Unit 2: Input, Output and Functions | **Application: Distance to the Horizon**

In this Application, you will write a program that that determines the distance to the horizon from a given altitude.

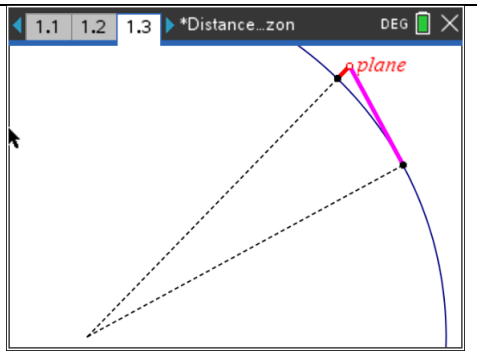
Objectives:

- Use import for additional functions
- Write a program using the menus
- Use multiple units in one problem

When a plane is flying, how far away is the horizon to the pilot? The higher she flies, the further the distance to the horizon. How does she determine the distance to the horizon given the plane's altitude?

The radius of the earth is 3,958.8 miles.

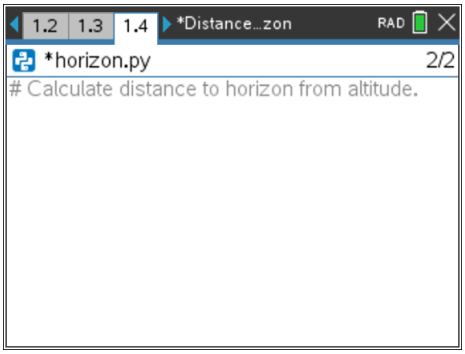
Write a program to input the altitude of the plane in feet and produce the distance to the horizon in miles.



Teacher Tip: This project uses the Pythagorean Theorem to calculate one leg of the right triangle pictured above. The hypotenuse is the *sum* of two distances in different units.

1. Start a new Python file (we call it **horizon**).

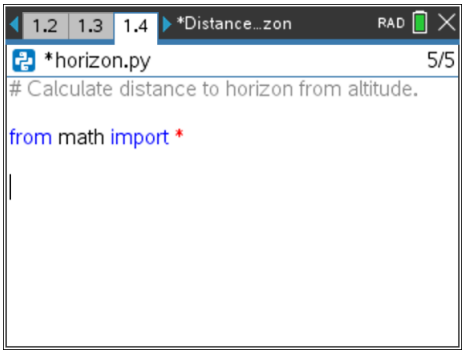
   Start with a comment explaining the purpose of the program.



2. This program uses the Pythagorean Theorem and requires the square root function which is not part of Python's built-in operations. This function and others are found in a standard Python module called **math**. To use this function, you must import the math module to your code. On **menu > math**, select the statement at the top:

   from math import *

   The asterisk (*) means 'everything'. You will see how to use the tools in this module using the menus.



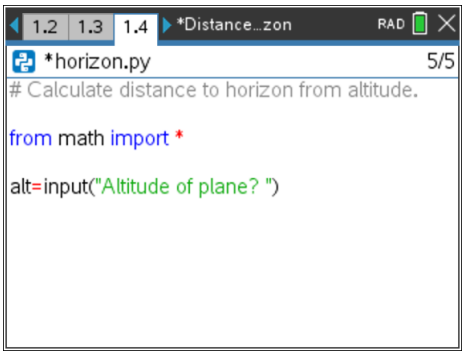
Teacher Tip: You can also write **from math import sqrt** if you know you are only going to need the sqrt function. Or **import math** which requires you to write **math.sqrt()**.
The math module (along with random and time) is a standard Python module.

3. Use the input statement to enter the altitude of the plane.

   First type the variable **alt** and the **=** sign.

   Then look on **menu > Built-ins > I/O** for the **input()** function.

   For the prompt inside the parentheses, write: **"Altitude of plane? "**



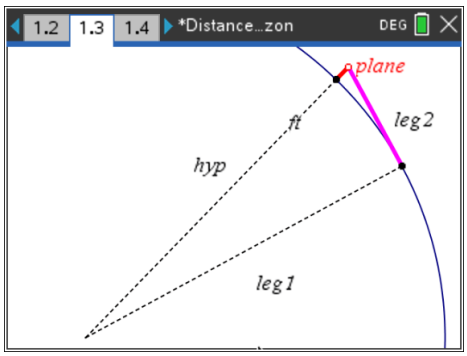
Teacher Tip: input() returns a string so this statement will need to convert the altitude into an **int** (integer) or **float** (numbers with decimals). See step 6.

4. From our labeled diagram we see a right triangle where one leg is the radius of the earth, the other leg is the distance from the plane to the horizon and the hypotenuse is *(the radius of earth plus the altitude of the plane)*. The Pythagorean Theorem states that, in a right triangle

   $$(\text{leg1})^2 + (\text{leg2})^2 = \text{hyp}^2$$

   or $$\text{radius}^2 + \text{leg2}^2 = (\text{radius}+\text{alt})^2$$

   Solving for **leg2** gives: $$\text{leg2} = \text{sqrt}((\text{radius}+\text{alt})^2 - \text{radius}^2)$$

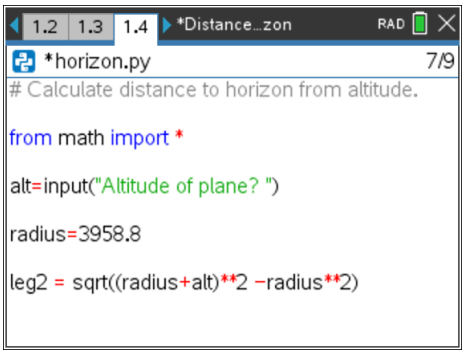


Teacher Tip: How do we know it is a right triangle? The distance to the horizon is tangent to the circle and the tangent to the circle is perpendicular to the radius at the point of tangency.

Note that the radius of the earth is given in miles and the altitude of the plane is given in feet. There is some conversion to be done first.

5. We enter this formula into our program:

   leg2 = sqrt((radius + alt)2 – radius**2)**



Be careful with the parentheses and be sure to use **2 for squaring. We also use the variable **radius** to represent the radius of the earth and set it equal to 3958.8:

radius = 3958.8

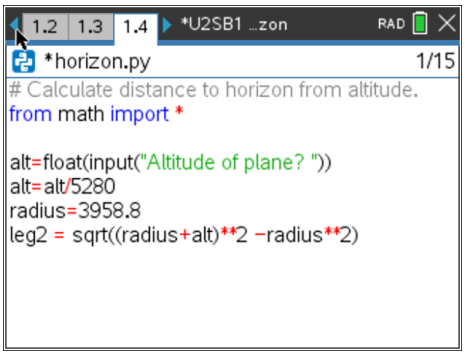
There are two more details to handle before we can test the program.

6. Recall that **input()** produces a string. We need a number, so add the **float** function to the input statement:

alt = float(input("Altitude of plane? "))

Also, the altitude is in feet but the radius is in miles. Convert the altitude into miles using the statement

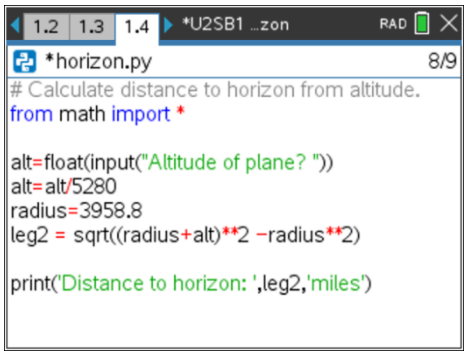
alt = alt / 5280



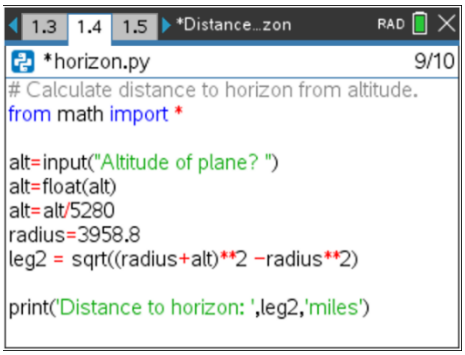
7. We're just about ready but we still have to print the answer!

print(leg2)
gives the answer, but a more informative message would be:
print('Distance to horizon: ', leg2', miles.')

When ready, press **ctrl+R** to run the program. Try various altitudes. Remember to save your document.



8. Summary: The order of the statements in the final program is important but the order in which they are entered into the program does not matter. This is the power of a text editor. This program and all the others in this unit are examples of the 'sequence' structure of the language, which processes statements from top to bottom.
Comments, extra spaces, and blank lines in the program are ignored when you run the program. 'import' statements bring in additional functions from separate modules that are included in the TI-Nspire Python programming language.



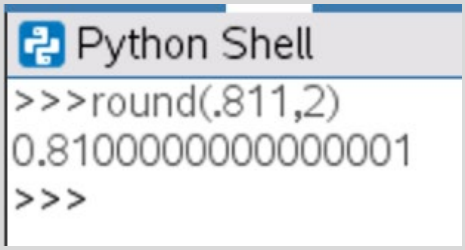
9. **Question 1:** The International Space Station is 254 *miles* above the surface of the earth. How far is it to the horizon for the crew?

Question 2: If you are standing on the beach at the edge of the water looking out over the ocean, how far away is the horizon?
Hint: Enter the height of your *eyes* above the ground (in feet).

Teacher Tip: Rounding: Python has a built-in **round(number, #places)** function.

Example: **leg2 = round(leg2, 3)** rounds leg2 to 3 decimal places.
round() is found on **menu > Built-ins > Type**.

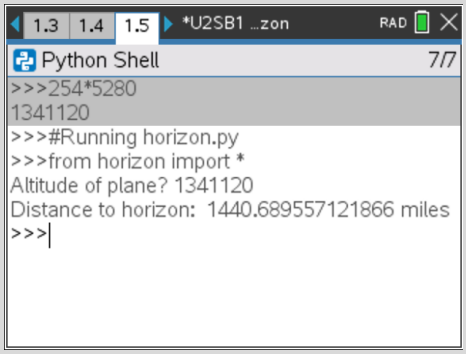
But…this sometimes produces undesired results:



[fail: Python's fault!]

Answer to Question 1:

First convert 254 miles to feet in the Shell, then run the program:



Answer to Question 2: depends on the student's eye height.