EXPERIMENT 1

ORIENTATION AND LAB SAFETY
ELEMENTS AND THE PERIODIC TABLE
THE BR OSCILLATING REACTION
BASIC MEASUREMENTS

CHEMISTRY 134L // SPRING 2020

Course Information, Canvas, and Syllabus

OFFICE	SCL 155
OFFICE HOURS	by appointment
E-MAIL	mioy.huynh@yale.edu

GRADING				
	6 Quizzes	25 points/quiz	(1 dropped)	125 points
	9 Lab Notebook Sheets			100 points
	6 Lab Reports	50 points/report	(1 dropped)	250 points
	Lab Conduct	5 points/experiment		*25 points
				500 points

Goals

- Sharper understanding of chemistry
- Appreciation of chemistry and science
- Excellent laboratory skills
- Critical thinking and quantitative reasoning

Laboratory Safety

1. Always wear safety glasses in the lab
2. Wear: full-length pants, full-sleeve shirt, closed-toe shoes, and a lab coat (*no ripped/torn clothing; pants and socks should cover entirety of legs*)
3. Discard chemical waste in labeled waster containers
4. Discard broken glass in broken glass containers
5. Do not bring into lab: food, drinks, phone, or laptop
6. Do not sit/kneel on floor or benchtops
7. Wear and remove gloves when appropriate
8. Wash your hands before you leave the lab

Laboratory Safety

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   should c
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4. Discard
5. Do not b
6. Do not s
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8. Wash yo

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YALE *Environmental Health & Safety*

Undergraduate Lab Safety

Personal Protective Equipment

APPOPRIATE LAB CLOTHING

Always-Long pants/closed toe shoes.
Safety or prescription glasses.
Never-Shorts, skirts or sandals.

When work involves hazardous materials:

- Safety glasses
- Lab coat
- Chemically-resistant gloves

Remember:

- Tie back/up long hair
- Remove lab coats and other PPE when leaving the lab.
- Contact lenses not recommended.

Emergencies

KNOW LOCATIONS OF NEAREST:

- Exits from room and building
- Safety shower
- Emergency eyewash
- Spill response supplies
- Phone
- Fire alarm pull station

EMERGENCY CONTACTS

Medical, Fire, Police:
911 or 203-432-4400
EHS Emergency Line:
203-785-3555
Yale Health Acute Care:
203-432-0123
EHS Main Line:
203-785-3550

Quantitative Measurements

BASIC QUANTITIES mass, length, time, temperature, mole, current, luminous intensity

volume, density, molar mass, speed, energy, concentration **DERIVED QUANTITIES**

ACCURACY

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Closeness to the true value

(agreement between determined and actual value)

PRECISION

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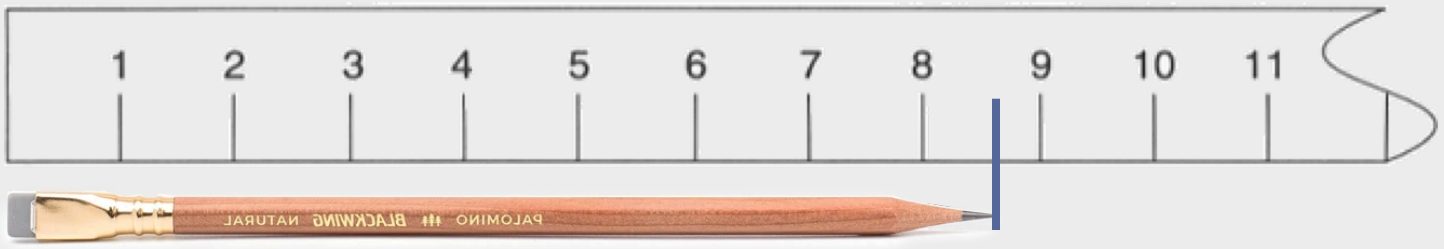
Repeatability of a measurement

(consistency among a set of measurements)

An exercise in accuracy and precision



Measuring Devices

ANALOG DEVICES

Tools in which the value of a quantity is represented by a continuously variable physical quantity.

Example 1: Temperature represented by the length of thin column of liquid.
Example 2: Volume of liquid represented by the change in distance a meniscus moves

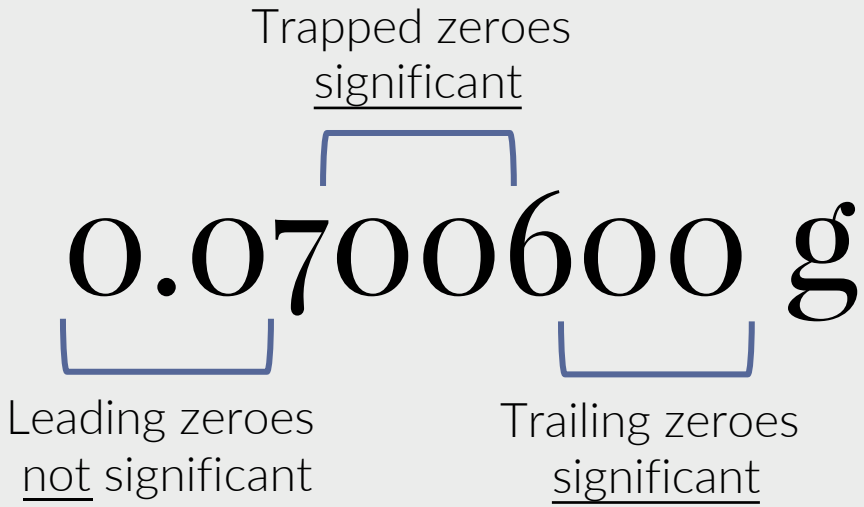
Read analog devices to “one more” decimal place.

DIGITAL DEVICES

Tools in which the value of a quantity is measured in terms of another physical quantity but displayed digitally by electronics.

How do we deal with accuracy & precision?

SIGNIFICANT FIGURES = all certain digits + one uncertain digit



How do we deal with arithmetic operations?

ADDITION & SUBTRACTION // draw a vertical line at less precise number

$34.78 + 55.9$	$84 - 63.04$	$0.071 + 1.4$	$101.2 - 98$	$27 + 273.15$
tenth	*ones*	*tenth*	*ones*	*ones*

MULTIPLICATION & DIVISION // smallest number of significant figures

1.23×740	$0.450 \div 0.063$	$7.2 \times 10^{-3}\ \text{g} \div 3\ \text{mL}$	$6.022 \times 10^{23} \times 0.100$
3 sf	*2 sf*	*1 sf*	*3 sf*

Sample Calculation

A metal rod of length 29.83 cm and diameter 1.25 inches has a mass of 451 g.
Can the rod be made of Mg?

$$\text{Radius} = 1.25\ \text{in} \times \frac{2.54\ \text{cm}}{1\ \text{in}} \times \frac{1}{2} = 1.58_8\ \text{cm}$$

$$\text{Volume} = 29.83\ \text{cm} \times [\pi \times (1.58_8\ \text{cm})^2] = 2.36_3 \times 10^2\ \text{cm}^3$$

$$\text{Density} = \frac{451\ \text{g}}{2.36_3 \times 10^2\ \text{cm}^3} = 1.91\ \text{g} \cdot \text{cm}^{-3}\ \{3\ \text{sig. figs.}\}$$

$$\text{Literature Value} = 1.74\ \text{g} \cdot \text{cm}^{-3}$$

Q: How do we minimize ”round-off error” in multi-step calculations?
A: In intermediate calculations, write down an extra subscripted digit.

Ex. 1 – The Basics

A → Elements & the Periodic Table

What are chemical elements?

- Each element is a substance consisting of only one kind of atom
- Elements are the building blocks of all matter
- An element cannot be broken down chemically into simpler elements

↓

B → Mass Spectroscopy

↓

C → The Briggs-Rauscher (BR) Oscillating Reaction

↓

D → Basic Measurements

Mass Spectrometry: How does it work?

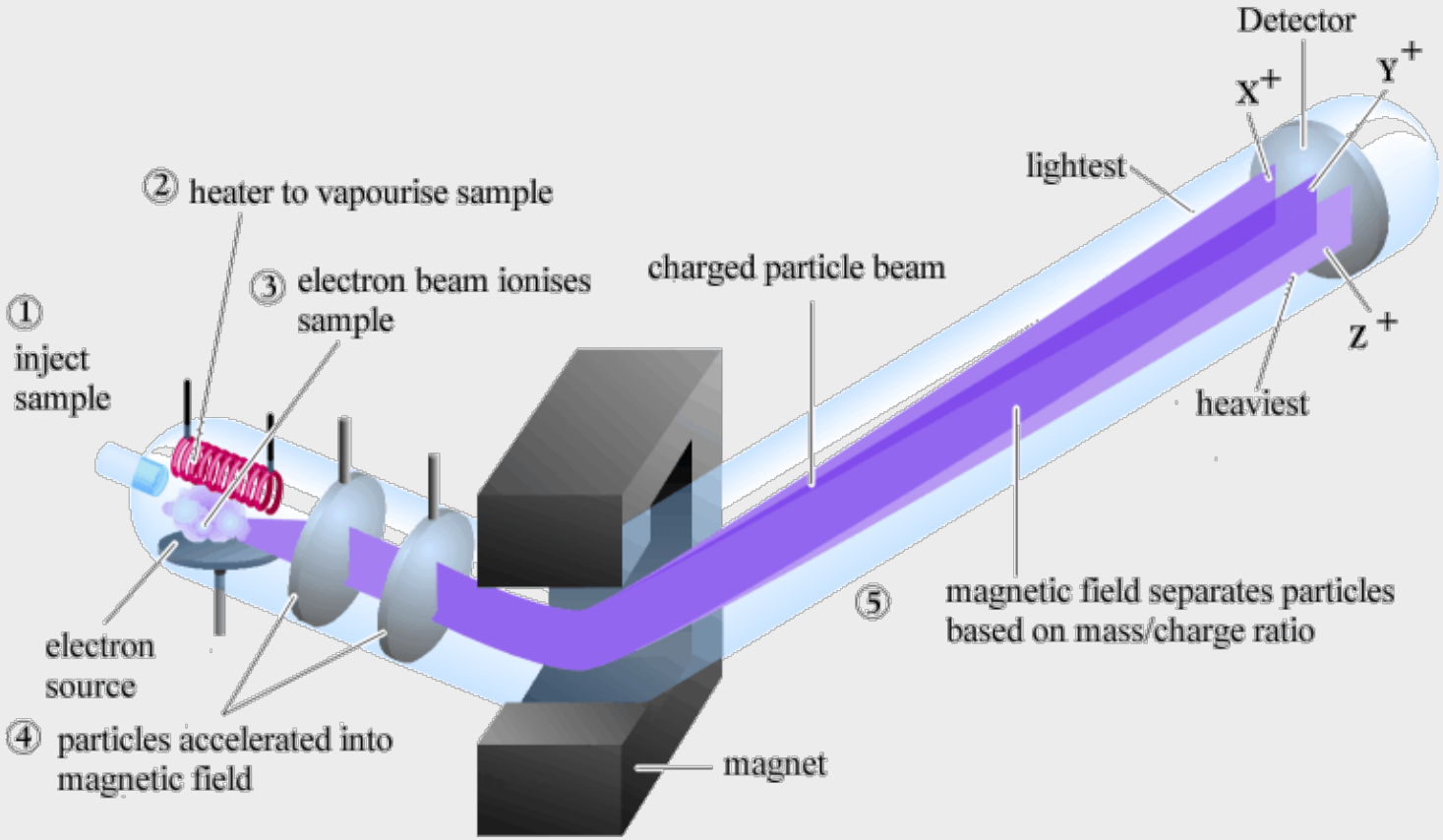
Vaporize

Ionize

Accelerate

Deflect

Detect



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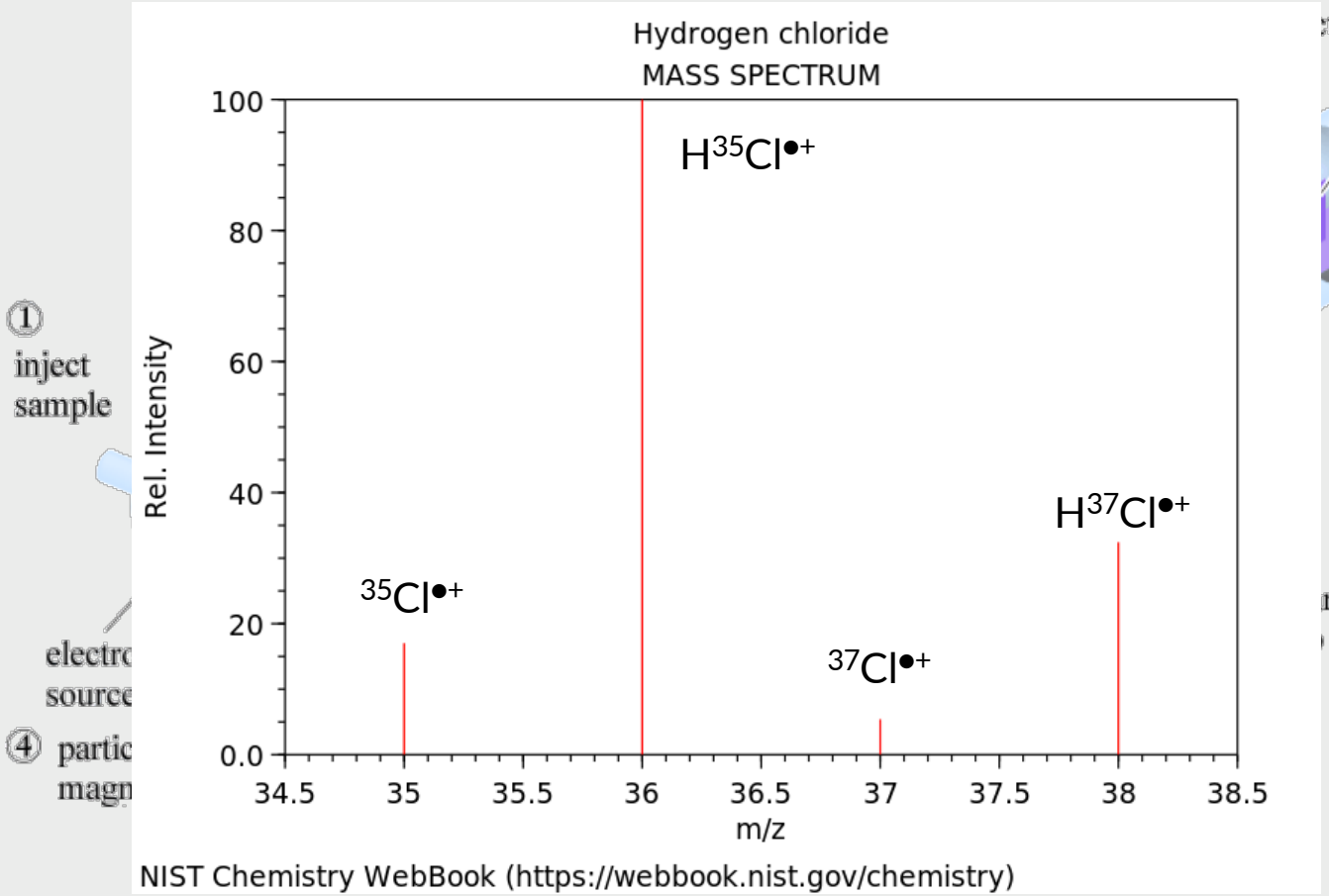


Isotopes & Isotopic Abundances

1 amu = 1/12 mass of 1 ^{12}C atom *exactly* (definition)

Fractional abundance of ^{12}C is 0.9893

Mass of 1 ^{13}C atom = 13.0035 amu

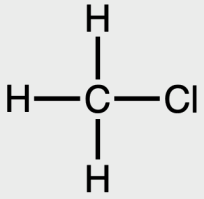
Fractional abundance of ^{13}C is (1 – 0.9893) = 0.0107

Average atomic mass of C = 12.0107 amu

Notes

1. Lab safety & requirements; lab coat + safety glasses
2. Manual + lab notebook + calculator + pen
3. Pre-lab material in lab notebook:
    - Identification information
    - Purpose(s) in present or future tense
    - Assigned problem
4. In-lab material in lab notebook:
    - Brief procedure in past tense
    - Then your observations and/or measurements
    - Always report measurements to correct sig. figs.
5. Lab notebook sheets (include TA name)
6. Prepare well for next week's experiment

Chloromethane



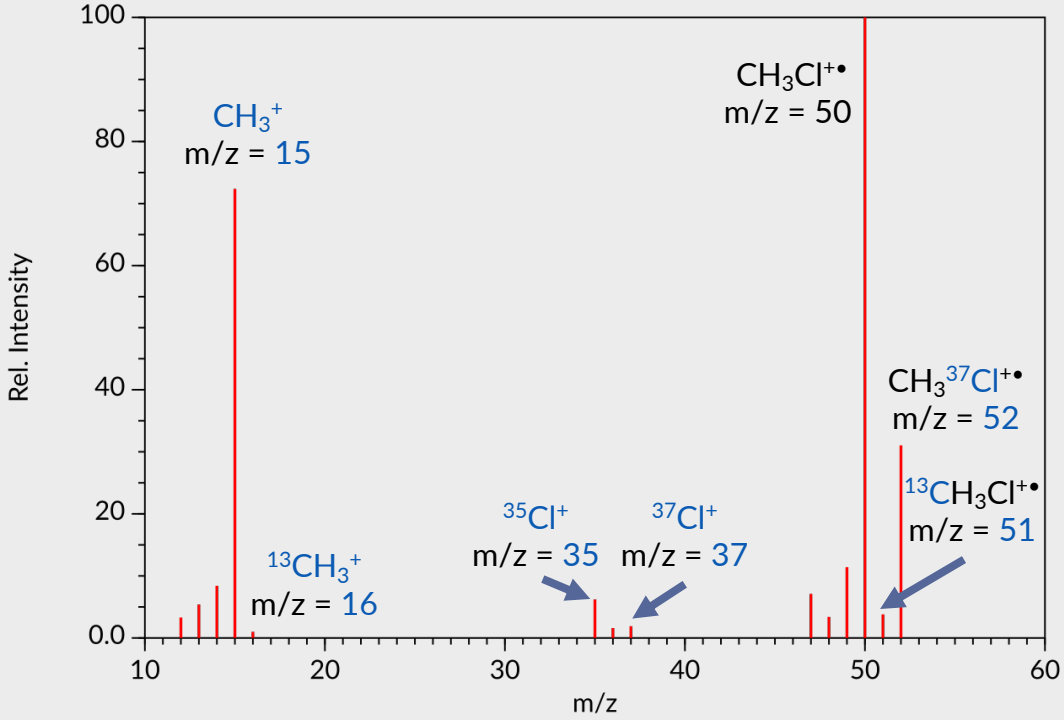
$$CH_3Cl + e^- \rightarrow CH_3Cl^{+\bullet} + 2\,e^-$$

$CH_3{}^{37}Cl^{+\bullet}$

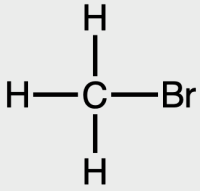
$^{13}CH_3Cl^{+\bullet}$

$$CH_3Cl^{+\bullet} \rightarrow CH_3^+ + Cl^\bullet$$
$$CH_3Cl^{+\bullet} \rightarrow CH_3^\bullet + Cl^+$$

$$CH_3^+ \rightarrow CH_2^{+\bullet} + H^\bullet$$
$$CH_2^{+\bullet} \rightarrow CH^+ + H^\bullet$$
$$CH^+ \rightarrow C^{+\bullet} + H^\bullet$$



Bromomethane



$$CH_3Br + e^- \rightarrow CH_3Br^{+\bullet} + 2\,e^-$$

$$CH_3{}^{81}Br^{+\bullet}$$

$$^{13}CH_3Br^{+\bullet}$$

$$CH_3Br^{+\bullet} \rightarrow CH_3^+ + Br^\bullet$$

$$CH_3Br^{+\bullet} \rightarrow CH_3^\bullet + Br^+$$

$$CH_3^+ \rightarrow CH_2^{+\bullet} + H^\bullet$$

$$CH_2^{+\bullet} \rightarrow CH^+ + H^\bullet$$

$$CH^+ \rightarrow C^{+\bullet} + H^\bullet$$