

➤ Last Lecture

➤ 2-D kinematics - describing motion

➤ Today

➤ More 2-D examples

➤ Circular motion (yes, even more vectors)

➤ Experiment #2 Projectile Motion

➤ Important Concepts

➤ Multiple dimensions are as independent as many objects

➤ A vector quantity can change in several ways

➤ Think carefully about directions

➤ Don't forget the units, they can help you find mistakes

Important Reminders

➤ Exam #1 is this Friday at 10am

➤ Material covered is through 2-D motion

➤ Information and sample problems are posted on the web page

➤ In addition to tutoring sessions, recitations, and office hours, there will be a Questions and Answer session Thursday night from 7-9pm.

Projectile Motion



$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2 \quad y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

$$v_x = v_{0x} + a_x t \quad v_y = v_{0y} + a_y t$$

$$a_x = 0 \quad a_y = -g$$

$$v_{0x} = v_0 \cos(\theta) \quad v_{0y} = v_0 \sin(\theta)$$

Circular Motion Equations

$$x = R \cos(\omega t) \quad y = R \sin(\omega t)$$

$$v_x = -R\omega \sin(\omega t) \quad v_y = R\omega \cos(\omega t)$$

$$a_x = -R\omega^2 \cos(\omega t) \quad a_y = -R\omega^2 \sin(\omega t)$$

$$a_x = -\omega^2 x \quad a_y = -\omega^2 y$$

$$|\vec{r}| = R \quad |\vec{a}| = R\omega^2 = \frac{|\vec{v}|^2}{R}$$

$$|\vec{v}| = R\omega \quad \vec{a} = -\omega^2 \vec{r}$$

Circular Motion Summary

- Motion in a circle with constant speed and radius is accelerated motion.
- The velocity is constant in magnitude but changes direction. It points tangentially.
- The acceleration is constant in magnitude but changes direction. It points radially inward.
- The magnitude of the acceleration is given by:

$$|\vec{a}| = \frac{v^2}{R}$$

Dimensional Analysis

- Name for a technique of checking the dimensions (or units) of an answer to check for careless mistakes in the formulas or algebra.

- Example: $|\vec{a}| = \frac{v^2}{R}$

$$\frac{m}{s^2} \cdot \frac{\left(\frac{m}{s}\right)^2}{m} = \frac{\left(\frac{m^2}{s^2}\right)}{m} = \frac{m^2}{s^2 m} = \frac{m}{s^2}$$

Summary

- Position, velocity, and acceleration are ALL vectors and need to be manipulated using either arrows (qualitative) or components (quantitative)
- A vector can change by changing its magnitude (speed) or direction or both. All three changes imply the presence of an acceleration
- Checking the units or dimensions of an answer will help to guard against simple careless mistakes

Preparing for Experiment #2

- Go to 8.01L Experiment web page and download both the writeup and the program to your desktop.
- You will get paper copies of the report (link says "questions") but feel free to look at it ahead of time.
- Click on the link to input your data. You will use this once you take your own data.
- Start the program to make sure it runs OK.
- Start reading the writeup. The summary that I will go through in detail starts on page 9.