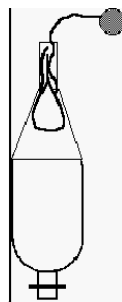


Calculating the Height of a Water Rocket:

There are three ways to calculate in this class. The first method would be to use right angle trigonometry. However, in order to use this method the rockets would need to always travel straight in the air (90° to the earth) and as you will soon learn, this isn't always the case. The second method is known as the **average angle method** and the third method would be the **Law of Sines**.

Since the **average angle method** is the easiest and most commonly used, it will be the method we will use for this activity.



the height of the water bottle rockets be to use right angle trigonometry. the rockets would need to always travel straight in the air (90° to the earth) and as you will soon learn, this method is known as the **average angle method** to use trigonometry and the **Law of Sines**.

easiest and most commonly used, it will be the method we will use for this activity.

Average Angle Method

This method makes an approximation of rocket height rather than an exact calculation. However, considering human error and the crude measuring instruments used in this activity, this method is fairly accurate in calculating rocket height.

Step #1

Measure two locations 150 feet on either side of and in a direct line with the launch pad. Place a person at each of these locations with an altitude gun (see the figure below).

Step #2

Assume that your team has launched a rocket and Person A measures 45° and Person B measures 30° (See figure above).

Step #3

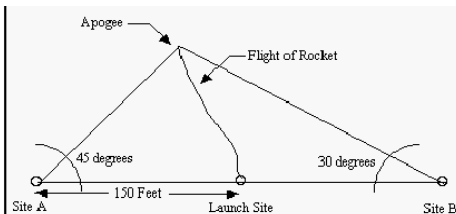
Use the average angle formula to calculate the height of the rocket.

Average Angle formula: $a = b(\tan A)$

a= height of rocket flight

b= distance from the launch pad (150 feet)

A = the average of the two angles (Given Angle 1 = 45° , and Angle 2 = 30° , $A = 37.5^\circ$)



Therefore, using the

example on the preceding page, if one person measured 45° and the other person measured 30° then the average angle (A) would be 37.5° .

Next, using the formula $a = 150 (\tan 37.5)$, the height of this rocket flight would be 115 feet (**a = 115 ft**).

Calculation Helps:

- Make sure your calculator is in degrees mode and not in radians mode.
- On most calculators you will need to
 - 1) enter in the average angle (in this case 37.5),
 - 2) hit the tangent button, and then
 - 3) multiply this value by 150.

Water Rocket Worksheet

Name: _____

You and a partner are to complete this worksheet together and hand it into the teacher. When you are finished, the teacher will give you materials so you can start designing and building your experimental rocket.

1. (Newton's 1st law - Page #1) How long does the thrust last when a rocket is launched?
2. (Newton's 2nd Law - Page #2) If you want your rocket to accelerate faster you need to: (Choose one of the following statements)
☐ Decrease the force and increase the mass of the rocket.
☐ Decrease the force and decrease the mass of the rocket.
☐ Increase the force and decrease the mass of the rocket.
☐ Increase the force and increase the mass of the rocket.
3. Describe how can you determine where the center of mass (CM) is on your rocket?(Page #4)
4. Describe how can you determine the center of pressure (CP) for your rocket? (Page #5)
5. If you want your rocket to have stable flight which of the following is true (Page #6)? (Choose one)
_____The center of mass (CM) and the center of pressure (CP) should be at the same point on the rocket.
_____The center of mass (CM) should be towards the tail of the rocket and the center of pressure (CP) should towards the nose of the rocket.
_____The center of mass (CM) should be towards the nose of the rocket and the center of pressure (CP) should towards the tail of the rocket.
6. What modification can you make to your rocket to change the position of the center of mass (CM)(Page #6)?
7. What modification can you make to your rocket to change the position of the center of pressure (CP)(Page #6)?
8. ☐ True or False: A longer rocket is typically more stable in flight than a short rocket? (Page #6)
9. Why does a rocket with water fly higher than a rocket with no water? (p. 8)

10. What is air drag? (Page #9)
11. List three things you can do to your rocket to decrease the air drag. (Page #9)
- 1.
 - 2.
 - 3.
12. What is the purpose of fins on a rocket? (Page #10)
13. List two purposes of a nose cone on a rocket? (Page #11)
- 1)
 - 2)
14. (Pages #13-14) When you launch your rocket, two persons from your group will use altimeter guns to measure the angle of the rocket flight and thus determine the flight height. If these persons measured angles of 55° and 49° respectively, use the average angle formula to determine the height of the rocket flight. Assume that each of the persons are 150 feet from the launch site.
Formula: $\text{Height} = 150 (\tan A)$ Note: $A =$ average of the two angles
- Height of rocket flight = _____ Ft
15. If you launched a second rocket and these persons measured angles of 55° and 61° respectively, what is the height of the rocket flight?
Height = _____ Ft