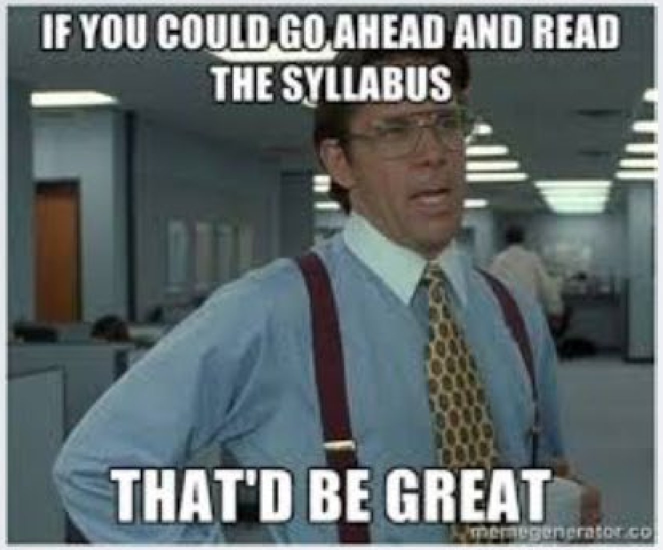
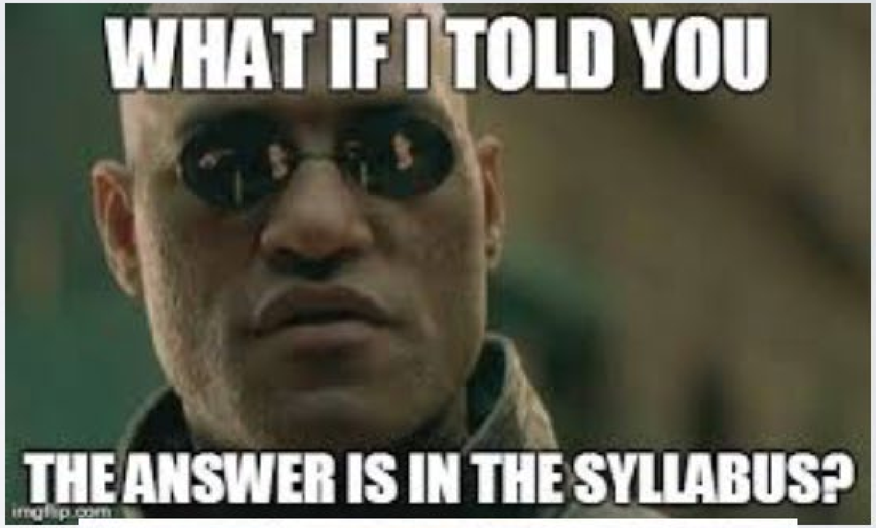
Chem 200

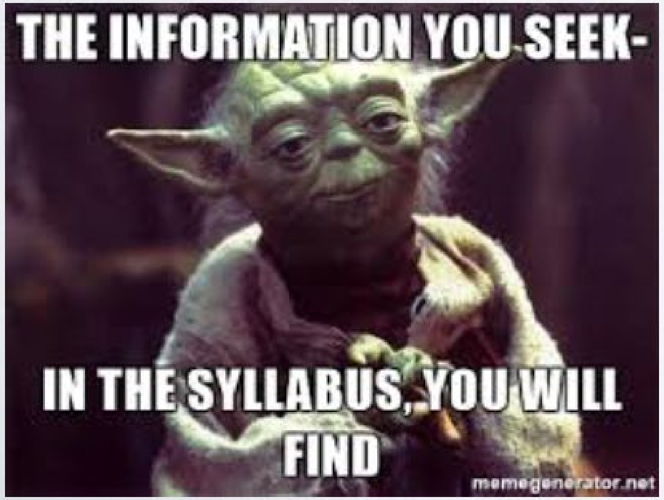
All emails sent to
chem200@sdsu.edu

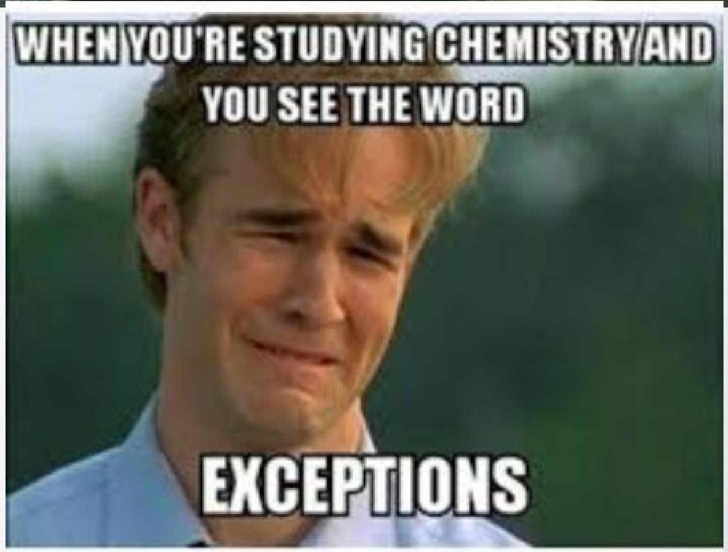
Office hours held virtually
through the MSLC.
Tues 9.00 am to 11.00 am

PLEASE READ THE SYLLABUS









IMPORTANT ANNOUNCEMENTS

1. Email chem200@sdsu.edu ONLY unless its regarding lab or discussion which then you need to email your respective TA.

2. Follow the directions in adding OWL that Theresa provided you in Module 1.0 > Adding OWL (READ). She made a video and has a pdf file with directions.

3. **There is no course key for OWL.**

4. **Read the announcements and emails that Theresa, Megan, or your TAs sends out.**

5. Again read the syllabus. A lot of questions are being asked that are in the syllabus. For example, emailing when the lab will be and what will take place can be answered by the syllabus. In the syllabus there is a lab schedule, read, use it, and print it out.

6. And for good measure read the announcements before sending out emails. The majority (98%) of questions can be answered by: the syllabus, videos Theresa has made, and in the announcements.

UPCOMING IMPORTANT DATES

- Safety Quiz due **Friday, February 3rd at 11:59 pm** (in OWL Lab & Canvas), *must pass with >60% to do in-person labs*
- How to write a lab notebook and prelab due **Sunday, February 5th at 11:59 pm**
- Volumetric Prelab due **Sunday, February 5th at 11:59 pm**
- Volumetric Lab Report due **Sunday, February 5th at 11:59 pm**
- Chapter 1-4 Chapter Problem Sets in OWL Lecture due **Thursday, February 9th at 11:59 pm** (**Start Now)**
- Chapter 1-4 Chapter Assessments in OWL Lecture is **Thursday, February 9th at 11:59 pm** (**Start Now**); 2 chances, no time limit
- Exam 1 starts at **3 pm Friday, February 10th and will close on Saturday, February 11th at 3pm** in OWL Lecture; Chapters 1-4. You have 24hrs. *Only 2 hrs once you start; be sure to give yourself a full 2 hr time slot.*

SUPPLEMENTAL INSTRUCTION (SI)

- Study sessions lead by former CHEM 200/202 students that excelled in the previous semesters class.
- Occur 15+ times a week.
- Free to access, no reporting to faculty.

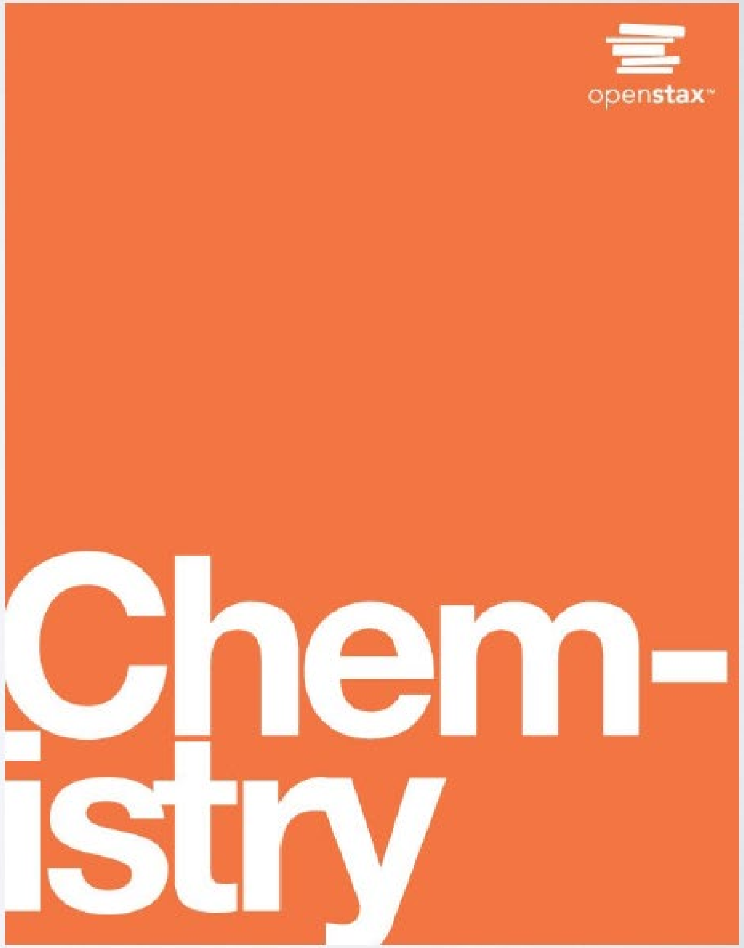
THE MATH AND SCIENCE LEARNING CENTER (MSLC)

Students are encouraged to make use of The Mathematics and Statistics Learning Center (MSLC) for free STEM tutoring, located in the Love Library, Room 328. For a full list of courses tutored, please visit the MSLC website: https://mlc.sdsu.edu/ .

The MSLC is supported by your student success fee. We strongly encourage you to use this wonderful, free resource. Some students believe that they shouldn't need to ask for help, but research has shown that the average grade for students who attend the MLC is almost one full grade higher than those who don't seek such support.

TEXTBOOK

- **Openstax Chemistry**
- **PDF is Free!***
- **Redshelf (in Canvas) is an interactive ebook for FREE!**
- Free for Kindle
- Available from iBooks ($4.99)

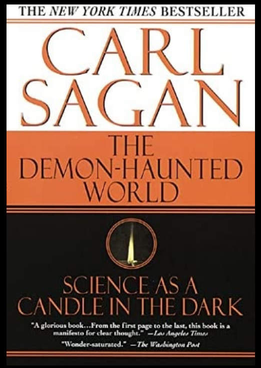


LECTURE OBJECTIVES

- Chapter 1.1 Chemistry in Context & The Scientific Method.
- Chapter 1.2 Phases and Classification of Matter
- Chapter 1.3 Physical and Chemical Properties
- Chapter 1.4 Measurement - SI Units, Prefixes
- Chapter 1.5 Measurement Uncertainty - Accuracy/Precision & Sig. Figs.
- Chapter 1.6 Mathematical Treatment of Measurement Results

Chapter 1: Introduction to Chemistry

"At the heart of science is an essential balance between two seemingly contradictory attitudes—an openness to new ideas, no matter how bizarre or counterintuitive they may be, and the most ruthless skeptical scrutiny of all ideas, old and new. This is how deep truths are winnowed from deep nonsense."- Carl Sagan

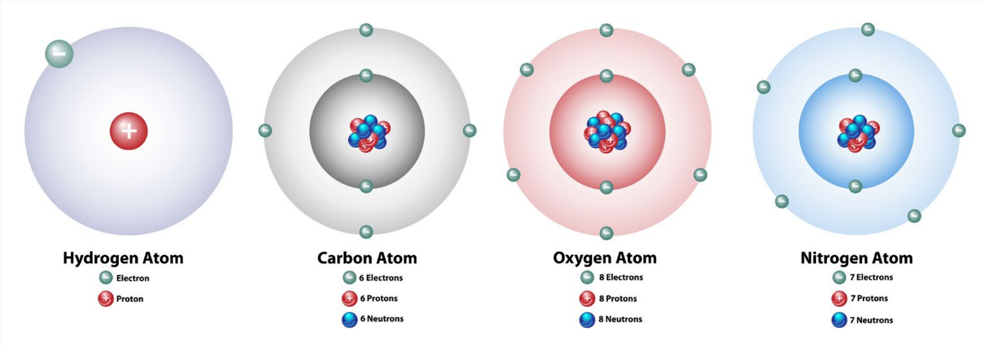


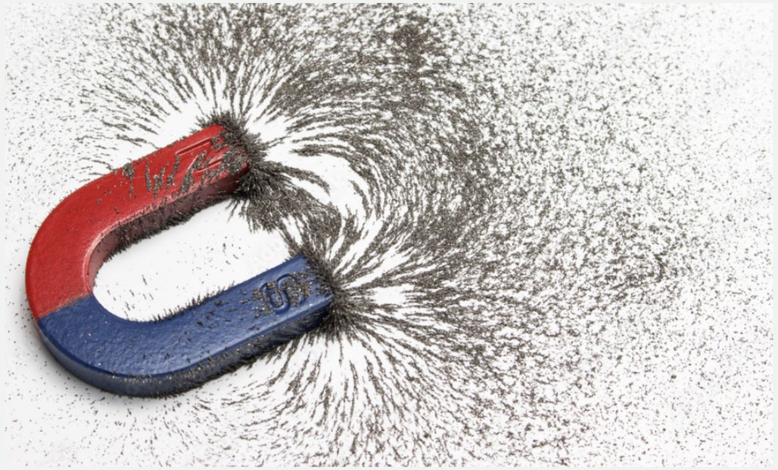
Chemistry: The Study of Matter

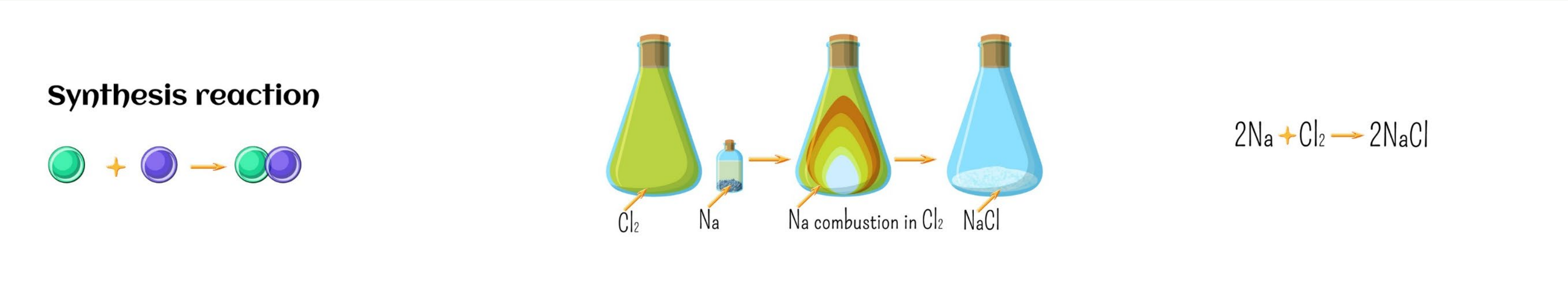
What are the properties of mater?

What are the components of matter?

How does matter interact with other matter?



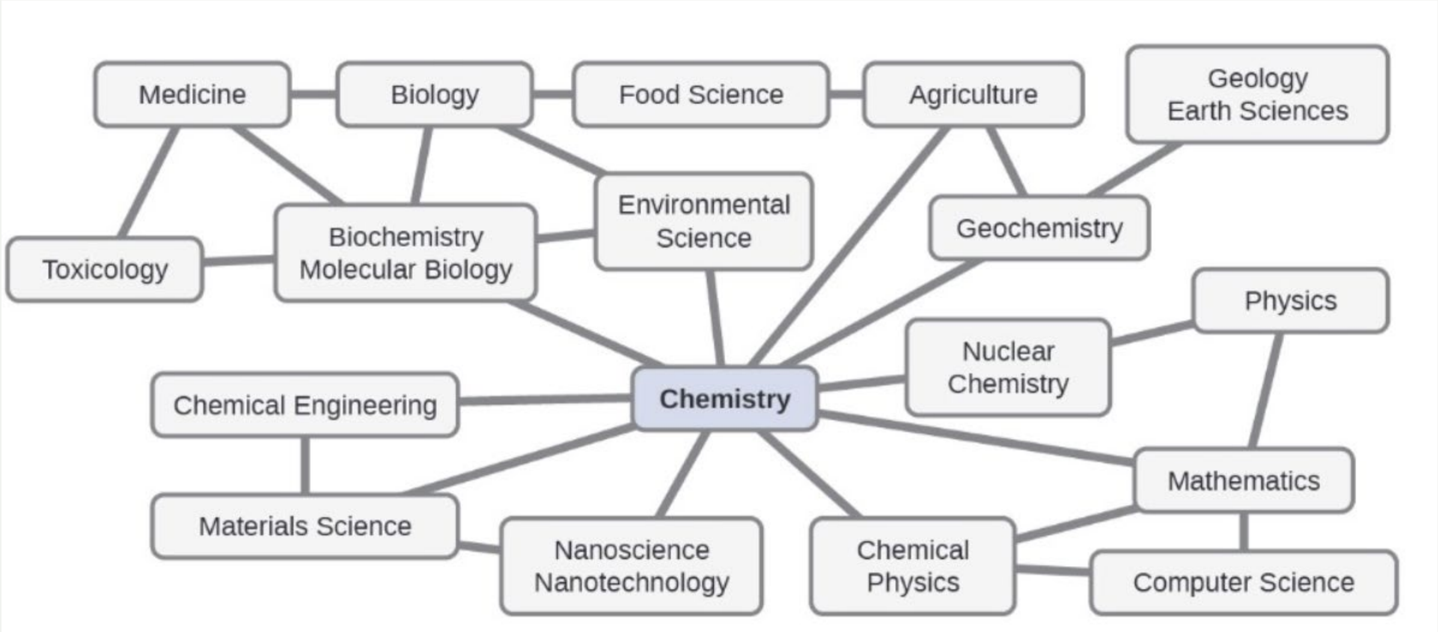




Chemistry is Everywhere!

- Polysaccharides
- Polypeptides
- Lipids
- Cellulose
- Polypeptides
- Metabolism
- Electro-chemical reactions
- Photosynthesis

Why study Chemistry?



- Unifying science
- 5 fields of chemistry:
  - Biochemistry
  - Analytical Chemistry
  - Organic Chemistry
  - Inorganic Chemistry
  - Physical Chemistry

The Scientific Method

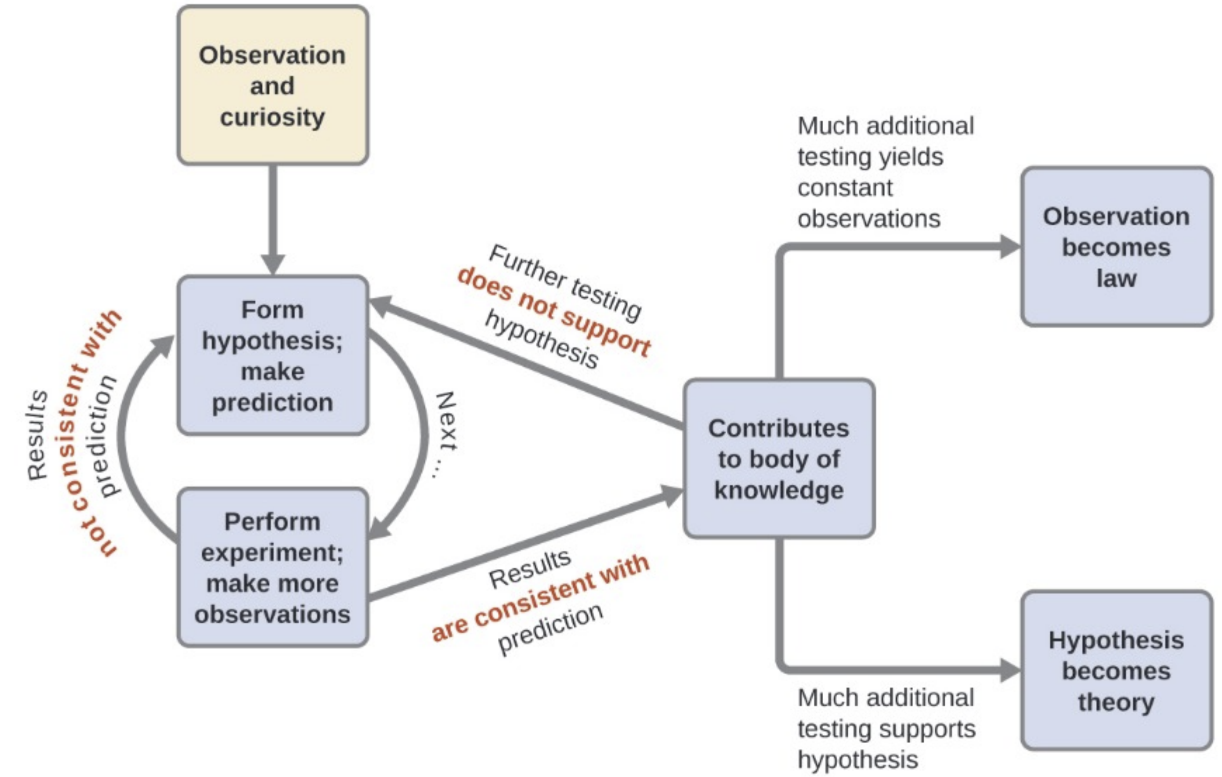
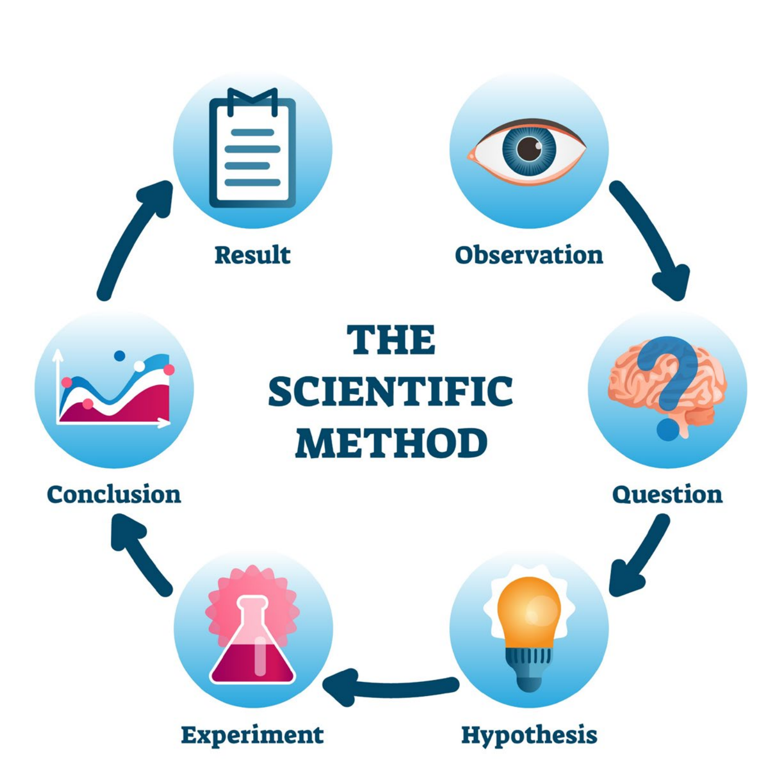


Figure 1.4 The scientific method follows a process similar to the one shown in this diagram. All the key components are shown, in roughly the right order. Scientific progress is seldom neat and clean: It requires open inquiry and the reworking of questions and ideas in response to findings.

The Scientific Method

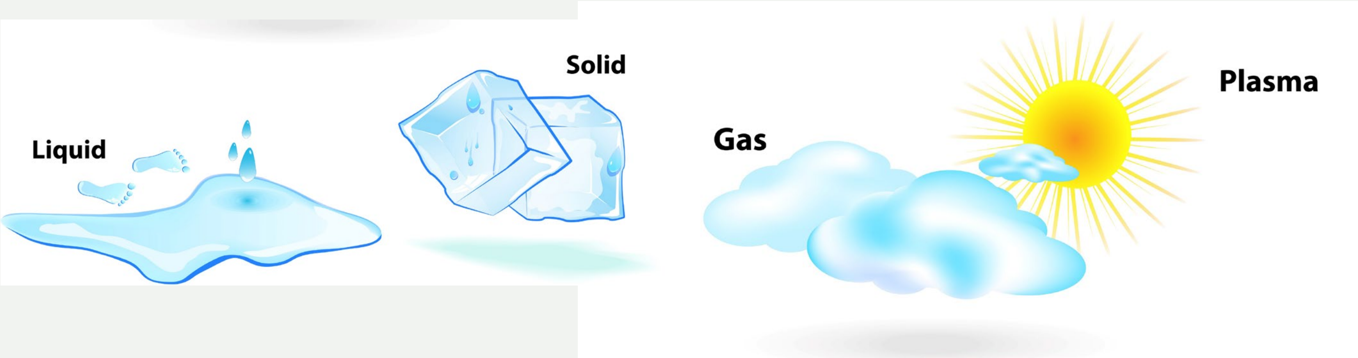


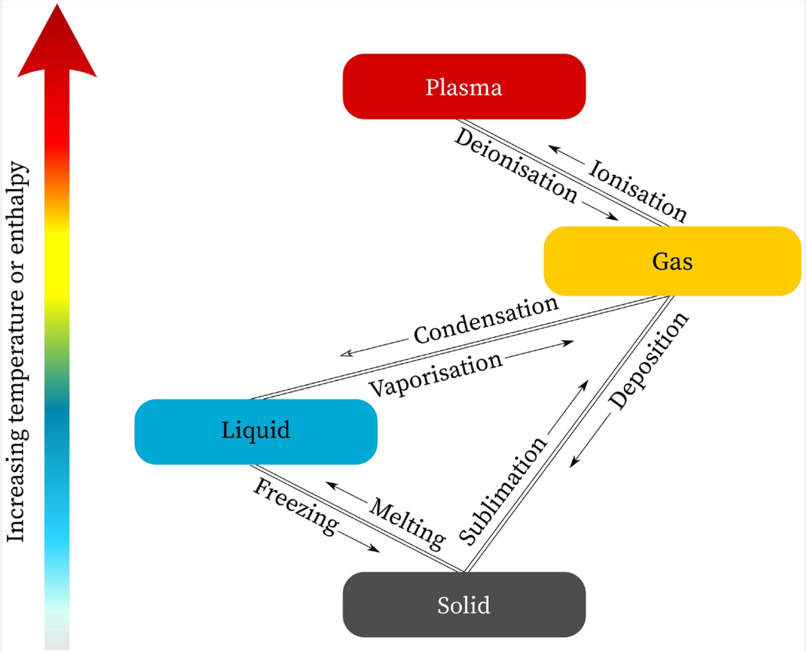
Extinction of the Dinosaurs

- Observation: The dinosaurs went extinct suddenly around 65 million years ago
- Question: What killed the dinosaurs?
- Hypothesis: Some massive global event must have occurred to cause a mass extinction event
- Experiment: High concentrations of iridium detected in rock layers formed around the same time
- Conclusion: Iridium came from an asteroid or comet that struck the earth
- Results: the dinosaurs went extinct when a large comet or asteroid struck the earth

1.2 Properties and Classification of Matter

The Phases of Matter





- MATTER: anything that occupies space (has) Volume and has Mass

- Solid
- Liquid
- Gas
- Plasma

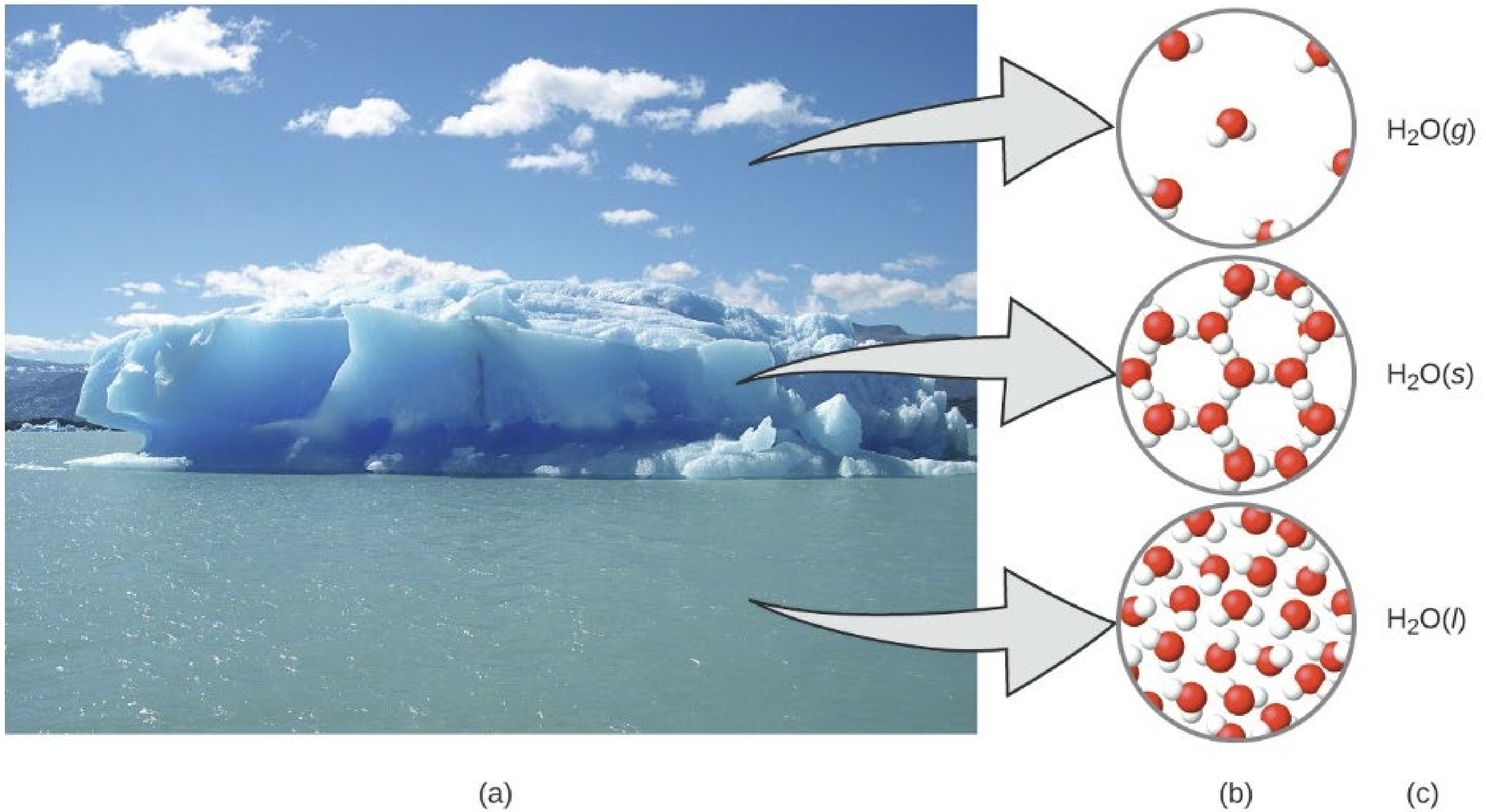


Figure 1.5 (a) Moisture in the air, icebergs, and the ocean represent water in the macroscopic domain. (b) At the molecular level (microscopic domain), gas molecules are far apart and disorganized, solid water molecules are close together and organized, and liquid molecules are close together and disorganized. (c) The formula H_2O symbolizes water, and (*g*), (*s*), and (*l*) symbolize its phases. Note that clouds are actually comprised of either very small liquid water droplets or solid water crystals; gaseous water in our atmosphere is not visible to the naked eye, although it

Pure Substances: Element or Compound??

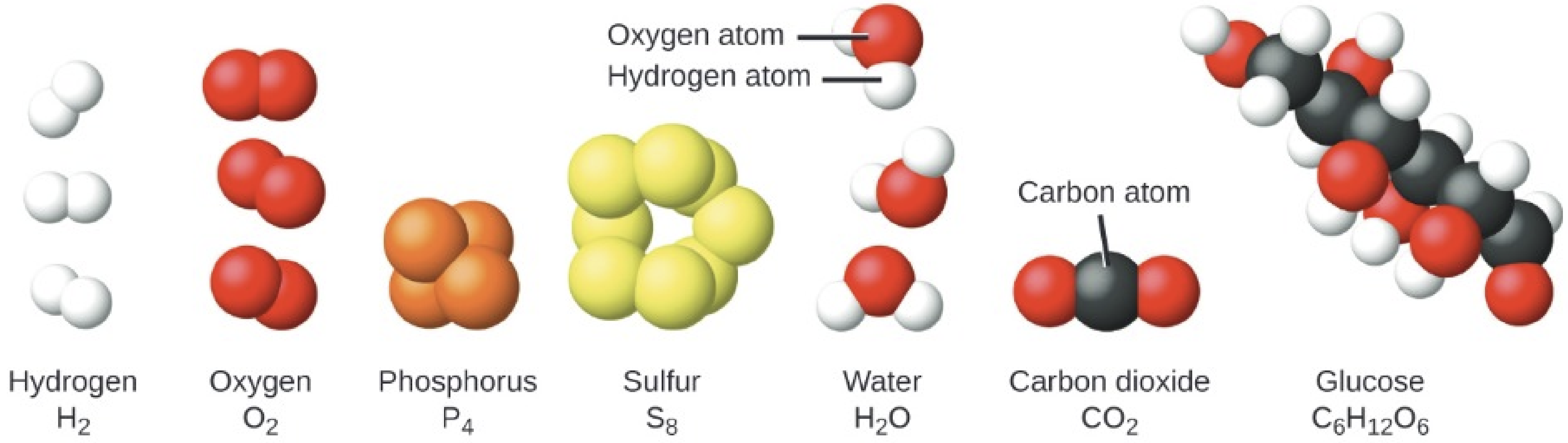


Figure 1.11 The elements hydrogen, oxygen, phosphorus, and sulfur form molecules consisting of two or more atoms of the same element. The compounds water, carbon dioxide, and glucose consist of combinations of atoms of different elements.

The Electrolysis of Water

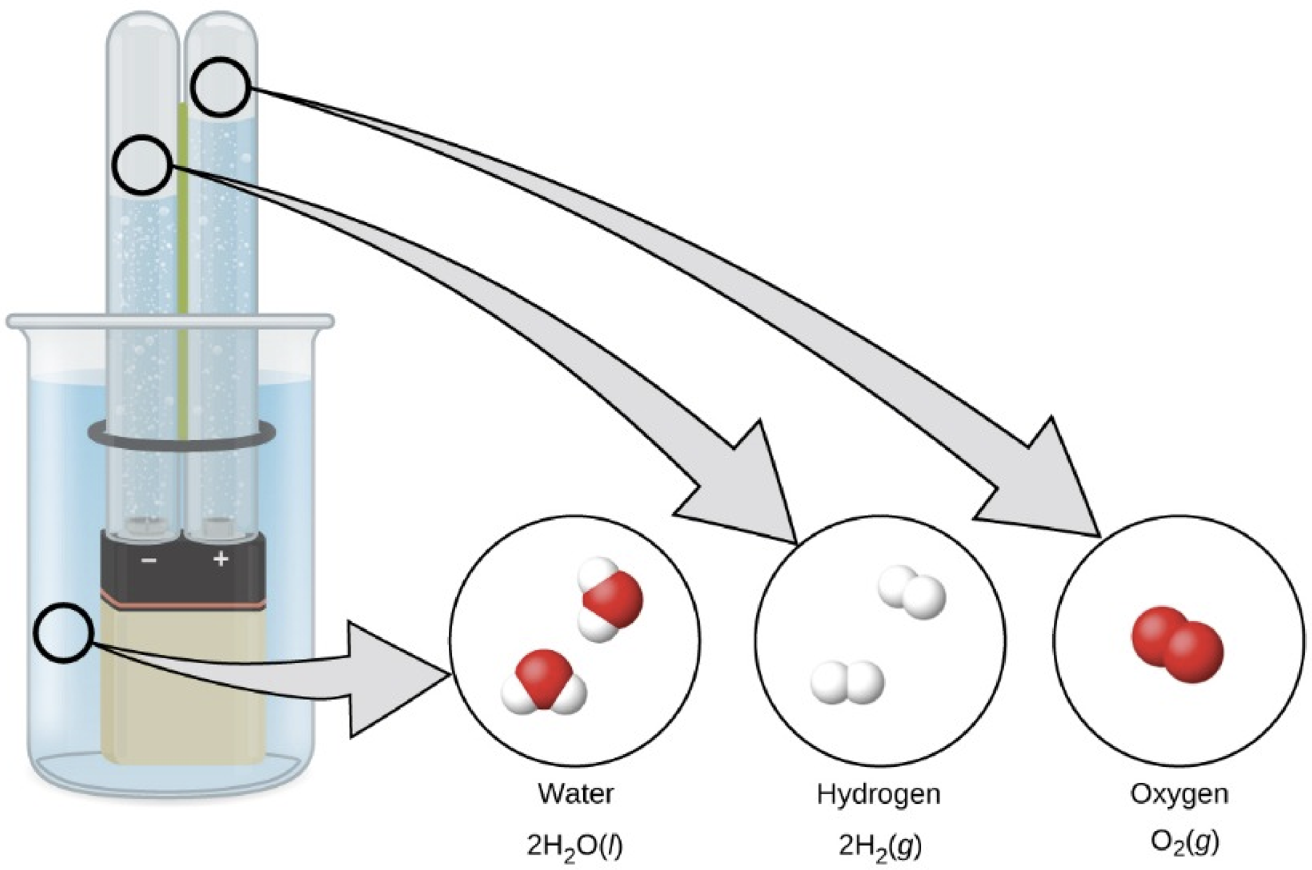
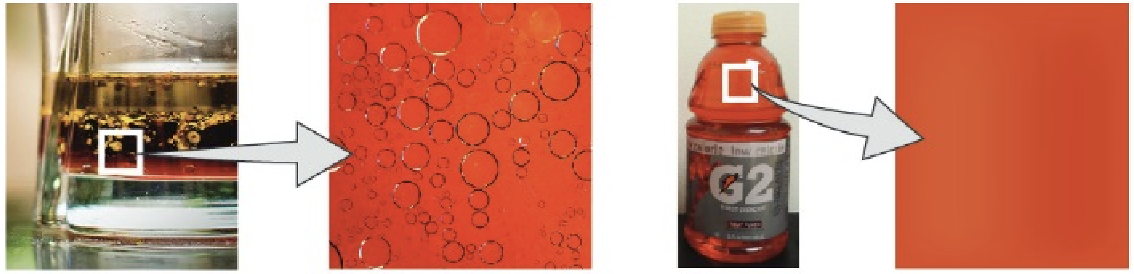


Figure 1.15 The decomposition of water is shown at the macroscopic, microscopic, and symbolic levels. The battery provides an electric current (microscopic) that decomposes water. At the macroscopic level, the liquid separates into the gases hydrogen (on the left) and oxygen (on the right). Symbolically, this change is presented by showing how liquid H_2O separates into H_2 and O_2 gases.

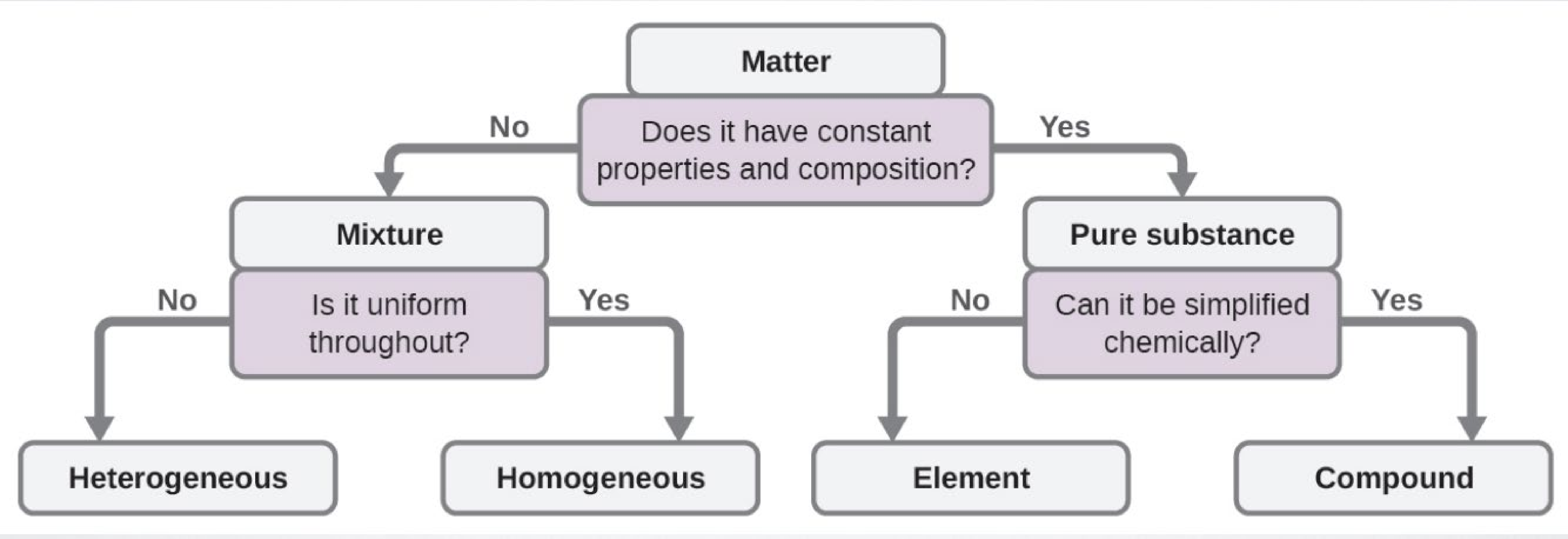
Mixture: Heterogenous or Homogenous??



(a) (b)

Figure 1.13 (a) Oil and vinegar salad dressing is a heterogeneous mixture because its composition is not uniform throughout. (b) A commercial sports drink is a homogeneous mixture because its composition is uniform throughout. (credit a “left”: modification of work by John Mayer; credit a “right”: modification of work by Umberto Salvagnin; credit b “left: modification of work by Jeff Bedford)

Classification of Matter: Overview



Physical vs. Chemical Properties

(a) (b)

Figure 1.18 (a) Wax undergoes a physical change when solid wax is heated and forms liquid wax. (b) Steam condensing inside a cooking pot is a physical change, as water vapor is changed into liquid water. (credit a: modification of work by “95jb14”/Wikimedia Commons; credit b: modification of work by “mjneuby”/Flickr)

- **Physical Properties**: Don’t depend on its interaction with other matter
  - Intrinsic (Intensive) Properties- Independent of Amount
    - Color
    - Density
    - Molar Mass
    - Boiling/Melting Point
    - Specific Heat
  - Extrinsic (Extensive) Properties – Depends on how much you have
    - Mass
    - Weight
    - Volume
    - Heat Capacity

Physical vs. Chemical Properties

(a) (b)

Figure 1.19 (a) One of the chemical properties of iron is that it rusts; (b) one of the chemical properties of chromium is that it does not. (credit a: modification of work by Tony Hisgett; credit b: modification of work by “Atoma”/Wikimedia Commons)

- **Chemical Properties:** How does it interact with other matter?
  - Intrinsic (Intensive) Properties- Independent of Amount
    - Color
    - Density
    - Molar Mass
    - Boiling/Melting Point
  - Extrinsic (Extensive) Properties – Depends on how much you have
    - Mass
    - Weight
    - Volume

Physical vs. Chemical Changes

- Physical Change: Changes form, but remains the same substance
  - Example: Melting Wax
- Chemical Change: Change in chemical identity of the components. A reaction has occurred
  - Example: Striking a match

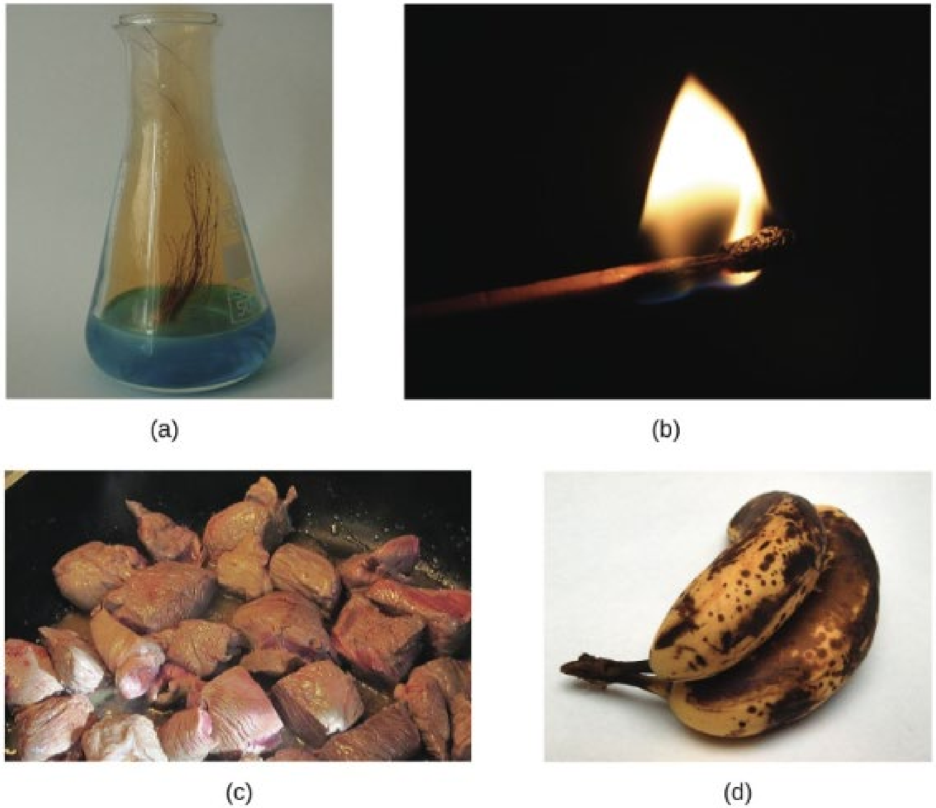


Figure 1.20 (a) Copper and nitric acid undergo a chemical change to form copper nitrate and brown, gaseous nitrogen dioxide. (b) During the combustion of a match, cellulose in the match and oxygen from the air undergo a chemical change to form carbon dioxide and water vapor. (c) Cooking red meat causes a number of chemical changes, including the oxidation of iron in myoglobin that results in the familiar red-to-brown color change. (d) A banana turning brown is a chemical change as new, darker (and less tasty) substances form. (credit b: modification of work by Jeff Turner; credit c: modification of work by Gloria Cabada-Leman; credit d: modification of work by Roberto Verzo)

The Periodic Table

THE ELEMENTS ON THE PERIODIC TABLE ARE ORGANIZED BY THEIR PHYSICAL PROPERTIES

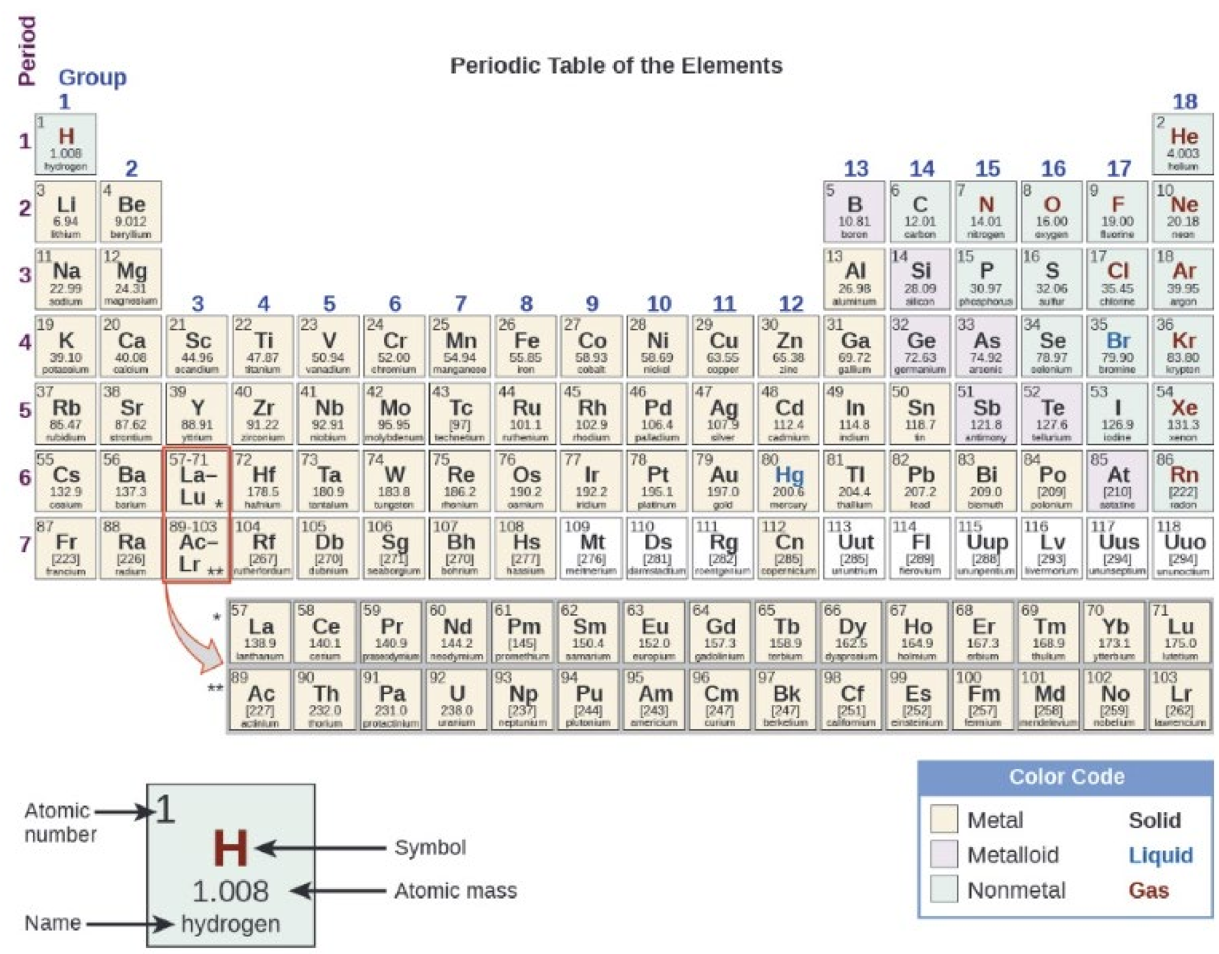


Figure 1.22 The periodic table shows how elements may be grouped according to certain similar properties. Note the background color denotes whether an element is a metal, metalloid, or nonmetal, whereas the element symbol color indicates whether it is a solid, liquid, or gas.

Question:

Which is a chemical property of Copper

a) Reddish Brown Copper

b) Reacts with Nitric Acid

c) Conducts Electricity

d) Melting point of 1083 ˚C

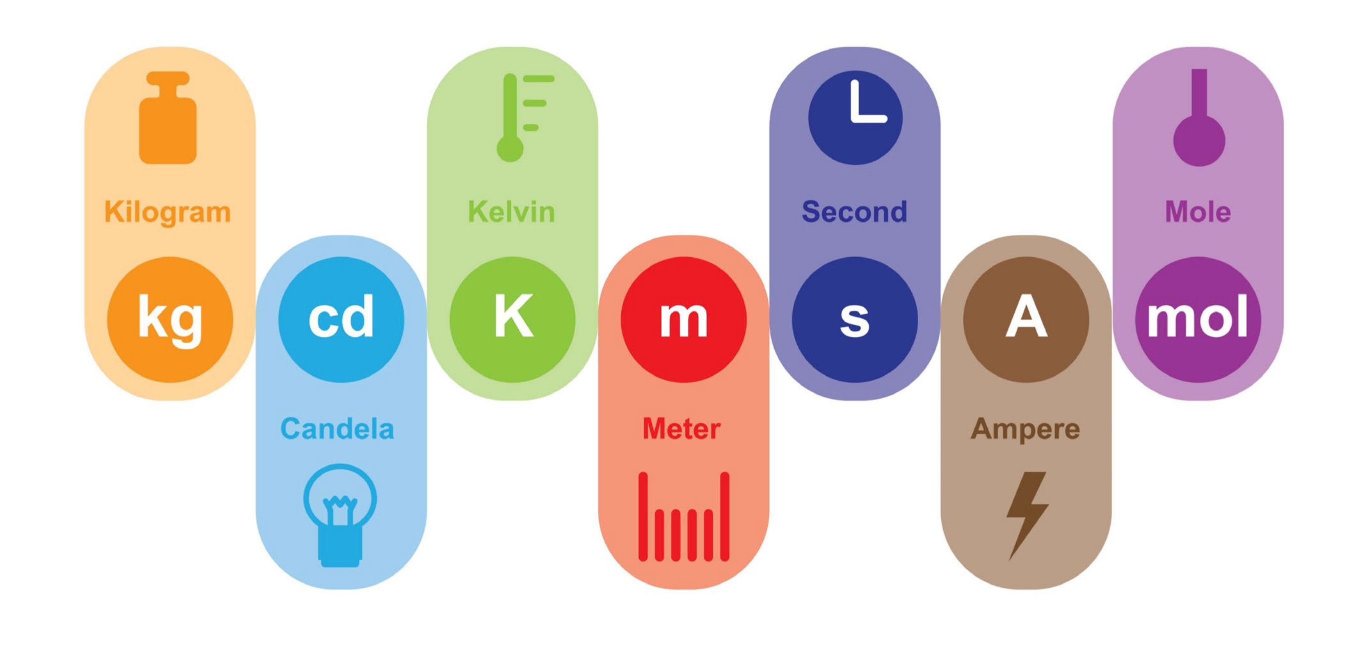
$$Cu_{(s)} + 4\ HNO_{3(aq)} \rightarrow Cu(NO_3)_{2(aq)} + 2\ NO_{2(aq)} + 2\ H_2O_{(l)}$$

Measurement and Uncertainty

Critical Units!

The Mars Climate Orbiter was Launched by NASA on December 11th, 1998 to study the Martian climate.

Base Units


Kilogram
kg
cd
Candela
Kelvin
K
m
Meter
Second
s
A
Ampere
Mole
mol

Metric Prefixes

METRIC PREFIXES

Tera-	T	10^{12}	1 000 000 000 000
Giga-	G	10^{9}	1 000 000 000
Mega-	M	10^{6}	1 000 000
Kilo-	K	10^{3}	1 000
Hecto-	H	10^{2}	100
Deka-	Da	10^{1}	10
Base	-	10^{0}	1
Deci-	d	10^{-1}	0.1
Centi-	c	10^{-2}	0.01
Milli-	m	10^{-3}	0.001
Micro-	μ	10^{-6}	0.00 000 1
Nano-	n	10^{-9}	0.00 000 000 1
Pico-	p	10^{-12}	0.00 000 000 000 1

Units are your Friend!

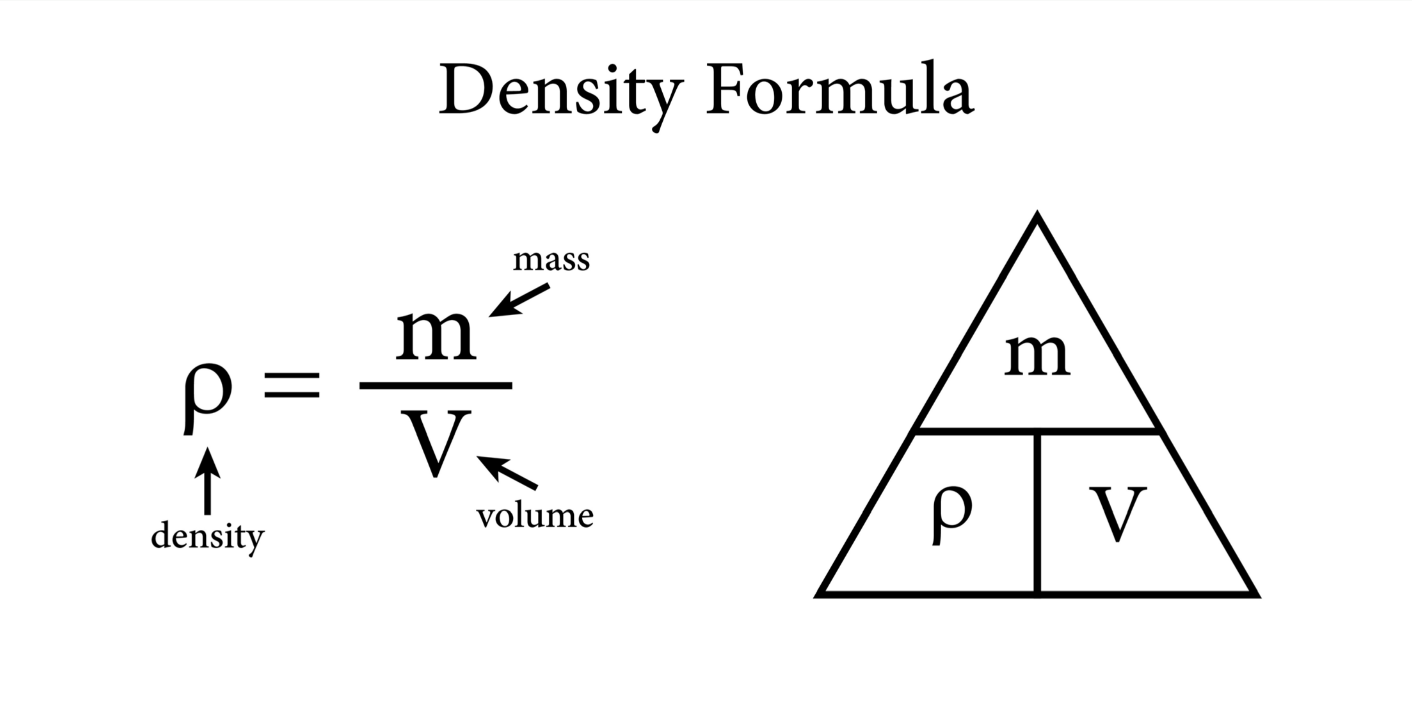
1. Help you understand the physical meaning
2. How to calculate the quantity
3. Identify errors in your calculations

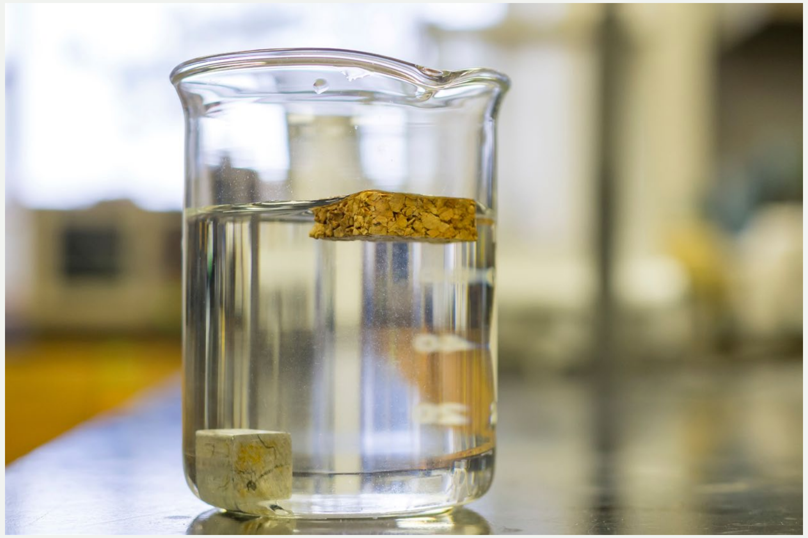
Example: Find the Specific Heat $(\frac{J}{g\,°C})$

Find the Specific Heat of Aluminum if 900 J of heat are required to raise the temperature of 100 g of Aluminum by 10 ˚C

c=0.900 J/g ˚C

Derived Units: Density





Example: Finding the Density

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

$$\rho = \frac{(69.658\ g)}{(22.4\ mL\ - 13.5\ mL)}$$

$$\rho = \frac{(69.658\ g)}{(8.9\ mL)}$$

$$\rho = 7.8\,\frac{\text{g}}{\text{mL}}$$

Uncertainty in Measurement

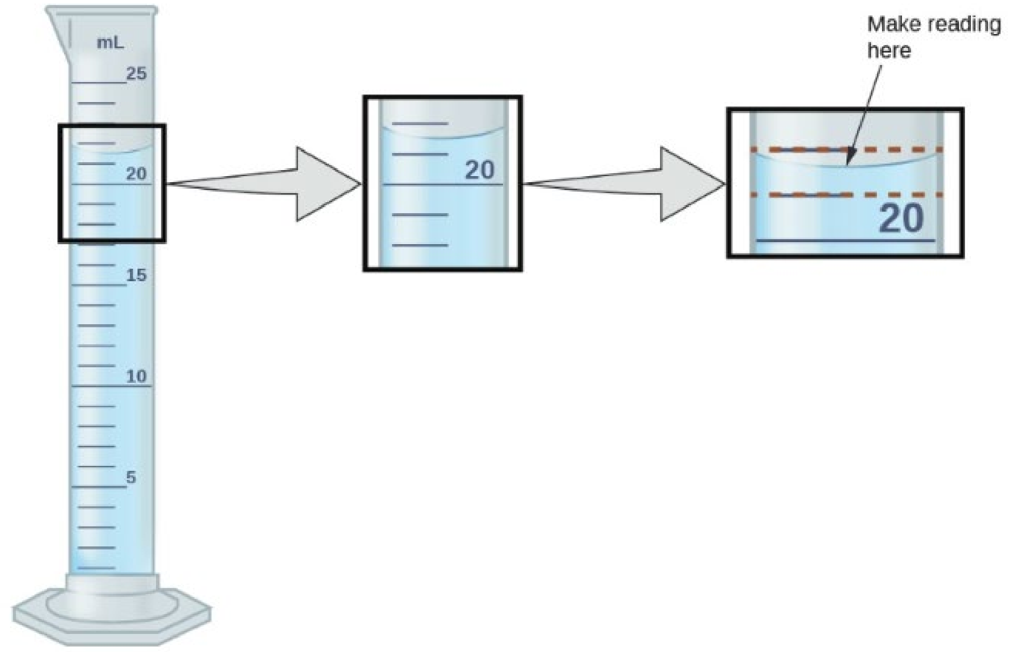


Figure 1.26 To measure the volume of liquid in this graduated cylinder, you must mentally subdivide the distance between the 21 and 22 mL marks into tenths of a milliliter, and then make a reading (estimate) at the bottom of the meniscus.

Person	Volume Recorded (mL)
1	21.7
2	21.8
3	21.6
4	21.7

Certain Digits

Uncertain Digits

Exact numbers

Values that have no uncertainty.

Examples:

- Defined Values
  - 12 in = 1 foot
  - 2.54 cm = 1 in
  - 1000 m = 1 km
- Quantities
  - Number of Trials
  - Number of Molecules
  - Number of People

Significant Figures

What is the difference between 5.67 g and 5.670 g?

The value 5.67 and 5.670 have 3 and 4 significant figures, respectively.

The more significant figures given in your answer, the more precise your results.

Significant Figures

1. Every non-zero digit is significant.
2. A zero between two non-zero numbers is significant; 402 has 3 sig figs
3. A zeros at the beginning of a number are not significant, they are "place holders" that locate the decimal point; 0.0034 has 2 sig figs.
   - 3.4 mg vs. 0.0034 g
4. A zero that comes to the right of a non-zero number after a decimal point is significant; 5.670 has 4 sig figs. The last digit would not have been recorded if it was not significant.
5. A zero that comes to the right of a non-zero number where there is no decimal point may or may not be significant. To specify the number of sig figs, the number can be written in scientific notation; 200 only has 1 sig fig while 2.00×10^2 has 3 sig figs.

Pacific–Atlantic Method

If a decimal point is **P**resent, use the **P**acific Method

Start counting from the first non-zero digit from the left side of the number

234.780

0.0000570

200.

If a decimal point is **A**bsent, use the **A**tlantic Method

Start counting from the first non-zero digit from the right side of the number

48000

39200

67

How could you write 1400 with 3 Sig Figs??

$$1.40 \times 10^3$$

Operations with Sig Figs

Addition and Subtraction:

Answer will have the same number of decimal places as the number with the fewest decimal places

Multiplication and Division:

Answer will have the same number of Sig Figs as the number with the fewest Sig Figs

Operations with Sig Figs Example

$$83.5\ mL + 22.28\ mL = 106.78\ mL$$ 106.8 mL

$$865.90\ g - 2.8121\ g = 863.0879\ g$$ 863.09 g

$$15.6\ cm \times 6.023\ cm \times 0.34\ cm = 31.945992\ cm^3$$ 32 cm^3

$$500\ g \div 305.4\ mL = 1.6371971\ \frac{g}{mL}$$ 2 g/mL

Combining Operation

$$\frac{23.09\ g\ -0.345\ g}{340.147\ mL\ +0.00991\ mL} = \frac{22.75\ g}{340.156\ mL} = 6.687\ \times 10^{-2}\,\frac{g}{mL}$$

Rounding Rules

If the first digit to be removed is > 5 ROUND UP!

$$45.648 \rightarrow 45.65$$

If the first digit to be removed is <5 ROUND DOWN!

$$319.0672 \rightarrow 319.067$$

New RULE:

If the first digit to be removed is EQUAL to 5….

Round the to the nearest EVEN number

$$78.045 \rightarrow 78.04$$

$$78.055 \rightarrow 78.06$$

$$78.065 \rightarrow 78.06$$

$$78.075 \rightarrow 78.08$$

This prevents systematic error, since sometimes you will be rounding up and sometimes you will be rounding down!

Rounding Rules Examples

46.7435 to 5 sig figs

46.744

108.5 to 3 sig figs

108

23.97 to 3 sig figs

24.0

Errors in Measurement

- Random Errors: Can make your values larger or smaller. Unavoidable, but can be minimized by taking multiple measurements

- Systematic Errors: Make your values either larger or smaller, not both. Harder to recognize, can be minimized by calibration

Precision and Accuracy

Precision: How close are your values to EACH OTHER?

Less variation (low standard deviation) means high precision.

Random errors affect your precision much more than systematic errors.

You get better precision with better technique and more accurate instruments.

Accuracy: How close are your values to the ACTUAL VALUE?

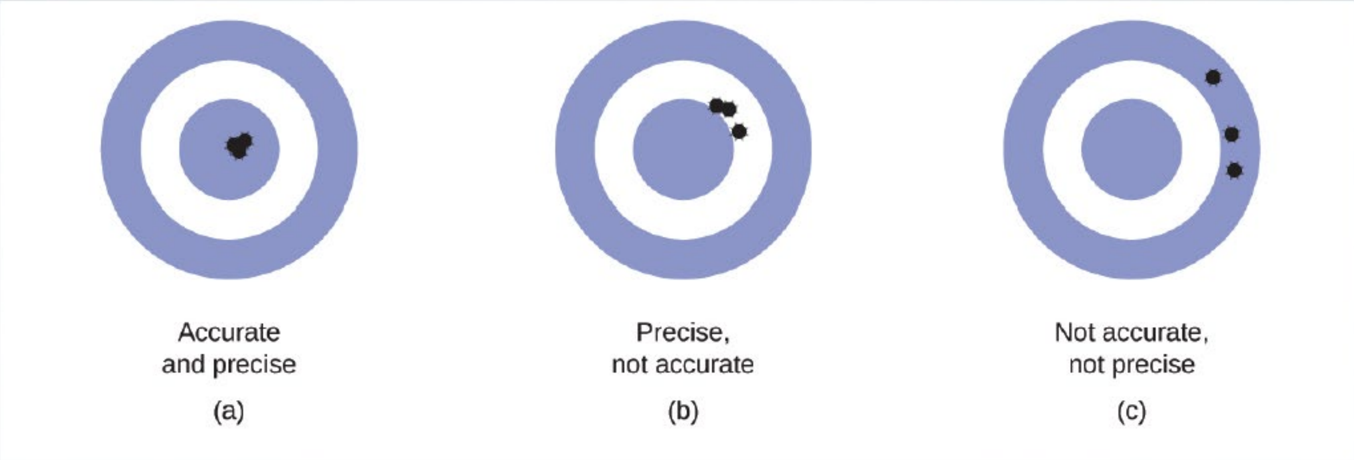
Low percent error means high accuracy

Sometimes the actual value (and therefore the level of accuracy) is not known

Systematic errors can greatly affect your accuracy, Random errors can be minimized by taking averages

You get better accuracy by eliminating systematic errors

Precision and Accuracy

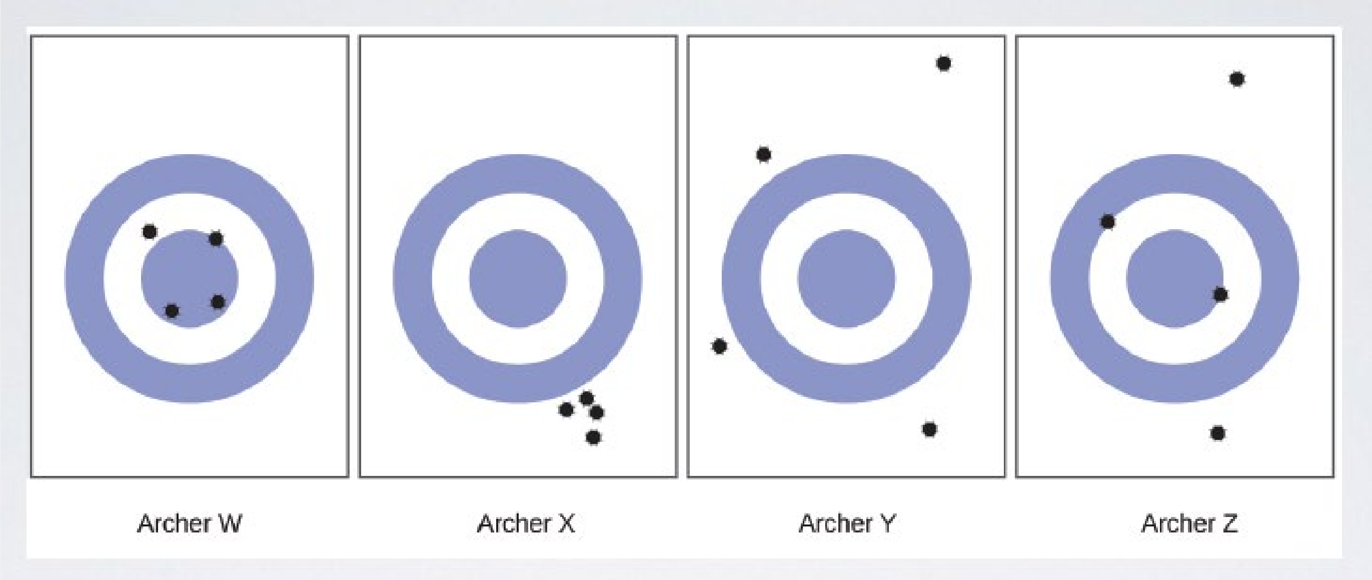


(a) These arrows are close to both the bull’s eye and one another, so they are both accurate and precise.

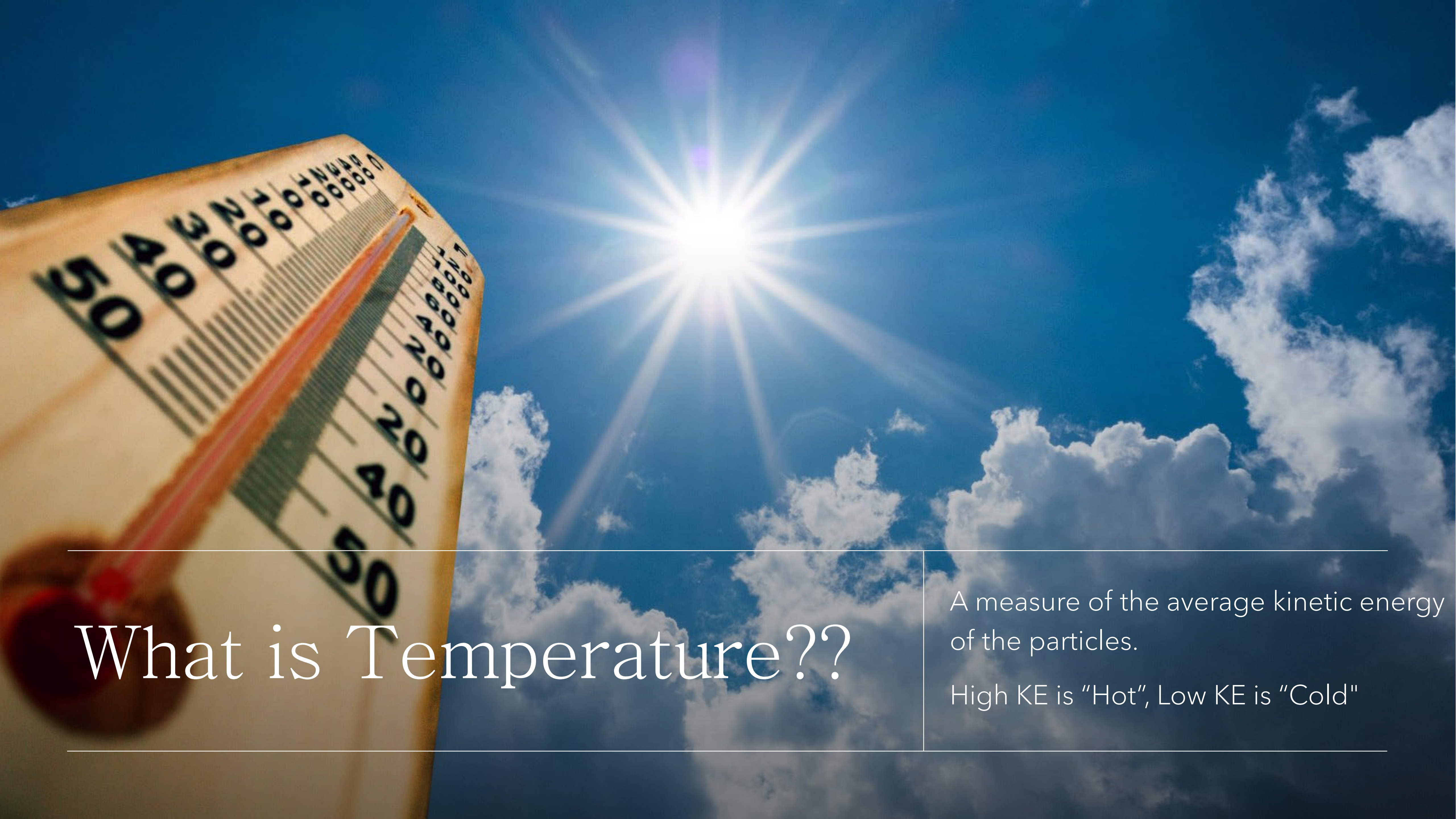
(b) These arrows are close to one another but not on target, so they are precise but not accurate.

(c) These arrows are neither on target nor close to one another, so they are neither accurate nor precise.

Lecture Participation:



1. Which archer is the most accurate?
2. Which archer is the most precise?
3. Which archer would you want to be?



What is Temperature??

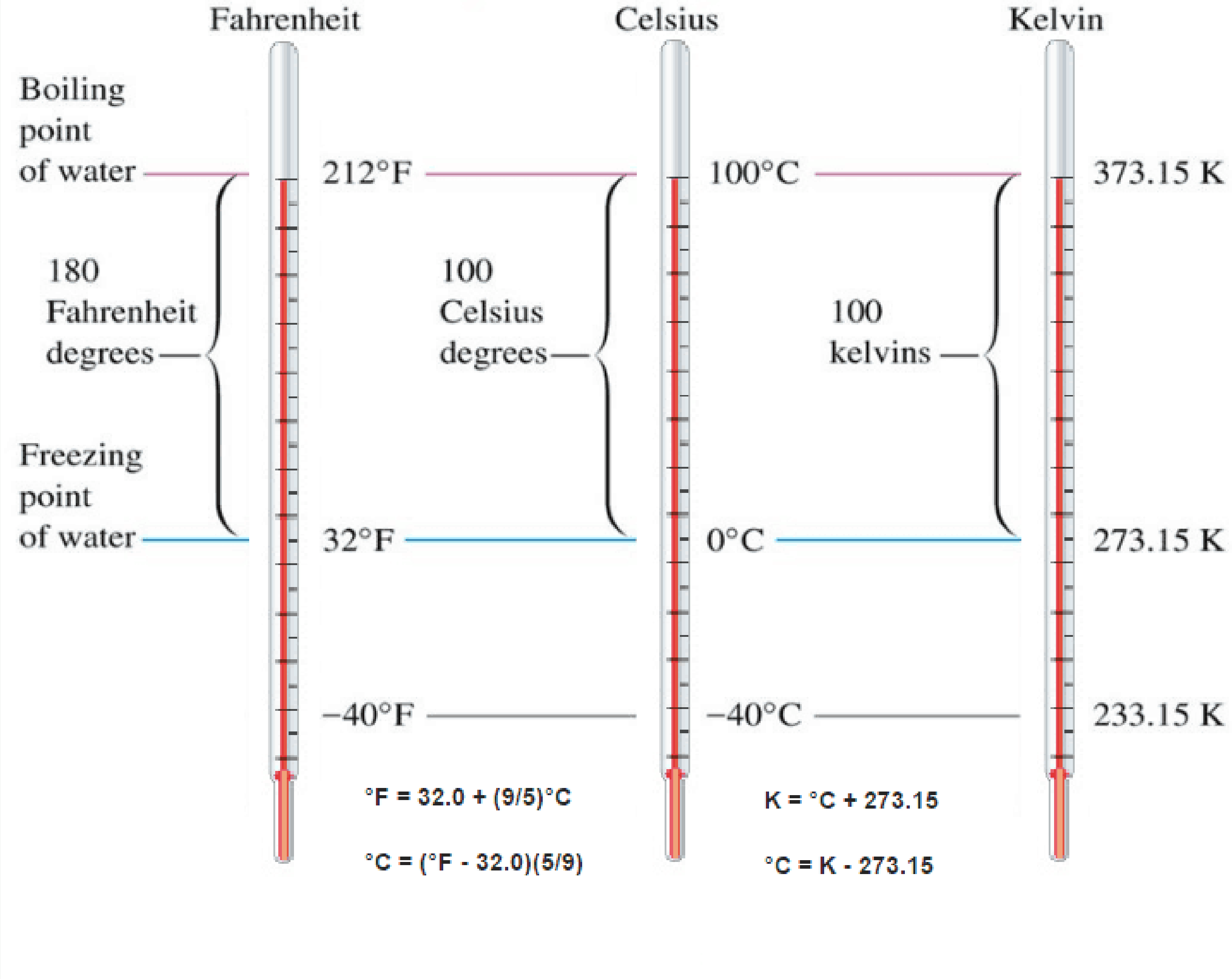
A measure of the average kinetic energy of the particles.

High KE is “Hot”, Low KE is “Cold"

Temperature Scales

- Fahrenheit (1724)
  - Generally not used in science
- Celsius (1742)
  - Principle temperature scale
- Kelvin (1848)
  - Absolute temperature scale
  - Same interval as Celsius scale
  - Incorrect to say "degree Kelvin"!

- Freezing Point of Water
  - 32 ˚F, 0 ˚ C, 273.15 K
- Boiling point of water
  - 212 ˚F, 100 ˚ C, 373.15 K



Temperature Conversion

$$T_C = \left(\frac{5}{9}\right)(T_F - 32)$$

$$T_K = T_C + 273.15$$

$$T_C = T_K - 273.15$$

Dimensional Analysis Examples

Convert 8.9 x 10^{18} m/s to km/day

$$\left(\frac{8.9\ \times 10^{18}\ m}{1\ s}\right)\left(\frac{1\ km}{1000\ m}\right)\left(\frac{60\ s}{1\ min}\right)\left(\frac{60\ min}{1\ hr}\right)\left(\frac{24\ hrs}{1\ day}\right) = 7.7\ \times 10^{20}\ \ km/day$$

How many miles in 1 light year?

$$\left(\frac{3.00\ \times 10^{8}\ m}{1\ s}\right)\left(\frac{100\ cm}{1\ m}\right)\left(\frac{1\ inch}{2.54\ cm}\right)\left(\frac{1\ ft}{12\ inches}\right)\left(\frac{1\ mile}{5280\ ft}\right)\left(\frac{3600\ s}{1\ hr}\right)\left(\frac{24\ hrs}{1\ day}\right)\left(\frac{365.25\ days}{1\ year}\right) = 5.88\ \times 10^{12}\ miles\ per\ year$$

Question

- You have a recipe that says to use 410 g of flour and to set you oven to 250 C. Your scale only has units of oz, and your oven uses Fahrenheit. How much flour are you going to measure out and what will you set your oven temperature to?

- 1 oz= 28 g

480 ˚C

15 oz

$$T_C = \left(\frac{5}{9}\right)(T_F - 32)$$

$$T_K = T_C + 273.15$$

$$T_C = T_K - 273.15$$