

# Physics III Lab

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## Lab 1: Characterizing the Atmosphere

Pre-Lab:

### 1) Pressure Review

a) The physics definition of pressure is defined as the normal force per unit area applied to a surface:  $P = \frac{F}{A}$ . In SI units, it's measured in pascals (Pa) where  $1 \text{ Pa} = 1 \text{ N/m}^2$ .

b) Atmospheric pressure is the pressure exerted by the weight of air above a surface. It comes from the fact that air molecules colliding with surfaces plus the fact that gravity makes the air stuck and push downward.

### 3) Phyphox

a) the readings appear stable by fluctuating randomly around a constant value (1,014.50) hPa, suggesting a normal distribution.

b) the smallest increment is 0.01 hPa, so the estimated uncertainty is  $0.01 \pm 0.01 \text{ hPa}$ .

#### 4) Accuracy & Precision

b) Reaction Time: Attempt time (s)

q) For  $N=20$  trials,  
the mean  $\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i$   
where  $x_i = t_i - 2.00\text{s}$ .  
The mean is  $\bar{x} = 0.0605\text{s}$ .

The sample standard deviation is

$$s = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

$$s = 0.120\text{s}$$

Interpretation:

~~my stopwatch shows a 0.01s resolution, then~~

~~$s_{\text{scale}} = \frac{0.01}{\sqrt{12}} \approx 0.0033\text{s}$~~

The Accuracy

~~iPhone stopwatch has accuracy of 0.00004s~~

which does not contribute significantly to the results

The spread is dominated by statistical uncertainty. The best approximation of my reaction-time uncertainty is approximately 0.12s.

10	Trial	time(s)	(a) The histogram appears approximately symmetric with values clustering around the mean rather than being uniformly distributed. Therefore a normal distribution PDF best describes the data.
1		1.36	
2		1.76	
3		1.10	
4		1.76	
5		1.46	
6		1.48	
7		1.73	(b) if $U_{\text{reaction}} = \frac{0.12}{\sqrt{20}} \approx 0.0275$ , then
8		1.48	The statistical standard uncertainty for the paper-fall data is $u_{\text{stat}} \approx 0.054s$ .
9		1.33	
10		1.01	This is about 2 times larger than
11		1.28	the reaction-time standard uncertainty
12		1.29	$U_{\text{reaction}} \approx 0.0275$ , so the paper-fall
13		1.36	measurement is more variable.
14		1.46	
15		1.33	(c) Non-Statistical (type B) uncertainties include the stopwatch resolution (rectangular PDF, $a=0.005s$ , giving $s=0.003s$ ), intrinsic stopwatch accuracy (rectangular PDF, negligible over $\pm 1-2s$ ), uncertainty in release height (triangular PDF) bounded by shoulder positioning. All type B contributions are small compared to the statistical uncertainty ( $0.0275s$ ), so the total uncertainty is dominated by type A effects.
16		1.61	
17		1.06	
18		1.61	
19		1.08	
20		1.26	