

Name: _____

Practicing Right Angle Trigonometry

Drone pilots are people who fly drones. Drones are unmanned aircrafts that fly. Some drones can transport items to places that humans cannot get to easily, like the side of a mountain. Drones can also transport items very quickly because they will not get held up in traffic.

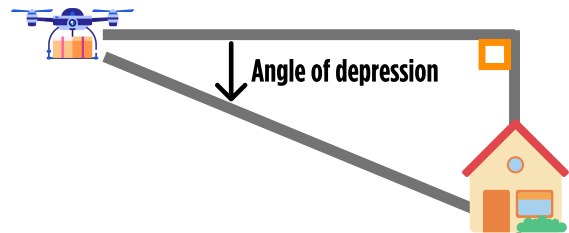
Companies, like Amazon and Walmart, are testing ways to use of drones to ship items to people's houses. Instead of using delivery trucks, drones would pick up a box at a warehouse, fly it to a person's house, and drop it at the front door. The drones would be controlled by a pilot at the warehouse. The pilot would be in charge of telling the drone where to fly so that it reaches the house safely.

Before drones can be used to deliver packages, drone pilots have a few things they need to think about. For instance, drones, like planes, need to watch out for air traffic. Drone pilots would need to watch out for other drones or low flying planes and helicopters. Drone pilots also need to think about how they will land their drone. Similar to a plane, the drone cannot just fly straight down and plop on the ground. They must fly down at an angle so they can safely land without harming anyone and damaging their equipment.

Below, you learn how drone pilots use math to help them safely land drones and deliver packages. Follow the steps below.

Step 1: Learn about angle of depression

An angle of depression is an acute angle in a right triangle. More specifically, it is the angle between your horizontal line of sight looking straight ahead and the line toward an object below. Take a look at the picture to the right. The angle of depression is the slanted line from the drone to the bottom of the house.



To find the angle of depression, we can use trigonometry relationships. Below a list of three relationships you can use:

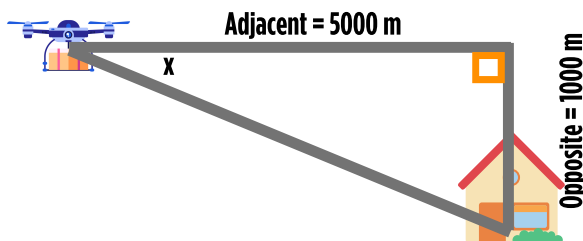
$$\text{sine} = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\text{cosine} = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\text{tangent} = \frac{\text{opposite}}{\text{adjacent}}$$

Here is an example on how to find the angle of depression:

A drone is at an altitude of 1000 meters and is a horizontal distance of 5000 meters away from a house. Help the pilot calculate the angle of depression from the drone to the house.



$$\text{tangent} = \frac{\text{opposite}}{\text{adjacent}}$$

$$\text{tangent}(x) = \frac{1000}{5000}$$

$$\text{tangent}(x) = 0.2$$

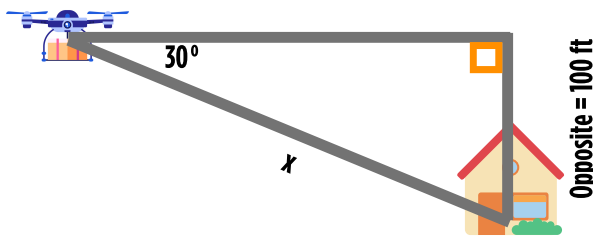
$$\text{Inverse of tangent} = 11.3 \text{ degrees}$$

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Here is another example:

A drone is at an altitude of 100 feet and is approaching a house at an angle of depression of 30 degrees. How far away is the drone from the house diagonally?



$$\text{sine} = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\text{sine } 30 = \frac{100}{x}$$

$$0.5 = \frac{100}{x}$$

$$x = 200 \text{ feet}$$

Step 2: Using trigonometry to land drones

Answer the questions below. For each question, draw a diagram of the information in the question. Then, show your calculations to find the different angles. You will need a calculator.

1. A drone is at an altitude of 500 feet and is 1000 feet horizontally from a house. Find the angle of depression.
2. A drone is at an altitude of 300 feet and approaching a house at an angle of depression of 20 degrees. How far is the drone from the house diagonally?
3. A drone is 1000 feet away from a house horizontally and approaching diagonally at an angle of 45 degrees. What is the altitude of the drone?

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4. A drone measures a diagonal distance of 5000 feet to a house at an angle of depression of 30 degrees. How far away horizontally is the drone from the target?

5. If a drone is to deliver a package to a home 5715 feet away, and the drone flies at a height of 500 feet, the angle of depression for the drone leaving the store should be 5 degrees. If the drone pilot misreads the data and sets the angle of depression at 6 degrees, how far from its intended drop point will the drone land?

6. If a customer orders a delivery that requires two drones, the drones must maintain a safe distance of 1000 feet between them. If the drone pilot knows that Drone 1 is flying at an altitude of 500 feet with an angle of depression of 20 degrees, and Drone 2 is also flying at an altitude of 500 feet with an angle of depression of 12 degrees, how far apart are the drones from each other? Are they maintaining a safe distance?

Extra Time?

- Check out Amazon's web page on using drones to deliver packages: https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011prime-air_01.jpg.zip
- Drone deliveries are a new service that is just now being tested. Below are things to think about as this form of delivery becomes more popular:
 - How would you stop people from taking down a drone and stealing its cargo?
 - How would you make sure that a drone doesn't harm a bird or other animal that flies?
 - How close to the ground should drones be able to fly?
 - If there is traffic, should some drones get priority to fly if they are carrying medical supplies or other essential items? Who should have the authority on what drone gets priority to fly?