
  - The SI unit of length or distance is the meter (m).
  - longer distances (kilometers – km)
  - shorter distances (centimeters – cm)

Displacement

- **Displacement** is the distance and direction of an object's change in position from the starting point
  - **Displacement states how far in a straight line an object is from where it started**

Speed

- **Speed** is the distance an object travels per unit of time.

$$s = d / t$$

- any change over time is called a rate.
  - d = distance
  - s = speed (rate)
  - t = time

Constant Speed

- If you are moving at the same speed for a period of time your speed is considered to be constant.
- Usually speed is not constant.

Average Speed

- Average speed is the speed you would have to travel constantly to go the same distance as an object speeding up and slowing down
  - Think of the Tortes and the Hare
- **Average speed**
  - the **total distance** traveled divided by the **total time** of travel

Instantaneous Speed

- **Instantaneous speed**
  - the speed at a given point in time
- The speed you see on the speedometer of a car
  - this is instantaneous speed
- when something is speeding up or slowing down, its instantaneous speed is changing
- if an object is moving with constant speed, the instantaneous speed doesn't change

Distance vs. Time

- The motion of an object over a period of time can be shown on a distance-time graph.
- On a distance-time graph, the distance is plotted on the vertical axis and the time on the horizontal axis.

Problems

$$d = s \cdot t$$

Where
d = distance
s = speed
t = time

Velocity

- speed describes only how fast something is moving
- to determine direction you need to know the velocity
- **Velocity**
  - includes the speed of an object and the direction of its motion

Velocity

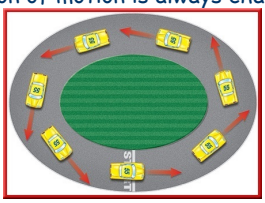
- velocity can change even if the speed doesn't

$$V = \frac{\text{Displacement}}{\text{change in time}}$$

V = (m/s)

Velocity

- The speed of this car might be constant, but its velocity is not constant because the direction of motion is always changing.



Section 2.2 Acceleration

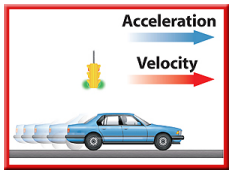
- **Acceleration**
  - the rate of change of velocity.
- When the velocity of an object changes, the object is accelerating.
- change in velocity → change in speed or direction
- Acceleration occurs when an object changes its speed, its direction, or both.

Acceleration

- Objects that speed up and slow down experience acceleration.
- Acceleration also has direction, just as velocity does.
- Change in velocity is the same as the change in speed when direction of motion is constant moving in a straight line

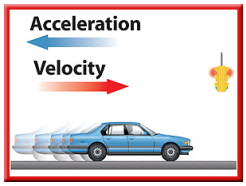
Speeding Up and Slowing Down

- If the acceleration is in the same direction as the velocity, the speed increases and the acceleration is positive.



Speeding Up and Slowing Down

- If the speed decreases, the acceleration is in the opposite direction from the velocity, and the acceleration is negative.

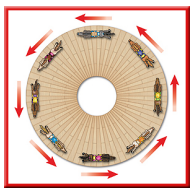


Changing Direction

- change in velocity
  - change in speed
  - change in direction
- any time a moving object changes direction, its velocity changes and it is accelerating

Changing Direction

- The speed of the horses in this carousel is constant, but the horses are accelerating because their direction is changing constantly.



Calculating Acceleration

- Change in velocity

$$\Delta V = V_f - V_i$$

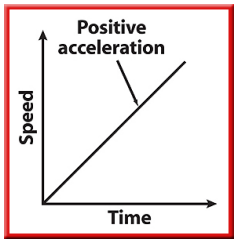
- Equation

$$a = \frac{V_f - V_i}{t}$$

Where
a = acceleration
v= velocity
t = time

Units
m/s/s or m/s^2

Positive Acceleration



Negative Acceleration