Motion in 2-Dimensions
Projectile Motion

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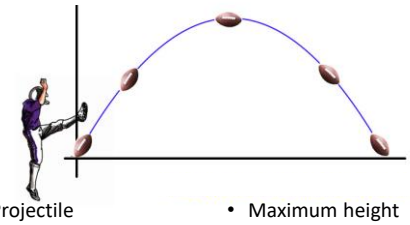
New Vocabulary



- Projectile
- Range
- Trajectory
- Maximum height
- v_x, v_y

http://sdsu-physics.org/physics180/physics180A/units/unit1/chapter3.html

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Trajectory Sketches

- Young JT Kirk drives a car off a cliff (but jumps out at the last second).
- (Slightly insane) Dave is shot from a cannon.

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Independence of Motion

- IGNORE AIR RESISTANCE!
- Separate into x- and y-components
- What forces are acting in the y-direction?
- What forces are acting in the x-direction?
- Use motion equations (keep x and y separate)

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Practice Problem #1

- A marble rolls off of a table that is 0.75 m tall. If the marble has an initial horizontal velocity of 0.25 m/s, how far away does the marble land? (0.098 m)
  - Draw a sketch
  - Determine your knowns and unknowns
  - Determine vertical time in air
  - Use t to determine Δx

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Practice Problem #2

- The Royal Gorge Bridge in CO rises 321 m above the Arkansas River. You kick a rock horizontally off the bridge and it lands with a horizontal displacement of 45.0 m. Find the speed at which the rock was kicked. (5.56 m/s)
  - Draw a sketch first and label!

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#2 (continued)

- Use triangles to calculate the (resultant) velocity of the rock (magnitude AND direction) when it hits the water (v = 79.5 m/s, 86° with horizon)

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Projectiles Launched at an Angle

- Initial velocity has both x- and y-components
- STEPS
  1. Calculate v_x and v_y
  2. Determine max height
  3. Calculate free fall time
  4. Determine flight time
  5. Calculate range

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Practice Problem #3

- A soccer ball on the ground is kicked at 4.5 m/s at an angle of 66° above the horizontal. What are the maximum height and flight time? (Δy_{max} = .86 m, t_{flight} = .84s)

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Practice Problem #4

- A baseball is thrown at an angle of 25° above the horizontal at a velocity of 23.0 m/s. If the ball is caught **41.3 m** from the thrower, how long was it in the air? How high was the tallest spot in the ball's trajectory? (t_{flight} = 1.98 s, Δy_{max} = 4.82 m)

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Practice Problem #5

- A quarterback throws the football to a stationary receiver who is 31.5 m away. If the football is thrown at an initial angle of 40° above the horizontal, at what initial speed must the ball be thrown for it to reach the receiver? (Assume the receiver catches the ball at the same height it was thrown.) What is the ball's highest point during its flight?
  (v_i = 17.7 m/s, Δy_{max} = 7.54 m)

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Practice Problem #6

- A baseball is thrown at an angle of **30°** above the horizontal at a speed of 23.0 m/s. How far away will the other player need to be to catch it? (Δx = 46.6 m)

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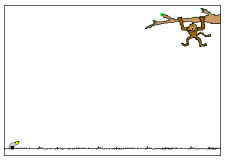
Monkey and the hunter



You want to shoot a banana at a monkey. The instant you fire the cannon, the monkey drops from the tree. Where do you aim?

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Aim at the monkey!

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College physics demo

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Elementary demo

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Mythbusters and bullets

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