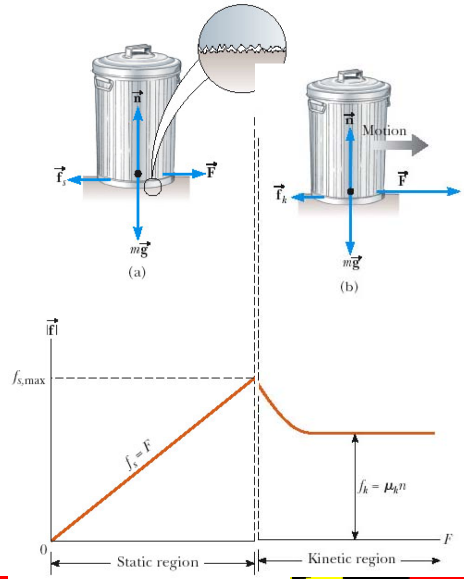
Physic^{2} 121:
Fundament°ls of Phy^{2}ics I

October 2, 2006

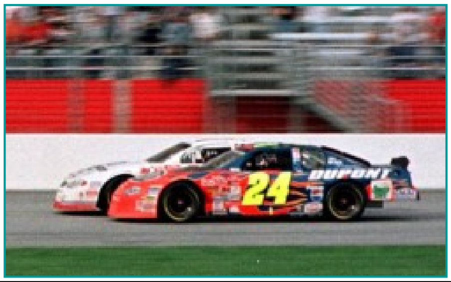
Friction Review

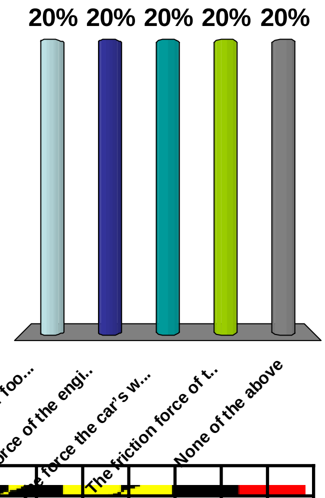
- Static Friction, f_s
  - Static friction acts to keep the object from moving
  - If F increases, so does f_s
  - If F decreases, so does f_s
  - $f_s \leq \mu_s n$
- Kinetic Friction, f_k
  - The force of kinetic friction acts when the object is in motion
  - $f_k = \mu_k n$
  - Variations of the coefficient with speed will be ignored



When you start your car, what force causes it to speed up?

1. The force of your foot on the gas pedal
2. The force of the engine turning
3. The force the car's wheels exert on the ground
4. The friction force of the ground on the car's wheels
5. None of the above





Vector vs. Scalar Review

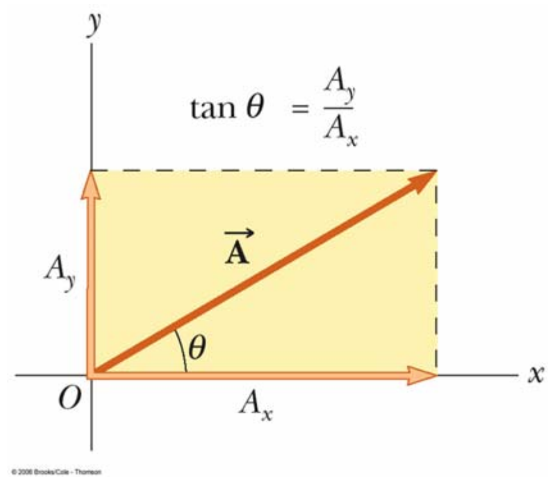
- All physical quantities encountered in this text will be either a scalar or a vector
- A **vector** quantity has both magnitude (size) and direction
- A **scalar** is completely specified by only a magnitude (size)

Adding Vectors

- When adding vectors, their directions must be taken into account
- Units must be the same
- Geometric Methods
  - Use scale drawings
- Algebraic Methods
  - More convenient

Components of a Vector

- A **component** is a part
- It is useful to use **rectangular components**
  – These are the projections of the vector along the x- and y-axes



Components of a Vector, cont.

- The x-component of a vector is the projection along the x-axis

$$A_x = A\cos\theta$$

- The y-component of a vector is the projection along the y-axis

$$A_y = A\sin\theta$$

- Then,

$$\vec{\mathbf{A}} = \vec{\mathbf{A}}_x + \vec{\mathbf{A}}_y$$

Projectile Motion

- An object may move in both the x and y directions simultaneously
  - It moves in two dimensions
- The form of two dimensional motion we will deal with is called **projectile motion**

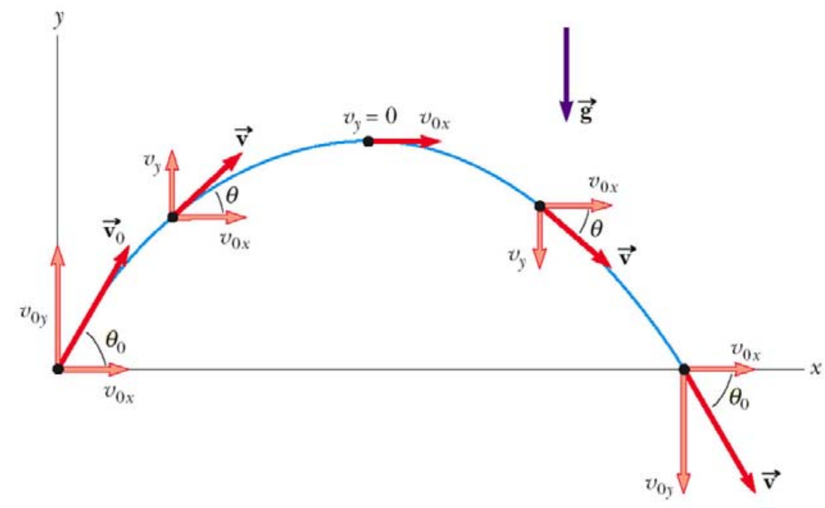
Assumptions of Projectile Motion

- We may ignore air friction
- We may ignore the rotation of the earth
- With these assumptions, an object in projectile motion will follow a parabolic path

Rules of Projectile Motion

- The x- and y-directions of motion are completely independent of each other
- The x-direction is uniform motion
  - $a_x = 0$
- The y-direction is free fall
  - $a_y = -g$
- The initial velocity can be broken down into its x- and y-components
  - $$v_{Ox} = v_O \cos\theta_O \qquad v_{Oy} = v_O \sin\theta_O$$

Projectile Motion



Some Details About the Rules

- x-direction
  - $a_x = 0$
  - $v_{xo} = v_o \cos \theta_o = v_x = \text{constant}$
  - $x = v_{xo}t$
    - This is the only operative equation in the x-direction since there is uniform velocity in that direction

More Details About the Rules

- y-direction
  - $v_{yo} = v_o \sin \theta_o$
  - free fall problem
    - a = -g
  - take the positive direction as upward
  - uniformly accelerated motion, so the motion equations all hold

Problem-Solving Strategy

- **Select** a coordinate system and sketch the path of the projectile
  - Include initial and final positions, velocities, and accelerations
- **Resolve** the initial velocity into x- and y-components
- **Treat** the horizontal and vertical motions independently

Problem-Solving Strategy, cont

- **Follow** the techniques for solving problems with constant velocity to analyze the horizontal motion of the projectile
- **Follow** the techniques for solving problems with constant acceleration to analyze the vertical motion of the projectile

Some Variations of Projectile Motion

- An object may be fired horizontally
- The initial velocity is all in the x-direction
  - $v_o = v_x$ and $v_y = 0$
- All the general rules of projectile motion apply