	**Iona Physics** **GPS Experiment** Br. R.W.Harris	

Title: To determine the accuracy of GPS measurements using Phyphox on a smartphone.

Background:
The Global Positioning System (GPS), originally NAVSTAR GPS, is a satellite-based radionavigation system owned by the United States government.[1]
It is an amazing system which uses incredibly precise timing. The calculations involved in the system employ the general theory of relativity. Happily, you do not have to do those calculations.

The Experiment:
You will make GPS measurements at two different locations using Phyphox, and calculate the distance between the points. You will also measure the distance between the points directly, and compare the results. Note: It is easier to detect GPS signals outside, rather than inside a building..

After having performed the experiment once, if practical, you will choose two locations which are twice as far apart, repeat the experiment, and compare the results of the two experiments.

Data:

	Latitude	Longitude
First Location		
Second Location		

[1] "Global Positioning System - Wikipedia." https://en.wikipedia.org/wiki/Global_Positioning_System. Accessed 12 Jul. 2020.

DIFFERENCE		

Actual measured distance ___________________

Calculating the distance:

(A) 1 degree of latitude = 111111 m

(B) 1 degree of longitude = 111111 m*cos(latitude)

Then the distance = $\sqrt{A^2 + B^2}$

Here is some actual data from an experiment performed on Iona's campus:

Data First experiment:

Position 1: Latitude 40.963797 Position 2: Latitude 40.963883

Position 1 Longitude -73.394356 Position 2 Longitude -73.794364

$\Delta\ Latitude\ (in\ degrees) = .000086$ = 8.6E-5

$\Delta Longitude\ (in\ degrees) = 0.000008$ = 8.0E-6

1 degree of latitude = 111111m

Therefore latitude distance = 111111 m *(8.6E-5) = 9.55 m

1 degree of longitude = 111111m*cos(latitude)

Therefore longitude distance = 111111m*cos(40.9)*8.0E-6 = .67m

Using Pythagorean Theorem distance = sqrt((9.55 m)^2 + (.67m)^2) =9.57 m

Measured distance = 7.62 m

% difference= 100%*(experimental - accepted)/accepted

% difference = 100%(9.57-7.62)/7.62 = 25.5%

To verify the calculations, the experimental data was entered into a website[2] Which calculated a distance of 9.586 m

Note: The website calculation and mine agree very well. I don't know why they differ so much from the measured distance, unless my calculations are wrong. Remember we are on the earth, which is not a plane. However over reasonable distances, I assume using plane geometry (Pythagorean theorem) is reasonable. Also, considering the absolute error is only a couple of meters, that is not bad considering the scale on which we were working. (We were using satellites!)

Second run

$\Delta\ lat = 2.19\ E - 4$

Δ long = 1.73E-4

Latitude distance 32.33 m

Longitude distance 14.7251 m

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[2] https://www.movable-type.co.uk/scripts/latlong.html

Pythogorean theorem answer 35.5 m

Actual measured distance 100 ft = 30.48 m

16% error
Less % error AND within the uncertainty listed on the Phyphox screen.