

Unit 2: Input, Output and Functions

Application: Distance to the Horizon

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

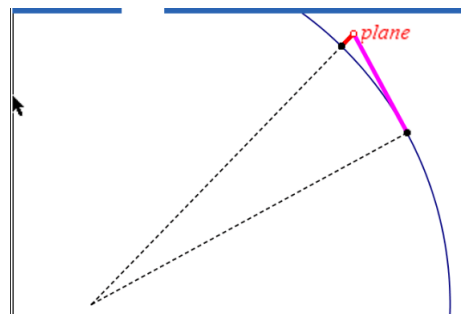
Objectives:

- 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 they fly, the further the distance to the horizon. How do they 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.



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

Start with a comment explaining the purpose of the program. You can press **[2nd] [3]** for the **#** symbol and turn on alpha-lock for the rest of the text. Remember that the space is on the **[0]** key.

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 *

Recall that the asterisk (*) means "everything."

3. Use the **input()** function to enter the altitude of the plane.

First type the variable **alt** and the **[sto ->]** to get the = sign.

Then look on **<Fns...> I/O** for the **input()** function.

For the prompt inside the parentheses, write: **"altitude (ft)?"**

Tip: Remember many symbols including ? can be used from the <a A #>.

```
EDITOR: HORIZON
PROGRAM LINE 0003
# calculate distance to
# horizon

Fns... a A # Tools Run Files
```

```
EDITOR: HORIZON
PROGRAM LINE 0004
# calculate distance to
# horizon
from math import *

alt=input("altitude (ft)?")

Fns... a A # Tools Run Files
```



4. Remember that input() gives a string that must be converted to a number. On the next line, convert the string alt to a float (decimal) value:

alt = float(alt)

float() is on <Fns...> Type.

```
EDITOR: HORIZON
PROGRAM LINE 0007
# calculate distance to
# horizon
from math import *

alt=input("altitude (ft)?")
alt=float(alt)

-

Fns... a A # Tools Run Files
```

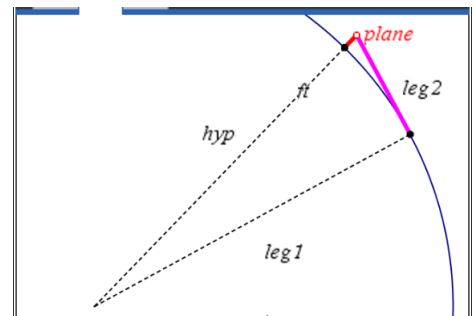
5. From our labeled diagram we see a right triangle where one leg is the radius of the Earth, the other leg is the distance from the plane to the horizon and the hypotenuse (*the radius of earth plus the altitude of the plane*). The Pythagorean Theorem states that, in a right triangle:

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

or

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

So, solving for leg2 gives: **leg2 = sqrt((radius+alt)² - radius²)**



6. The Python exponent symbol is **
Enter this formula into your program:

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

Yes, you may use shorter variable names!

Be careful with the parentheses.

Pressing the [x²] key produces **2 in your code.

Pressing the caret key [^] produces **

Or you can just type them yourself.

```
EDITOR: HORIZON
PROGRAM LINE 0008
# calculate distance to
# horizon
from math import *

alt=input("altitude (ft)?")
alt=float(alt)
leg2=sqrt((radius+alt)**2-radius
**2)

-

Fns... a A # Tools Run Files
```

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

- Set the variable radius to be 3958.8:
radius = 3958.8
- Convert the altitude variable from feet to miles:
alt = alt/5280

Both of these statements must occur **before** the Pythagorean Theorem formula, as shown here. If you made a mistake, under <tools> try cut and paste the line to the new location.

```
EDITOR: HORIZON
PROGRAM LINE 0010
# calculate distance to
# horizon
from math import *

alt=input("altitude (ft)?")
alt=float(alt)

radius=3958.8
alt=alt/5280

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

-

Fns... a A # Tools Run Files
```



8. You are almost ready ... you still must print the answer.

print(leg2)

gives the answer, but a more informative message would be:

print(" Distance to horizon: " , leg2 , " miles. ")

When ready, select **<Run>** to run the program. Try various altitudes.

If you see a **SyntaxError**, check your punctuation carefully.

Extra spaces have been added to illustrate order of the punctuation.

9. **Challenge:** Revise the program to use a **defined** function to calculate the distance. There will be one argument for the function: the **altitude** (n feet). The function **returns** the distance (in miles).

Find the altitude of the outdoor observation deck (86th floor) of the Empire State Building in NYC. Use this program to determine how far you can see in any direction. Or you can use the NYC One World Trade Center observation floor, or the highest one in the world, the Burj Khalifa observation deck in Dubai.

Can you write a metric version?

```
PYTHON SHELL

>>> # Shell Reinitialized
>>> # Running HORIZON
>>> from HORIZON import *
altitude (ft)?37000
235.6528971521095
>>> |
```

