# Lab 3-7: Projectile Range

- **Purpose:** 1. To determine the initial launch angle that will give the maximum range of a projectile with a given initial speed.
  - 2. To determine the relationship between angles that give the same range of a projectile with a given initial speed.

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### **Procedure:**

- 1. Go to the web address listed above and start the simulation.
- 2. Go to the "Vectors" set up. Make sure that "Air Resistance" is turned off, "Velocity Vectors" are turned on and the "Components" are checked. Fire a few different projectiles and answer the following questions:
  - a. While the projectile was in the air, you should have seen two green arrows. What did the horizontal arrow represent? Explain what happened to the horizontal arrow while the projectile was in the air and what this means.
  - b. What did the vertical arrow represent? Explain what happened to the vertical arrow while the projectile was in the air and what this means.
- 3. Now click on the "Lab" portion of the simulation. Set the initial speed to 15 m/s and the initial angle to 25°. Make sure "Air Resistance" is turned off and that the initial height is 0.
- 4. Fire the projectile. Using the weird "Time, Range, Height" tool, record the Range and Time where the projectile landed. Then record the Height and Time when the projectile was at its maximum height (this will be the small green point on the projectile's path.)
- 5. Repeat step 4 for each of the listed initial angles.

Launch Angle	Range (m)	Time in Air (s)	Max Height (m)	Time to Max (s)
25°				
30°				
35°				
40°				
45°				
50°				
55°				
60°				
65°				

Materials: https://phet.colorado.edu/en/simulation/projectile-motion

### **Conclusions:**

- 1. What initial angle will give a projectile the maximum range?
- 2. What initial angle will give a projectile the largest maximum height? (Be careful you will have to think about this as it is not in your data.)

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- 3. What initial angle will give a projectile the largest amount of time in the air? (*Be careful you will have to think about this as it is not in your data.*)
- 4. For a projectile, how does the time to the maximum height compare to the total time in the air?
- 5. You should have noticed that there were usually two different angles that would result in the same range. In general, what is the relationship between those angles?

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### **Calculations:**

1. A projectile is fired from the ground with an initial speed of 20 m/s at an angle of 30° above the horizontal. Calculate the range, maximum height and time in the air for the projectile. When you are done, use the simulation to check your answers. (Set gravity to 10 m/s<sup>2</sup> first though.)

2. What other initial angle would let the projectile land (still with an initial speed of 20 m/s) in the same place? Calculate the range, maximum height and time in the air for this projectile and check your answers.