Phy 2053 Announcements

- Homework 1 due Jan 21 is posted in webassign. It will count towards course grade.
- Optional solution manual: a limited number of copies is available at the UF bookstore, at ~ $54. It contains solutions to some but not all of the problems at the back of chapters; one copy on reserve at the Marston Science Library.
- Yellow book (past exams and solutions) available at Target Copy for $16.
- Should have received email listing your clicker response. Clicker questions will count towards course grade starting Jan 27.

Vectors

- **Equality of Two Vectors**
  - Two vectors are equal if they have the same magnitude and the same direction.
  - \( \vec{A} = \vec{B} \)
  - \( \vec{A} \neq \vec{C} \)
  - \( \vec{A} \neq \vec{D} \)

Graphically Adding Vectors

- When you add vectors, just put the tail of one on the head on the next...
- The resultant \( \vec{R} \) is drawn from the origin of the first vector to the end of the last vector.

Commutative law of addition

- The order in which the vectors are added doesn't affect the result \( \vec{R} \).
  - \( \vec{A} + \vec{B} = \vec{B} + \vec{A} \)

Scalar Multiplication

- The result of the multiplication or division of a vector by a scalar is a vector-the magnitude of the vector is multiplied or divided by the scalar.
  - If the scalar is positive, the direction of the result is the same as of the original vector.
  - If the scalar is negative, the direction of the result is opposite that of the original vector.

Vector Subtraction

- Special case of vector addition--add the negative of the subtracted vector.
- Continue with standard vector addition procedure.
**Vector Components**

- The x-component of a vector is the projection along the x-axis
  \[ A_x = A \cos \theta \quad \vec{A}_x = A \cos \theta \hat{x} \]
- The y-component of a vector is the projection along the y-axis
  \[ A_y = A \sin \theta \quad \vec{A}_y = A \sin \theta \hat{y} \]

Then, \[ \vec{A} = \vec{A}_x + \vec{A}_y \] These equations are valid only if \( \theta \) is measured with respect to the x-axis.

**Adding Vectors Algebraically**

- Choose a coordinate system and sketch the vectors
- Find the x- and y-components of all the vectors
- Add all the x-components \( R_x = \sum A_x \)
- Add all the y-components \( R_y = \sum A_y \)
- Use Pythagorean theorem find The magnitude of the resultant: \[ R = \sqrt{R_x^2 + R_y^2} \]
- Use inverse tangent function To find the direction of \( R \): \[ \theta = \tan^{-1} \frac{R_y}{R_x} \]

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**3.18** A small map shows Atlanta to be 730 miles in a direction 5° north of east from Dallas. The same map shows that Chicago is 560 miles in a direction 21° west of north from Atlanta. Assume a flat Earth and use the given information to find the displacement from Dallas to Chicago.

**Projectile Motion**

- Object may move in x and y directions simultaneously: 2D motion
- The form of two dimensional motion we will deal with is called **projectile motion**
  - Ignore air friction
  - Ignore the rotation of the earth
  - With these assumptions, object in projectile motion will follow a parabolic path

**Rules of Projectile Motion**

- The x- and y-directions of motion completely independent
- The initial velocity \( v_0 \) can be broken down into its x- and y-components
  \[ v_{0x} = v_0 \cos \theta \quad v_{0y} = v_0 \sin \theta \]
- y-direction: free fall: \( a = -g \)
  - take the positive direction as upward
  - uniformly accelerated motion, so the kinematic equations all hold
- x-direction: \( a_x = 0 \)
  \[ v_{0x} = v_x \cos \theta \quad v_x = \text{constant} \]
  \[ x = v_{0x}t \]
  - uniform velocity in the x direction
- Velocity at any time \( v = \sqrt{v_x^2 + v_y^2} \quad \theta = \tan\frac{v_x}{v_y} \)
Projectile Motion at Various Initial Angles

- Complementary values of the initial angle result in the same range
  - The heights will be different
- The maximum range occurs at a projection angle of 45°

71. One strategy in a snowball fight is to throw a snowball at a high angle over level ground. Then, while your opponent is watching that snowball, you throw a second one at a low angle timed to arrive before or at the same time as the first one. Assume that both snowballs are thrown with a speed of 25.0 m/s. The first is thrown at an angle of 70.0° with respect to the horizontal. (a) At what angle should the second snowball be thrown to arrive at the same point as the first? (b) How many seconds later should the second snowball be thrown after the first in order for both to arrive at the same time?

Assume that both snowballs are thrown with a speed of 25.0 m/s. The first is thrown at an angle of 70.0° with respect to the horizontal. (b) How many seconds later should the second snowball be thrown after the first in order for both to arrive at the same time?

Non-Symmetrical Projectile Motion

- Follow the general rules for projectile motion

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
  - **Horizontal motion**: Use techniques for problems with constant velocity
  - **Vertical motion**: Use techniques for problems with constant acceleration. It determines the time in air.

Object may be fired horizontally

- The initial velocity is all in the x-direction
  - \( v_0 = v_x \) and \( v_y = 0 \)
- All the general rules of projectile motion apply

Some Special Cases of Projectile Motion

Assume that both snowballs are thrown with a speed of 25.0 m/s. The first is thrown at an angle of 70.0° with respect to the horizontal. (b) How many seconds later should the second snowball be thrown after the first in order for both to arrive at the same time?

\[
\begin{align*}
\mathbf{v} &= \mathbf{v}_0 + \mathbf{a}t \\
\Delta x &= \mathbf{v}_0 t + \frac{1}{2} \mathbf{a}t^2 \\
\mathbf{v}^2 &= \mathbf{v}_0^2 + 2\mathbf{a}\Delta x
\end{align*}
\]