

CH204 Experiment 1

**Dr. Brian Anderson
Spring 2007**

**Are the Densities of
Coke and Diet Coke
Different?**



$$d = \frac{m}{V}$$



Today

- **Random error in experimental data**
- **Calculating standard deviation**
- **Reporting significant digits**
- **Quick look at Experiment 1**

A graphic of a spiral-bound notebook with a brown cover and a white page. The spiral binding is on the left side. The text is centered on the page.

But first...

Sections 53215 and 53315

Yu-shan Yeh is out.

Ashley Garcia is in.

**Stay tuned for any changes in the
TA office hour schedule.**

How much does a quarter weigh?



5.7128 grams

Weigh a few more...

5.7128

5.6947

5.7085

5.6907

5.6106

5.6339

5.6009

5.7205

5.6466

5.7195

Now what does a quarter weigh?

Average = 5.67387

**Every data point
is an estimate!**

But how good of an estimate is it?

**If we don't know the true value,
how do we know how much
variability (random error) there
is in our measurement?**

**There's gotta be
a better way!**

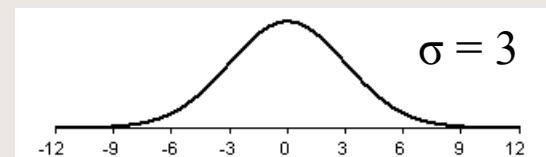
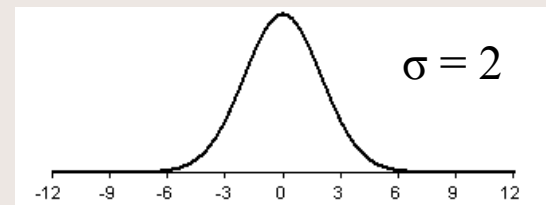
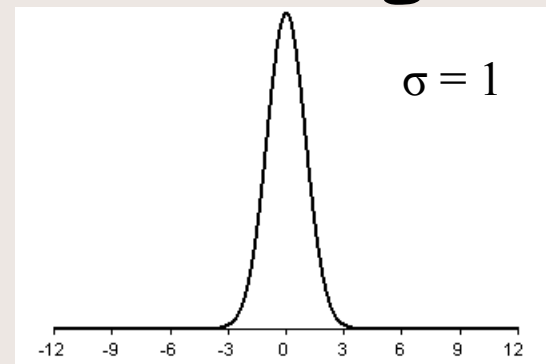
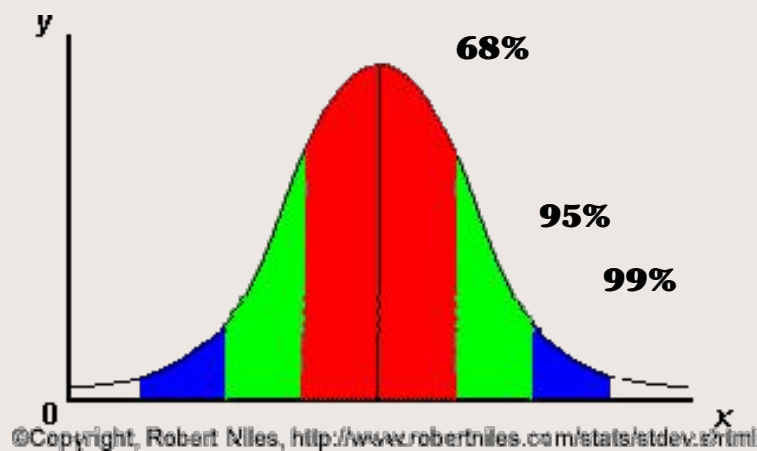
**There is. Calculate the
average \pm standard deviation**

**Standard deviation is a measure of
the scatter in the data - and it
also tells us how many decimal
places we should keep in our
average.**

What is Standard Deviation?

It's a calculation based on a set of data points that tells us how widely the data points are scattered around the average.

$$\sigma = \left[\frac{\sum (x_i - \bar{x})^2}{(n-1)} \right]^{1/2}$$



Calculating Standard Deviation

This is 2007. Use a built-in calculator function or use Excel. Don't calculate it by hand.

Let's head to Excel right now and see how E-Z this is.

So now what does a quarter weigh?

5.67287 ± 0.046377 g

Variability occurs HERE



**Only report data up to the first
uncertain digit - which is the same
decimal place where the standard
deviation falls.**

**This is really
important, folks!**

$$5.67287 \pm 0.046377 \text{ g}$$

**Round the standard deviation to ONE
significant digit: 0.05**

**And report the average only up to that
decimal place: 5.67**

Variability (random error) limits your answer

5.67287 ± 0.046377 g

should be reported as

5.67 ± 0.05 g

And that's what a quarter weighs!

So what does a quarter weigh?

5.67 ± 0.05 g

68% of all quarters should weigh between 5.62 and 5.72 grams.

5.7128

5.6947

5.7085

5.6907

5.6106

5.6339

5.6009

5.7205

5.6466

5.7195

Variability limits significant digits

There were five significant digits in the mass of each quarter, but only three significant digits in the final result.

The last two digits are insignificant because they are less than the variability in the measurement.

“Variability in the measurement” = experimental error.

Ways of Determining Experimental Error

For a single reading:

Precision of the equipment

Tolerance of the glassware

For many readings:

Statistics

This is what we're gonna do in lab today.



Std. Dev. = random error

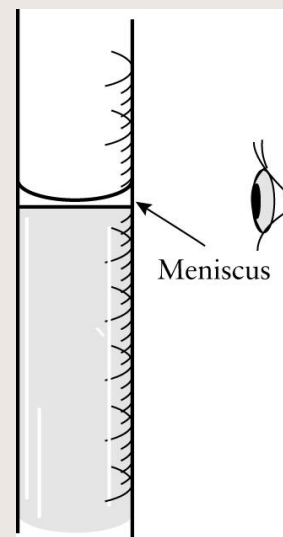
**We'll use this same procedure
to determine random error
and significant digits
in Experiment 1.**

And speaking of Experiment 1...

Equipment

Graduated cylinder
Volumetric pipette
Burette

0.01 mL



Analytical balance

0.0001 grams!



Two-Part Lab

Part One:

- **Measure the mass of 5 mL of sample using the analytical balance and three different types of glassware (pipette, burette, and graduated cylinder).**
- **Calculate density. Total of six data points.**
- **Enter your results into the spreadsheet on the computer nearest the printer, and use all the class data in your report.**

Two-Part Lab

Part Two:

- **Dispense your assigned volume using a burette, and measure the mass of the sample on the analytical balance.**
- **Do NOT calculate density.**
- **Enter your mass and volume measurements into the spreadsheet on the computer nearest the door, and use all the class data in your report.**

Important!

You will need all three graphs:

Part One:

1 - Density chart and graph comparing different methods (includes average and standard deviation for each method).

Part Two:

2 - Mass vs volume graph for Coke

3 - Mass vs volume graph for Diet Coke

Handling bad data

If you know it's bad - because you know something went wrong, or because the number is physically impossible - you can discard it.

If you don't like it because it's widely scattered, you can't just toss it, you have to apply the Q-test (see the appendix of the lab manual).

Interpolation

In order to calculate the density of water at the same temperature as your Coke or Diet Coke sample, you will have to **interpolate between the density values in the table on page 7 of the notebook.**

Final comments

Type with your fingers, not with your thumbs.

Beakers are not volumetric!

Remember to rinse your burette and put it away.

Final final comments

Quiz next week during lecture.

**There are a couple of sample
quizzes on the web site
Freebies page.**

Bring a calculator!