

Name: _____

Lab: Measuring Pressure with smart phones

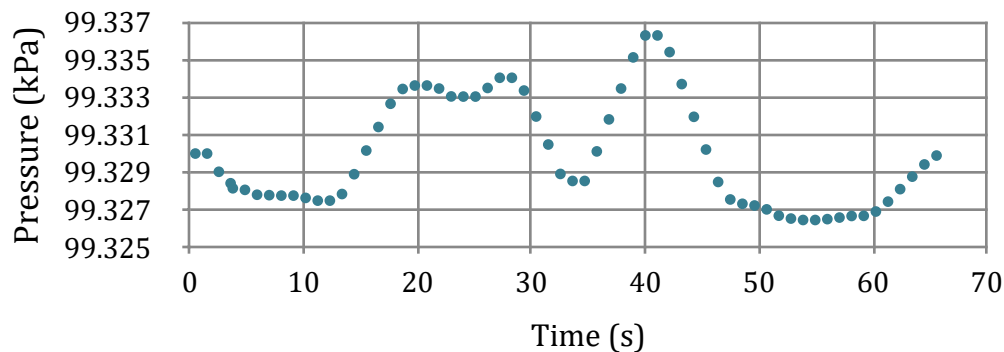
Hypothesis: Most smartphones have a pressure sensor and we're going to use those sensors to measure the pressure around us.

1. Measuring Pressure with phyphox app and your phone (or tablet)

- Start the app, choose Pressure and then hit the 'play' button to start recording data.
- Set your phone on the floor and start measuring pressure
- After 30 seconds, pick up the phone and hold it above your head for another 30 seconds.
- Stop data collection and explain your observation.

2. Measure atmospheric pressure with your phone.

- Using the pressure sensor application in phyphox, measure atmospheric pressure. Report the value in kPa ($100 \text{ Pa} = 1 \text{ hPa}$).
- Take data for at least 60 seconds. Estimate the precision of the pressure measurement by looking at the pressure variation during your measurement when your phone was not moving. Which of the values below best represents the precision of your measurement? $\sim 100 \text{ Pa}$ $\sim 10 \text{ Pa}$ $\sim 1 \text{ Pa}$ or $\sim 0.1 \text{ Pa}$
- What is causing the variation in the pressure data below? Sensor noise or a real change in pressure? Look at how much it varies and compare to last answer.



It can be difficult to estimate the precision of the pressure measurement when there is a real change in pressure during the measurement period.

Determine the data collection rate of your phone or tablet, in other words, how many data points per second does it record?) _____

3. Change in Pressure with altitude

Design an experiment to measure the change in pressure as a function of altitude. First just measure pressure at two altitudes, then do a wide range of altitudes and calculate the density of air based on your measurements. Record the temperature of the air where you perform your experiment.

- A. Identify locations on campus where an experiment could be conducted over a greater range of altitudes and where you can make accurate measurements of altitude.
- B. Consider making measurements of pressure at several intermediate altitudes (heights) as well as the minimum and maximum altitudes.

location	height (m)	Pressure (hPa)	Pressure (kPa)

- C. Graph your data, Pressure vs Altitude, and use a best fit line to determine the relationship between pressure and altitude.

Equation of linear fit: _____

- D. Use the results of the fit in part C to determine the density of air and compare the accepted value for air at that temperature.

Density of air from data: _____

- E. Estimate the altitude of the edge of the atmosphere... what height does the pressure go to zero?

top edge of the atmosphere = _____

- F. Explain why this is a low estimate, what assumptions are we making?
Why is it gravity not to blame for the estimate being too low?

4. Characterize the pressure sensor in your device

- A. Determine the accuracy of pressure measurements by calculating the average pressure and standard deviation using multiple devices at the same location. *Use the Simple mode* for the pressure sensor for this measurement.

Device	Pressure (_____)
average P =	

- B. Measure pressure vs time in the lab or classroom with two independent devices (its best to pair up with another android phone if you have an android). The constant difference between the two pressure measurements provides a measure of the accuracy of the sensors. Significant pressure variations in the room observed by both detectors would suggest that the pressure variations are real changes in pressure in the room.
- C. Graph the pressure difference between the two sensors as a function of time. The variation of the difference (standard deviation) provides a measure of the precision of the pressure sensor.

Accuracy: _____

Precision: _____

5. Pressure from external forces

- A. Put your device in a 1 gallon ziplock bag, partially inflated and seal it. Place a textbook on top of the bag while recording the pressure as a function of time.
- B. Make two plots of the data, one where the pressure axis is 'zoomed in' to show the change in pressure and one where the pressure axis is full scale (0 to 100 kPa) to illustrate the change in pressure caused by the book.
- C. Try adding a second book and measure the weight/force being exerted. How does the pressure depend on the force? Do your values for the pressure increase caused by the books seem reasonable?