CHEM 200/202

Professor Theresa Carlson
Office: GMCS-213B

All emails are to be sent to:
chem200@sdsu.edu

My office hours will be held on zoom via MSLC on **Mondays & Wednesday from 8:00 am to 10:00 am** or by appointment

HOW THE CLASS WILL WORK

Email (for all needs): *chem200@sdsu.edu*
Website: https://sdsuchem200.sdsu.edu/ (Website is meant for waitlisters and has everything except: grades and Turnitin. For the previous two items please find on Canvas when you are enrolled. **The CHEM 200 Website will close after Exam 1**)

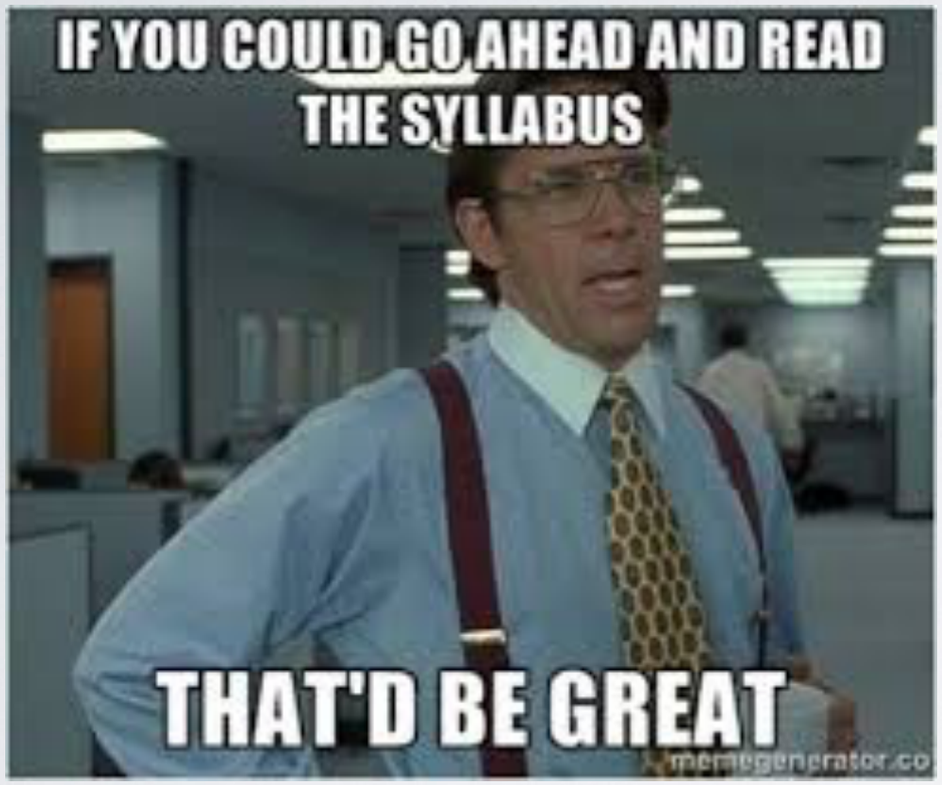
Instructor: Prof. Theresa Carlson, M.A.
Lecture: 12:00 PM – 12:50 PM MWF in HT-140
Help Room (Zoom): 8:00 AM - 10:00 AM Mondays & Wednesdays **Zoom *via* https://mlc.sdsu.edu/**

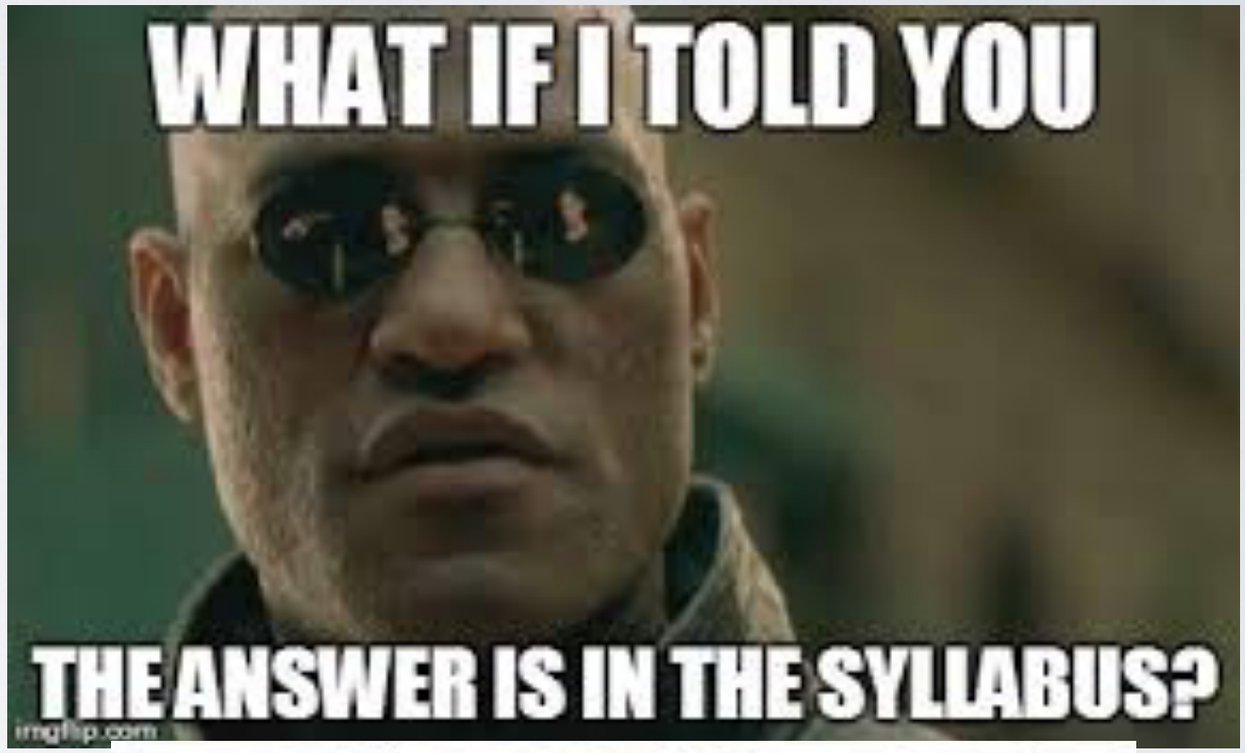
Lab Coordinator: Megan Bowles, M.A.
Help Room (Zoom): 9:00 AM - 11:00 AM Tuesdays **Zoom *via* https://mlc.sdsu.edu/**

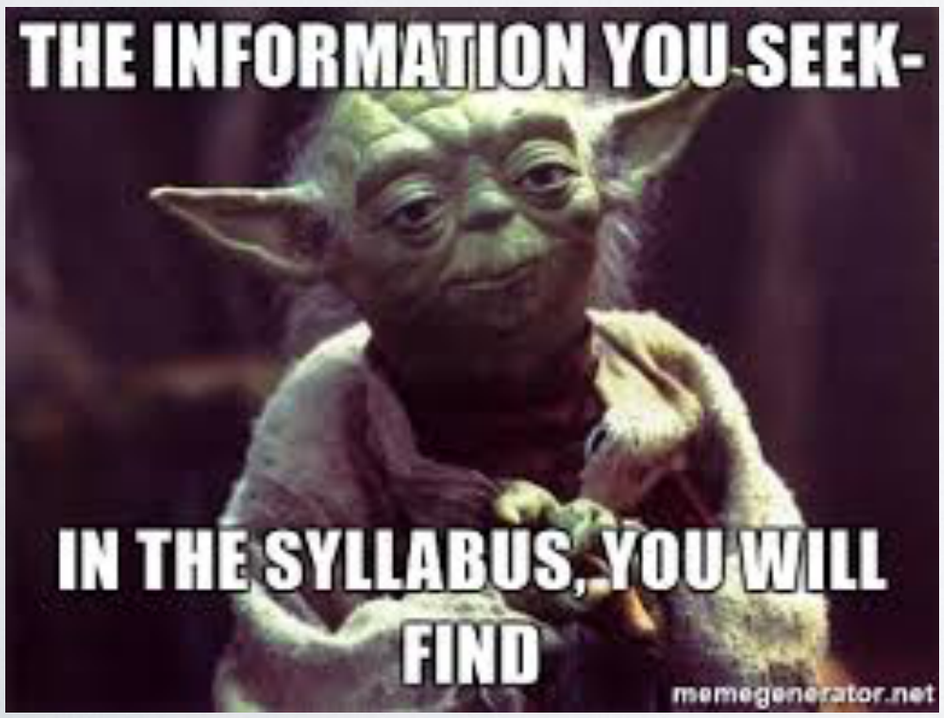
Mode of Instruction: Face-to-Face. Lectures will be recorded using Course Capture/Mediasite and available on Canvas. Attendance is strongly encouraged. There will be 40 points out of 43 points for lecture participation. Labs sessions are in-person as well.

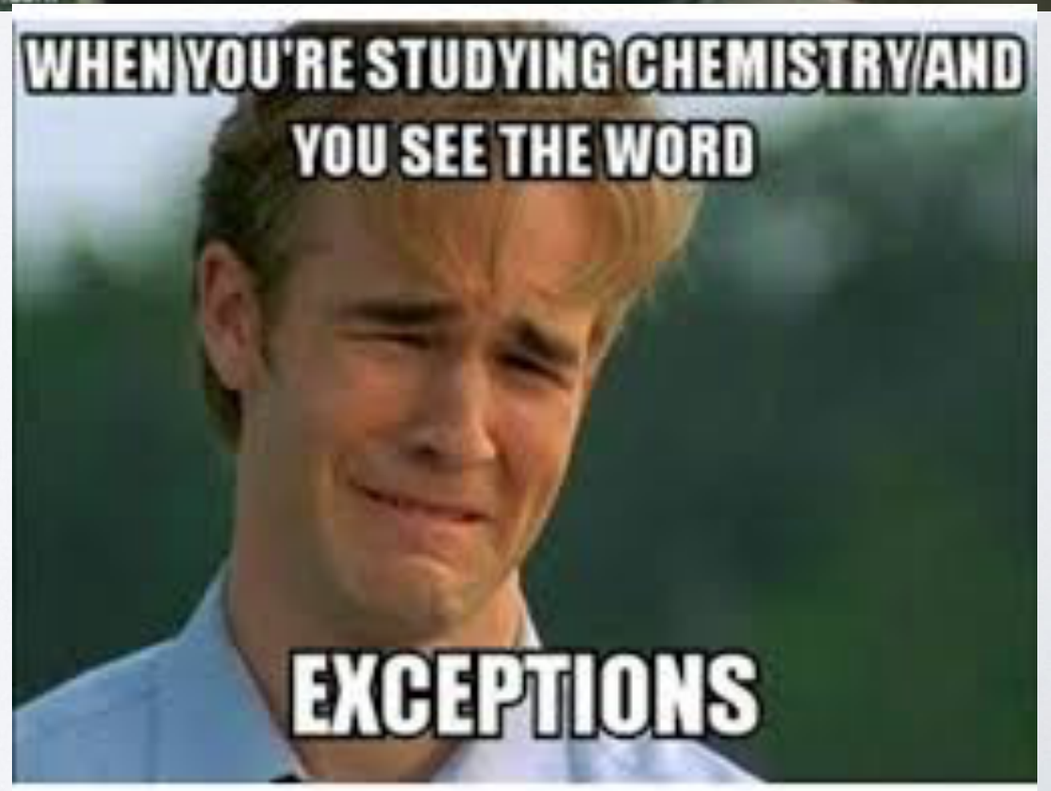
Exams will take place online via OWL.

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.

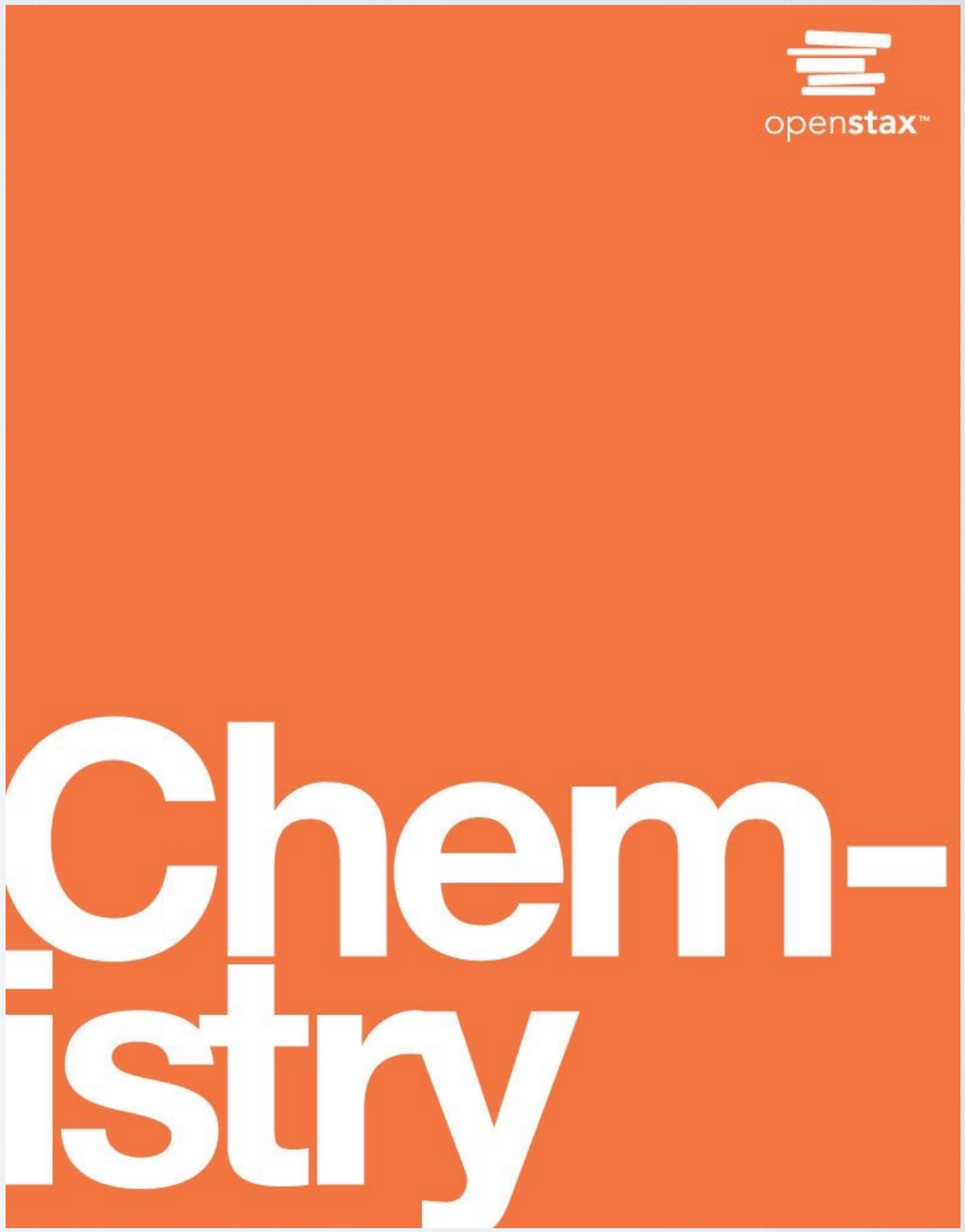
THE MATH AND SCIENCE LEARNING CENTER (MSLC)

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

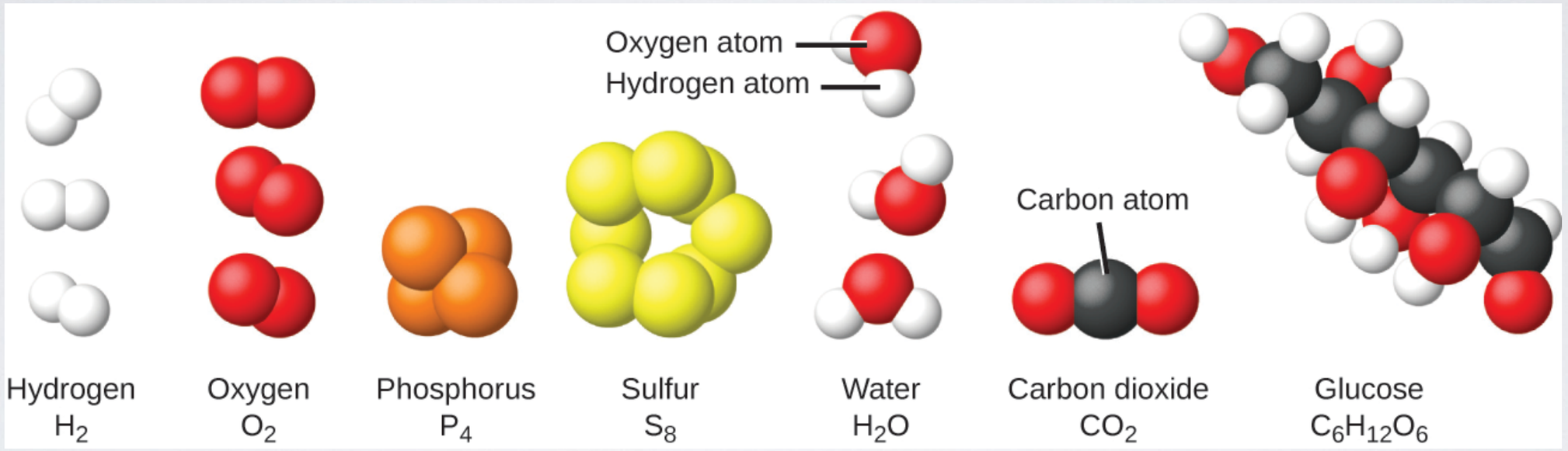
- **Openstax Chemistry**
- **PDF is Free!***
- **Redshelf (in Canvas) is an interactive ebook for FREE!**
- Free for Kindle
- Available from iBooks ($4.99)



CLASSIFICATION OF MATTER

- Pure substance- a constant composition.
  - Elements- pure substances that cannot be broken down into simpler substances by chemical change.
  - Compounds- pure substances that can be broken down by chemical change.

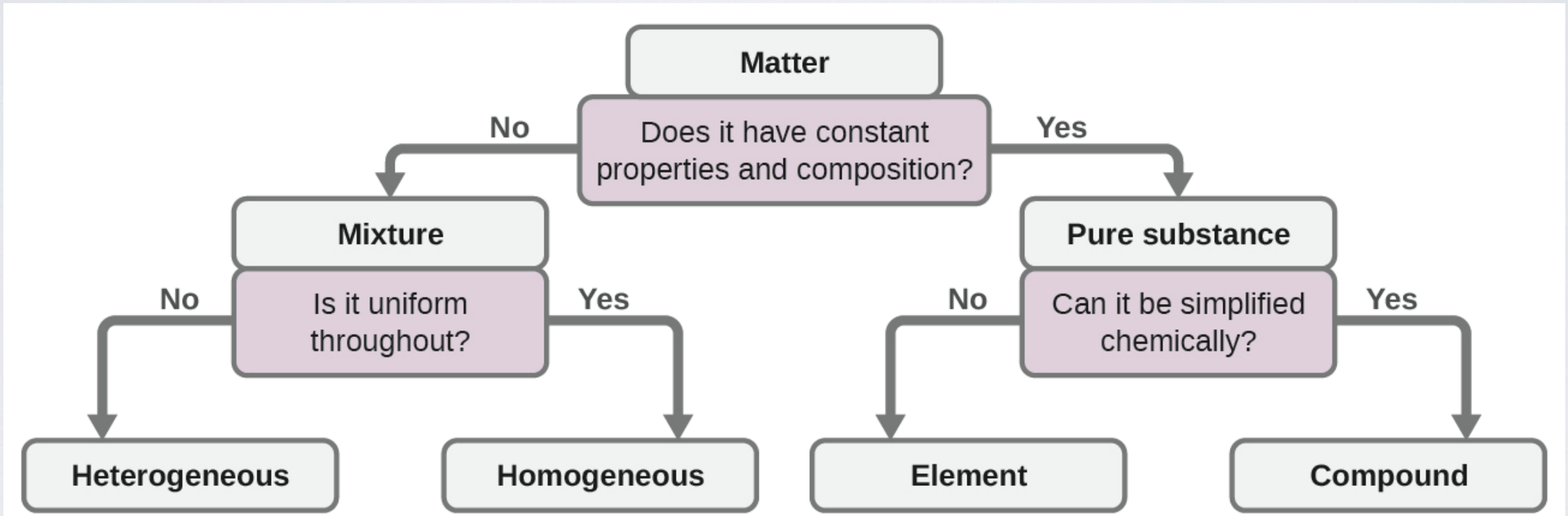
CLASSIFICATION OF MATTER



Elements

Compounds

CLASSIFICATION OF MATTER



MEASUREMENTS

Provides the macroscopic information that is the basis of most of the hypothesis, theories, and laws that describe the behavior of matter and energy in both the macroscopic and microscopic domains of chemistry.

SI UNITS

The rational units of measurement.

Dimension	Unit name	Abbreviation
Mass	kilogram	kg
Length	meter	m
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
amount of substance	mole	mol
luminous intensity	candela	cd

SCIENTIFIC NOTATION & PREFIXES

Prefix	Symbol	Word	Conventional	Scientific
-	-	one	1	1×10^{0}
deci	d	tenth	0.1	1×10^{-1}
centi	c	hundredth	0.01	1×10^{-2}
milli	m	thousandth	0.001	1×10^{-3}
micro	μ	millionth	0.000001	1×10^{-6}
nano	n	billionth	0.000000001	1×10^{-9}
pico	p	trillionth	0.000000000001	1×10^{-12}
femto	f	quadrillionth	0.000000000000001	1×10^{-15}

SCIENTIFIC NOTATION & PREFIXES

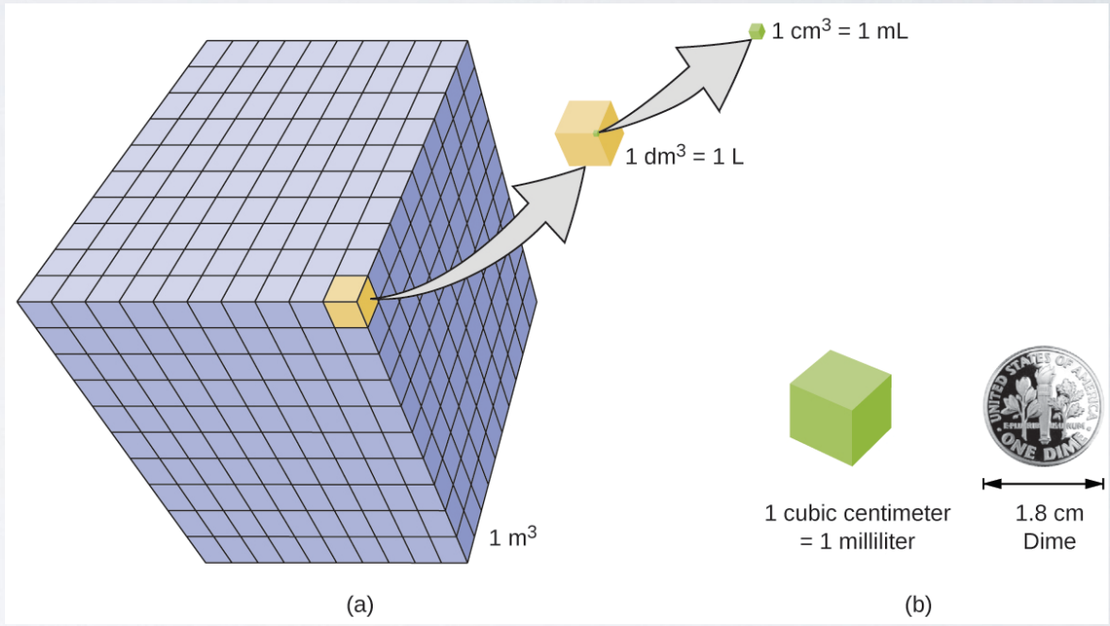
Prefix	Symbol	Word	Conventional	Scientific
tera	T	trillion	1,000,000,000,000	1×10^{12}
giga	G	billion	1,000,000,000	1×10^{9}
mega	M	million	1,000,000	1×10^{6}
kilo	k	thousand	1,000	1×10^{3}
hecto	h	hundred	100	1×10^{2}
deka	da	ten	10	1×10^{1}
-	-	one	1	1×10^{0}

DENSITY

Density is the measurement of mass over volume

Density = mass / volume

$cm^3 = mL$



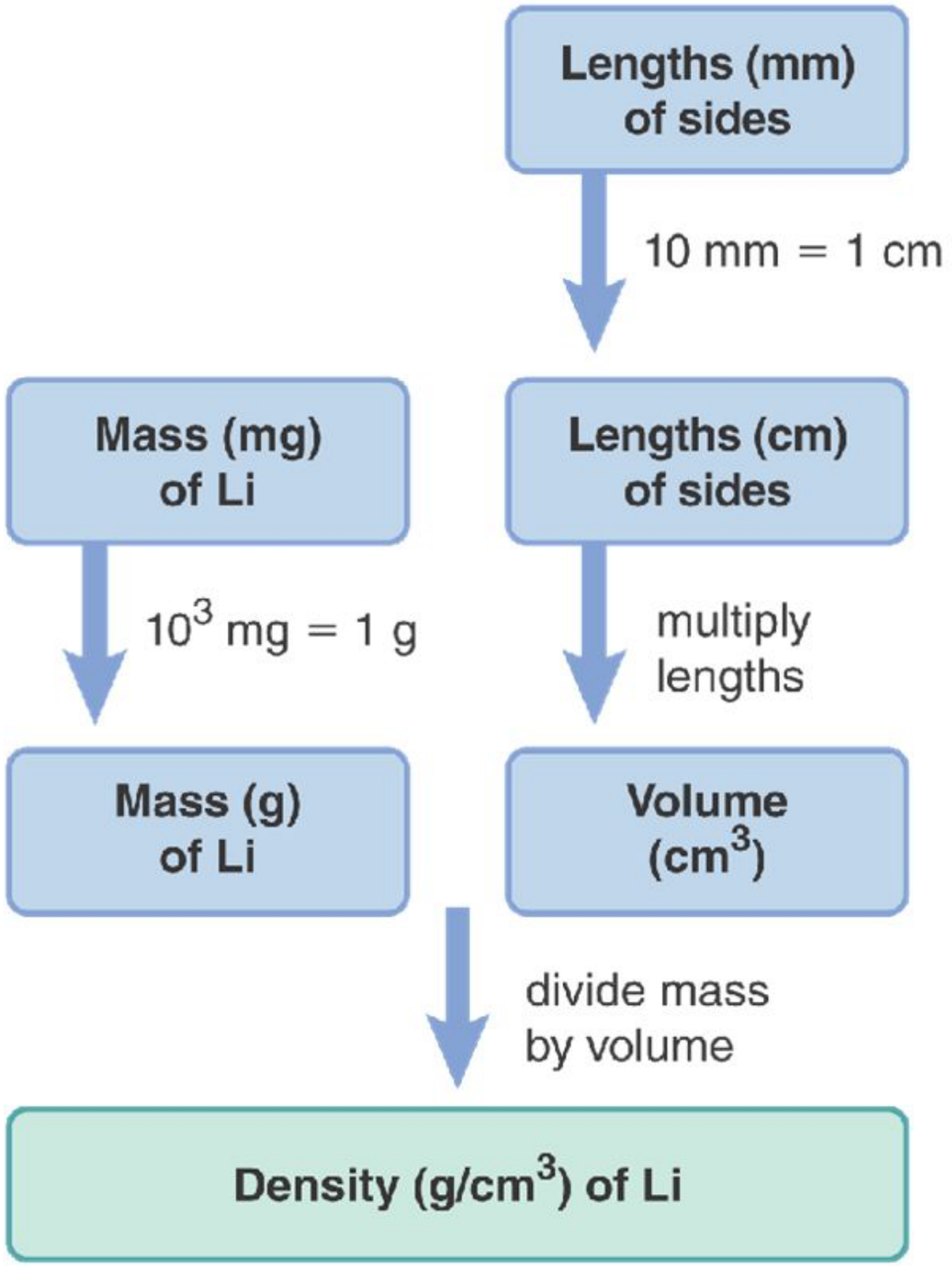
DENSITIES OF COMMON SUBSTANCES

Substance	Physical State	Density (g/cm^3)
Hydrogen	Gas	8.9×10^{-5}
Oxygen	Gas	1.4×10^{-3}
Ethanol	Liquid	0.789
Water	Liquid	1
Table Salt	Solid	2.16
Aluminum	Solid	2.7
Lead	Solid	11.3
Gold	Solid	19.3

QUESTION

Lithium, a soft, gray solid with the lowest density of any metal, is a key component of advanced batteries, such as the one in your laptop. A slab of lithium weighs 1.49×10^4 mg and has sides that are 20.9 mm by 11.1 mm by 11.9 mm. Find the density of lithium in g/cm^3.

Road Map


Lengths (mm) of sides
10 mm = 1 cm
Mass (mg) of Li
Lengths (cm) of sides
10^3 mg = 1 g
multiply lengths
Mass (g) of Li
Volume (cm^3)
divide mass by volume
Density (g/cm^3) of Li

QUESTION

Lithium, a soft, gray solid with the lowest density of any metal, is a key component of advanced batteries, such as the one in your laptop. A slab of lithium weighs 1.49×10^4 mg and has sides that are 20.9 mm by 11.1 mm by 11.9 mm. Find the density of lithium in g/cm^3.

5.40 g/cm^3

EXACT NUMBERS

- Exact numbers do not have uncertainty
- These numbers do not impact the number of significant figures in the calculations
  - 60 min = 1 hour
  - 1000 g = 1 kg
  - 4 people

SIGNIFICANT FIGURES

- Significant figures have real meanings - they represent how accurately something was quantified or measured.

- The last number is always the first number that is uncertain.

- Any numbers beyond that one are purely fictional.

- The results of mathematical transformations are limited by the number of significant digits.

MATH & SIGNIFICANT

- Non-zero digits are always significant.
- Any zeros between two significant digits are significant.
- A final zero or trailing zeros in the decimal portion ONLY are significant.
- For more on significant figure rules and practice see chem team website:
- http://bit.ly/1Qw6KBb (case sensitive)

MATH & SIGNIFICANT

- 0 counts as a sig fig when: between numbers and before a decimal place or after numbers to the right of the decimal place.
- Addition & subtraction: the last common decimal place is the least significant figure.
- Multiplication & division: the answer is limited to the number of significant digits of the factor with the fewest significant figures.
- More rules for logarithms and exponents but we won't worry about those.

MATH & SIGNIFICANT FIGURES

Addition & Subtraction

$$\begin{array}{r} 83.5\ \text{mL} \\ +\ 23.28\ \text{mL} \\ \hline 106.78\ \text{mL} \end{array} = 106.8\ \text{mL}$$

$$\begin{array}{r} 865.90\ \text{g} \\ -\ 2.8121\ \text{g} \\ \hline 863.0879\ \text{g} \end{array} = 863.09\ \text{g}$$

Multiplication & Division

$$\begin{array}{rl} 15.6 & \text{cm} \quad \leftarrow \text{3 sig figs} \\ \times\ 6.023 & \text{cm} \quad \leftarrow \text{4 sig figs} \\ \times\ 0.34 & \text{cm} \quad \leftarrow \text{2 sig figs} \\ \hline 31.945992 & \text{cm}^3 \end{array} = 32\ \text{cm}^3$$

$$\begin{array}{rl} 500 & \text{g} \\ \div\ 305.4 & \text{mL} \\ \hline 1.6371971 & \text{g/mL} \end{array}$$

$$= 2\ \text{g/mL}$$

NEW RULES FOR ROUNDING NUMBERS

- Round UP when:
    - The first digit removed is >5
    - If the first digit removed is 5 and the preceding number is odd (e.g. 23.475 becomes 23.48).
- Round DOWN when
    - The first digit removed is <5
    - If the first digit removed is 5 and the preceding number is even (e.g. 23.485 becomes 23.48).

WHICH ANSWER HAS THE RIGHT NUMBER OF SIG. FIGS.?

$$\frac{(4.6981 - 3.482)}{0.0961} = ?$$

A: 12.6545
B: 12.65
C: 12.7
D: 12.6

ERRORS IN MEASUREMENTS

- Random error: ALL measurements have some level of random error, they can be either positive or negative errors.

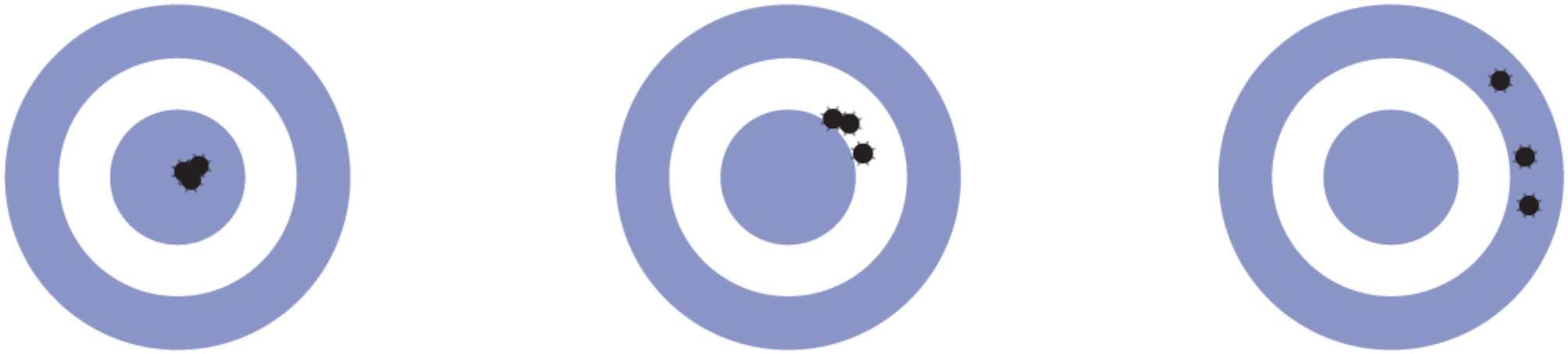
- Systematic error: arise from problems in the measurement procedure, they will be either positive or negative, but not both.

- Systematic errors will also be subject to random error; there will be variations in replicate measurements that have systematic error.

PRECISION & ACCURACY

- Precision relates to how reproducible each measurement is; how close each measurement is to the other measurements.
- Accuracy relates to how close the measured values are to the true value.

PRECISION & ACCURACY

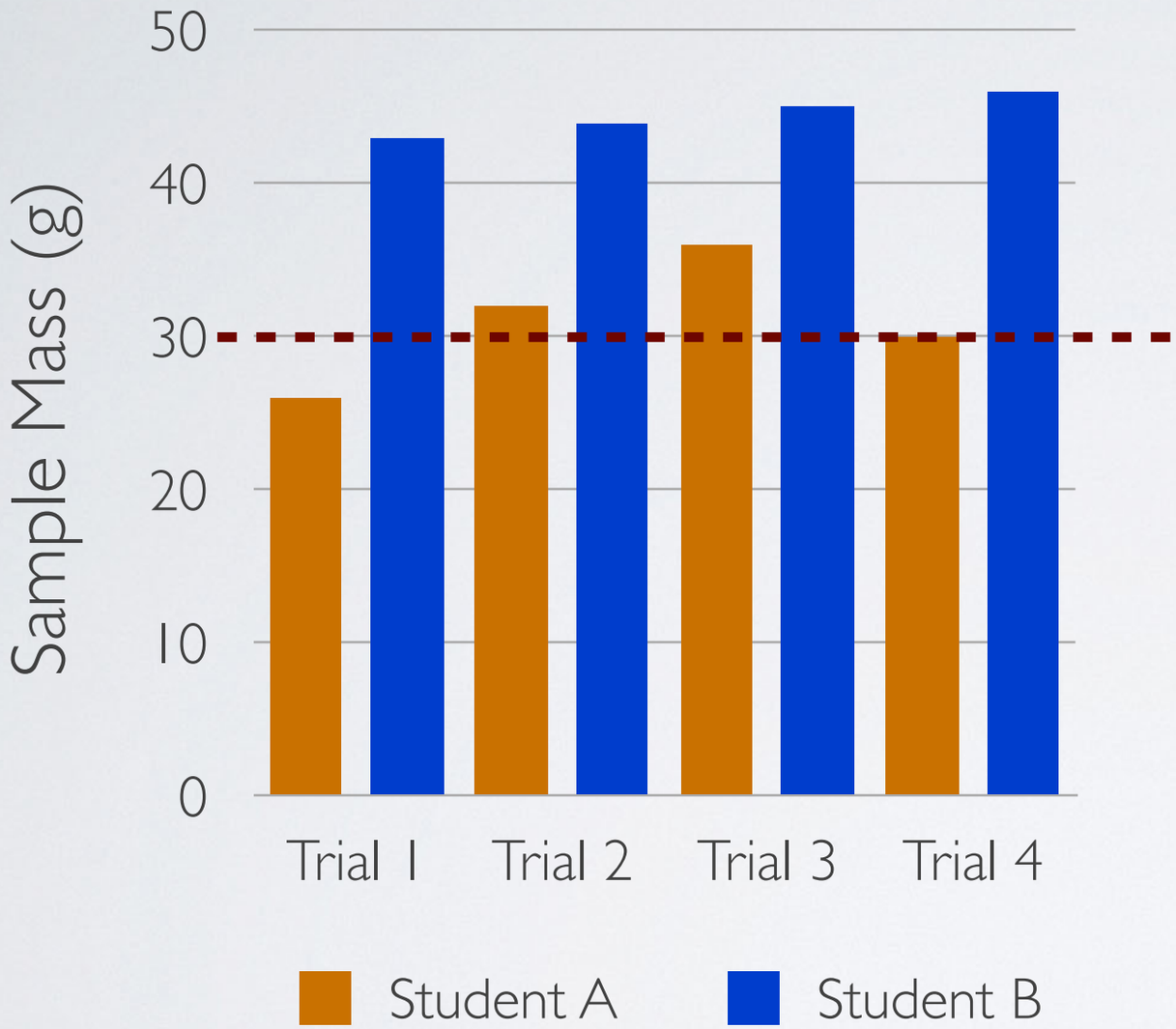


(a) These arrows are close to both the bull's eye and one another, so they are both accurate and precise.

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

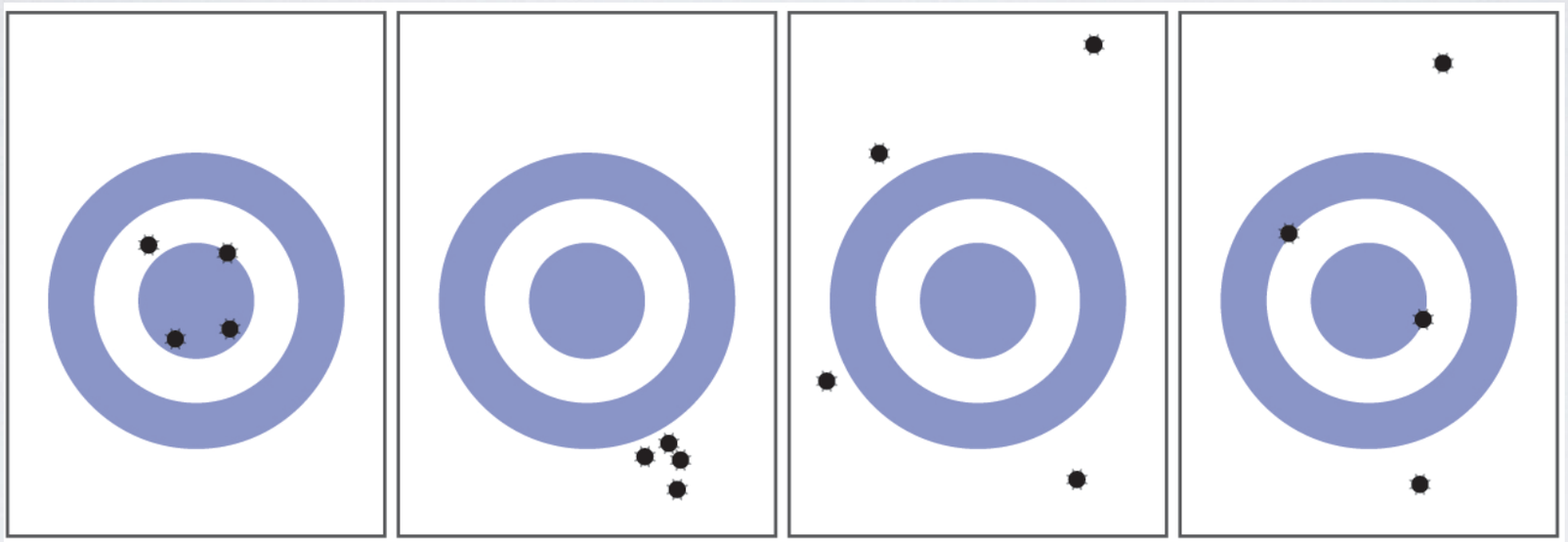
(c) These arrows are neither on target nor close to one another, so they are neither accurate nor precise.

PRECISION & ACCURACY



Systematic error: Student B
Random error: Both Students
Better precision: Student B
Better accuracy: Student A

PRECISION & ACCURACY QUESTION



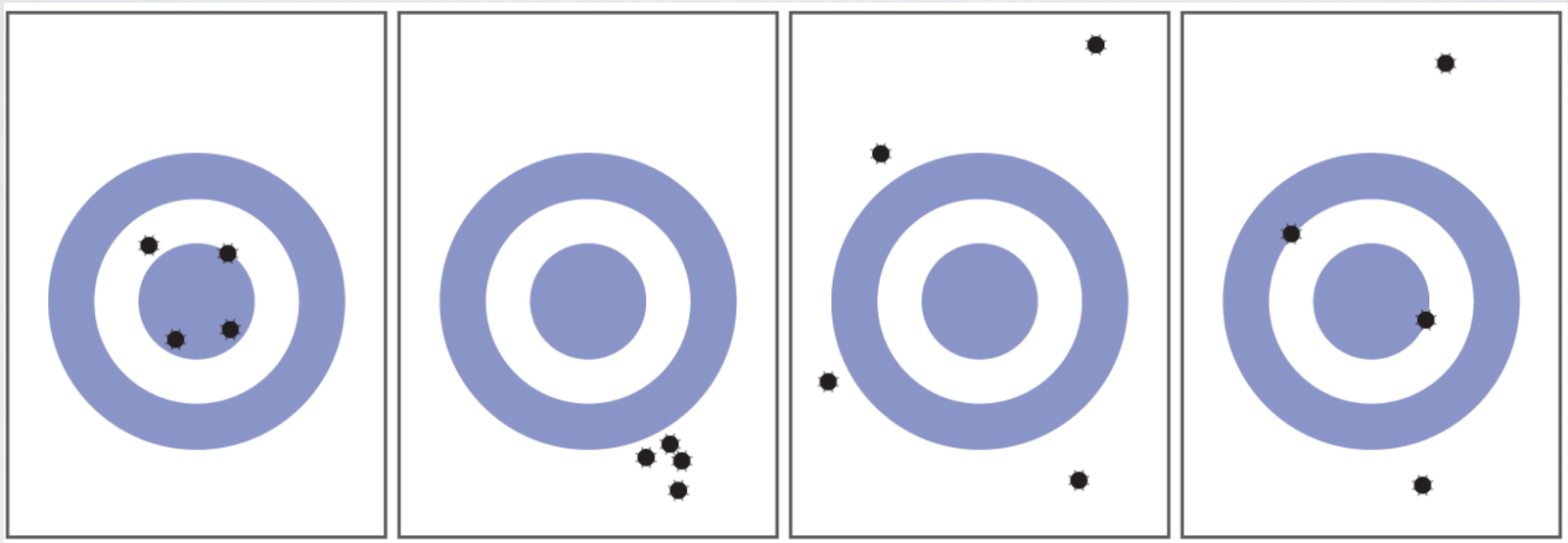
Consider the results of the archery contest shown in this figure.

(a) Which archer is most precise?

(b) Which archer is most accurate?

(c) Who is both least precise and least accurate?

PRECISION & ACCURACY QUESTION



Consider the results of the archery contest shown in this figure.

(a) Which archer is most precise? Archer X

(b) Which archer is most accurate? Archer W

(c) Who is both least precise and least accurate? Archer Y

MEASUREMENT UNCERTAINTY

How long is the red line?

COMMON CONVERSION FACTORS

Length	Volume	Mass
1 m = 1.0936 yd	1 L = 1.0567 qt	1 kg = 2.2046 lb
1 in. = 2.54 cm (exact)	1 qt = 0.94635 L	1 lb = 453.59 g
1 km = 0.62137 mi	1 ft^3 = 28.317 L	1 (avoirdupois) oz = 28.349 g
1 mi = 1609.3 m	1 tbsp = 14.787 mL	1 (troy) oz = 31.103 g

QUESTION

While being driven from Philadelphia to Atlanta, a distance of about 1250 km, a 2014 Lamborghini Aventador Roadster uses 213 L gasoline.

(a) What (average) fuel economy, in miles per gallon, did the Roadster get during this trip?

(b) If gasoline costs $3.80 per gallon, what was the fuel cost for this trip?

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(a) What (average) fuel economy, in miles per gallon, did the Roadster get during this trip?

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(a) 13.8 mpg

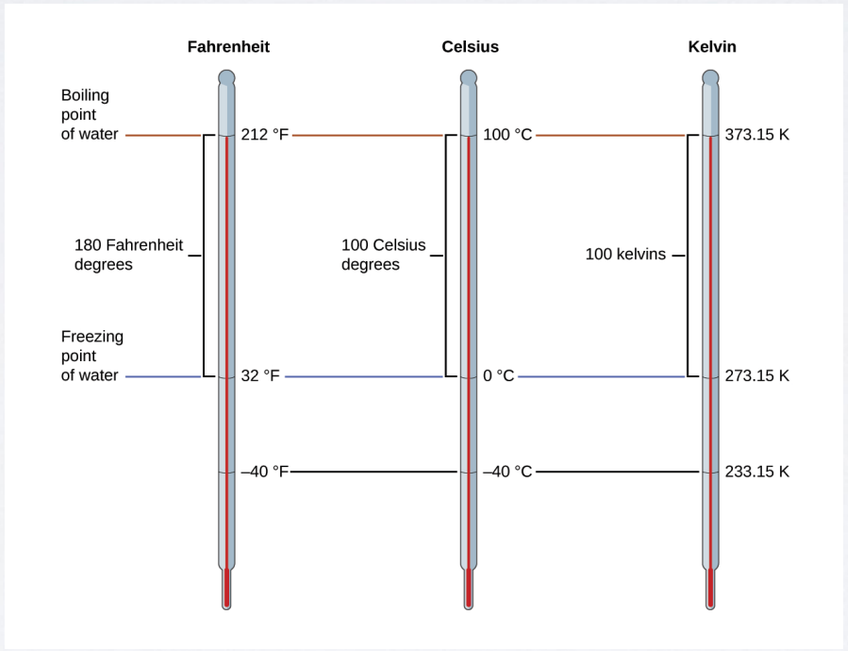
(b) $214

TEMPERATURE SCALES

- **Kelvin (K)** - The "Absolute temperature scale", begins at zero and only has positive values

- **Celsius (°C)** - The principal scientific temperature scale

- **Fahrenheit (°F)** - Not used scientifically, used in some countries for weather reports.



Relative temperatures:

Water freezes at:

32°F

0°C

273.15 K

Water boils at:

212°F

100°C

373.15 K

TEMPERATURE CONVERSIONS

$$T_{°C} = 5/9\ (T_{°F} - 32)$$

$$T_K = T_{°C} + 273.15$$

$$T_{°C} = T_K - 273.15$$

QUESTION

Baking a ready-made pizza calls for an oven temperature of 450 °F. If you are in Europe, and your oven thermometer uses the Celsius scale, what is the setting? What is the kelvin temperature?

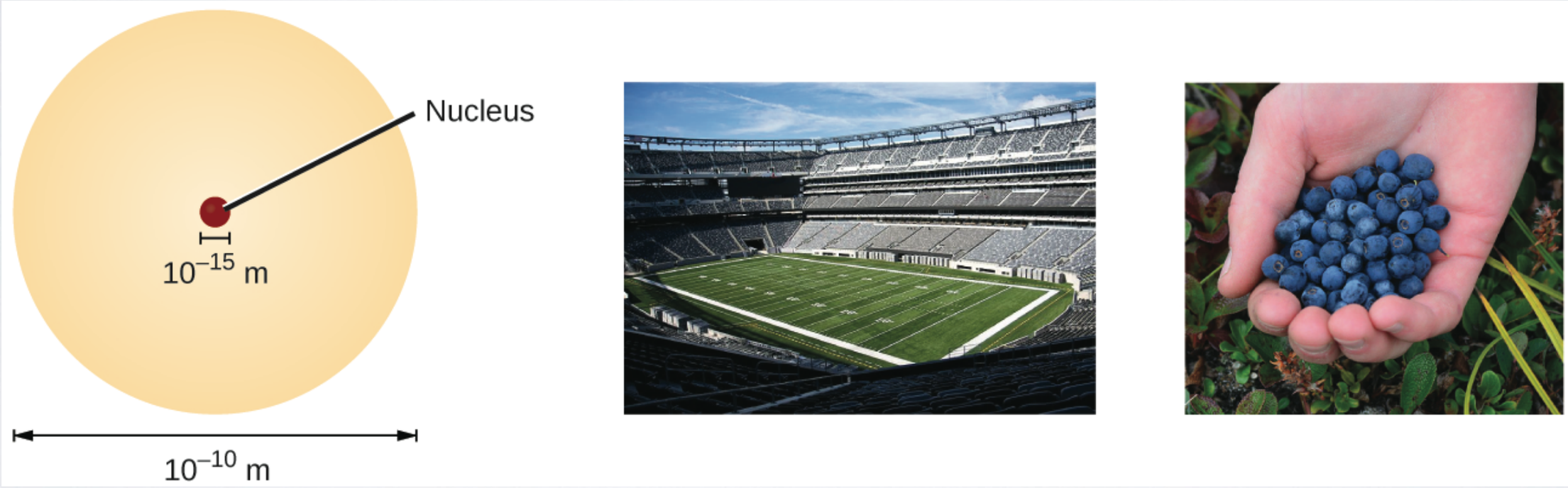
QUESTION

Baking a ready-made pizza calls for an oven temperature of 450. °F. If you are in Europe, and your oven thermometer uses the Celsius scale, what is the setting? What is the kelvin temperature?

232 °C

505 K

CAPTER 2 - ATOMS, MOLECULES AND IONS



If an atom could be expanded to the size of a football stadium, the nucleus would be the size of a single blueberry. (credit middle: modification of work by “babyknight”/ Wikimedia Commons; credit right: modification of work by Paxson Woelber)

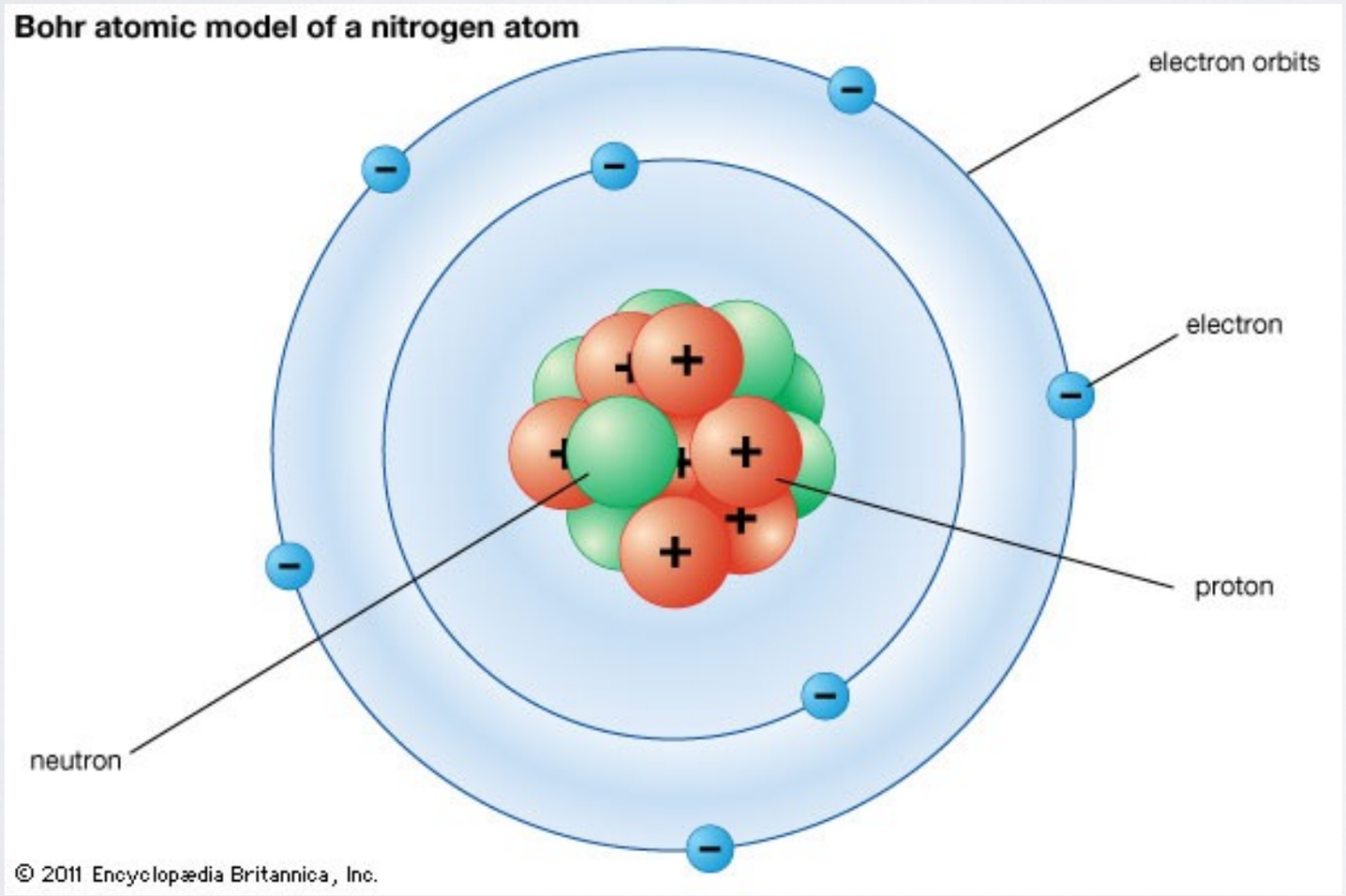
ATOMIC THEORY

John Dalton

- All Matter is made of Atoms.
- Atoms of an element are identical
- Atoms can engaged in chemical reactions.
- Atoms can not be destroyed nor be created.
- Atoms are indivisible.

BOHR'S MODEL OF ATOM

- Electron orbit the nucleus like planets orbit the sun

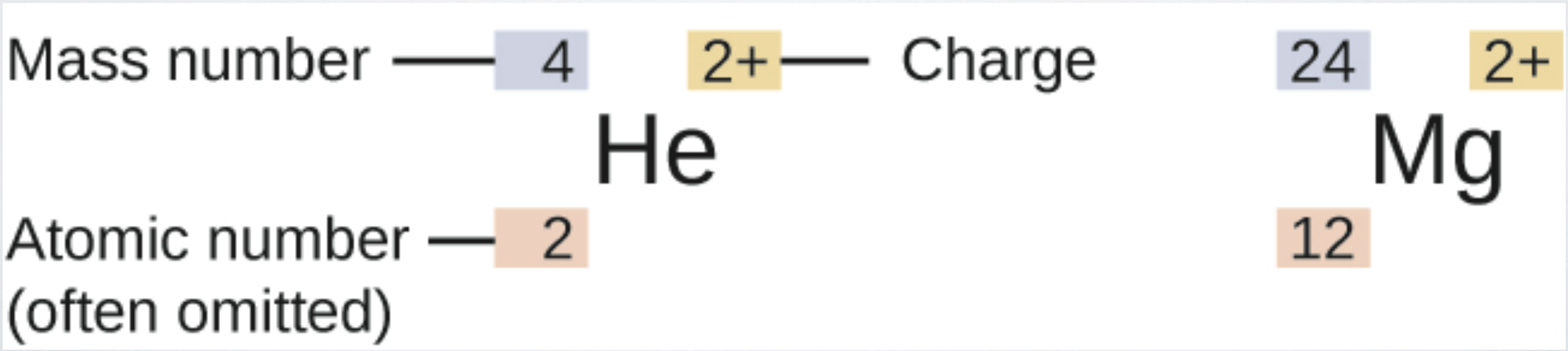


Niels Bohr

ATOMIC STRUCTURE AND SYMBOLISM

- Atomic Number (Z) = number of protons
- Atomic Mass (A) = number of protons + number of neutrons
- A - Z = number of neutrons

- Charge: Proton (+1), Electron (-1), Neutron (0)



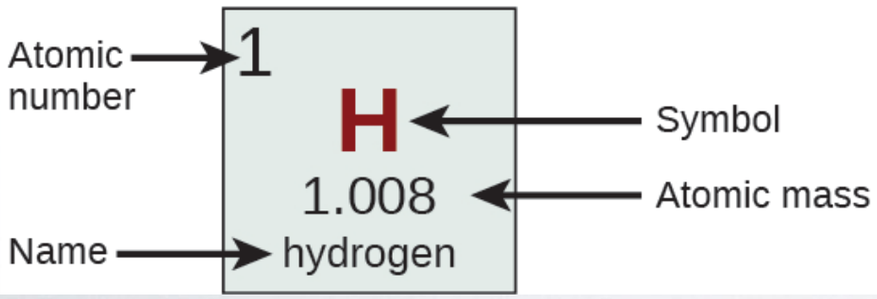
Note: Mass number and atomic number are displayed differently in Periodic Table

THE PERIODIC TABLE

Periodic Table of the Elements

Period	Group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.008 hydrogen																	2 He 4.003 helium
2	3 Li 6.94 lithium	4 Be 9.012 beryllium											5 B 10.81 boron	6 C 12.01 carbon	7 N 14.01 nitrogen	8 O 16.00 oxygen	9 F 19.00 fluorine	10 Ne 20.18 neon
3	11 Na 22.99 sodium	12 Mg 24.31 magnesium											13 Al 26.98 aluminum	14 Si 28.09 silicon	15 P 30.97 phosphorus	16 S 32.06 sulfur	17 Cl 35.45 chlorine	18 Ar 39.95 argon
4	19 K 39.10 potassium	20 Ca 40.08 calcium	21 Sc 44.96 scandium	22 Ti 47.87 titanium	23 V 50.94 vanadium	24 Cr 52.00 chromium	25 Mn 54.94 manganese	26 Fe 55.85 iron	27 Co 58.93 cobalt	28 Ni 58.69 nickel	29 Cu 63.55 copper	30 Zn 65.38 zinc	31 Ga 69.72 gallium	32 Ge 72.63 germanium	33 As 74.92 arsenic	34 Se 78.97 selenium	35 Br 79.90 bromine	36 Kr 83.80 krypton
5	37 Rb 85.47 rubidium	38 Sr 87.62 strontium	39 Y 88.91 yttrium	40 Zr 91.22 zirconium	41 Nb 92.91 niobium	42 Mo 95.95 molybdenum	43 Tc [97] technetium	44 Ru 101.1 ruthenium	45 Rh 102.9 rhodium	46 Pd 106.4 palladium	47 Ag 107.9 silver	48 Cd 112.4 cadmium	49 In 114.8 indium	50 Sn 118.7 tin	51 Sb 121.8 antimony	52 Te 127.6 tellurium	53 I 126.9 iodine	54 Xe 131.3 xenon
6	55 Cs 132.9 cesium	56 Ba 137.3 barium	57-71 La–Lu *	72 Hf 178.5 hafnium	73 Ta 180.9 tantalum	74 W 183.8 tungsten	75 Re 186.2 rhenium	76 Os 190.2 osmium	77 Ir 192.2 iridium	78 Pt 195.1 platinum	79 Au 197.0 gold	80 Hg 200.6 mercury	81 Tl 204.4 thallium	82 Pb 207.2 lead	83 Bi 209.0 bismuth	84 Po [209] polonium	85 At [210] astatine	86 Rn [222] radon
7	87 Fr [223] francium	88 Ra [226] radium	89-103 Ac–Lr **	104 Rf [267] rutherfordium	105 Db [270] dubnium	106 Sg [271] seaborgium	107 Bh [270] bohrium	108 Hs [277] hassium	109 Mt [276] meitnerium	110 Ds [281] darmstadtium	111 Rg [282] roentgenium	112 Cn [285] copernicium	113 Uut [285] ununtrium	114 Fl [289] flerovium	115 Uup [288] ununpentium	116 Lv [293] livermorium	117 Uus [294] ununseptium	118 Uuo [294] ununoctium

*	57 La 138.9 lanthanum	58 Ce 140.1 cerium	59 Pr 140.9 praseodymium	60 Nd 144.2 neodymium	61 Pm [145] promethium	62 Sm 150.4 samarium	63 Eu 152.0 europium	64 Gd 157.3 gadolinium	65 Tb 158.9 terbium	66 Dy 162.5 dysprosium	67 Ho 164.9 holmium	68 Er 167.3 erbium	69 Tm 168.9 thulium	70 Yb 173.1 ytterbium	71 Lu 175.0 lutetium
**	89 Ac [227] actinium	90 Th 232.0 thorium	91 Pa 231.0 protactinium	92 U 238.0 uranium	93 Np [237] neptunium	94 Pu [244] plutonium	95 Am [243] americium	96 Cm [247] curium	97 Bk [247] berkelium	98 Cf [251] californium	99 Es [252] einsteinium	100 Fm [257] fermium	101 Md [258] mendelevium	102 No [259] nobelium	103 Lr [262] lawrencium



Color Code

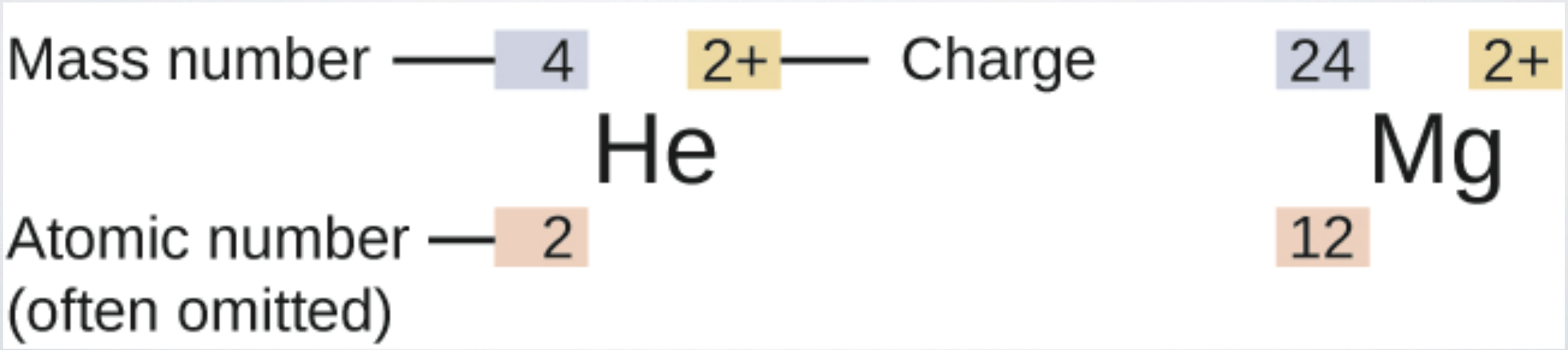
Metal	**Solid**
Metalloid	**Liquid**
Nonmetal	**Gas**

ISOTOPES & ATOMIC MASS

- Isotopes are variants of atoms, which have a different number of neutrons in the nucleus.

- This influences the average mass of the atom (which is listed on the periodic table).

- Some elements only have one isotope (monoisotopic, ^{9}Be, ^{19}F, ^{23}Na)



PERCENT ABUNDANCE

This exercise will lead you to verify that the average atomic mass of magnesium is 24.31 amu, based on the following information:

isotope	mass (amu)	percent abundance
^{24}Mg	23.985042	78.99%
^{25}Mg	24.985837	10.00%
^{26}Mg	25.982593	11.01%

The average atomic mass is the weighted average of the atomic masses of all isotopes.

$$\text{atomic mass} = \sum_{\substack{\text{all} \\ \text{isotopes}}} \text{atomic mass} \times \text{fractional abundance}$$

What is the fractional abundance of ^{24}Mg?

AVERAGE MASS

The element **indium** has an atomic weight of **115** and consists of two stable isotopes **indium-113** and **indium-115**.

The isotope **indium-113** has a mass of **113** amu and a percent natural abundance of **4.28** %.

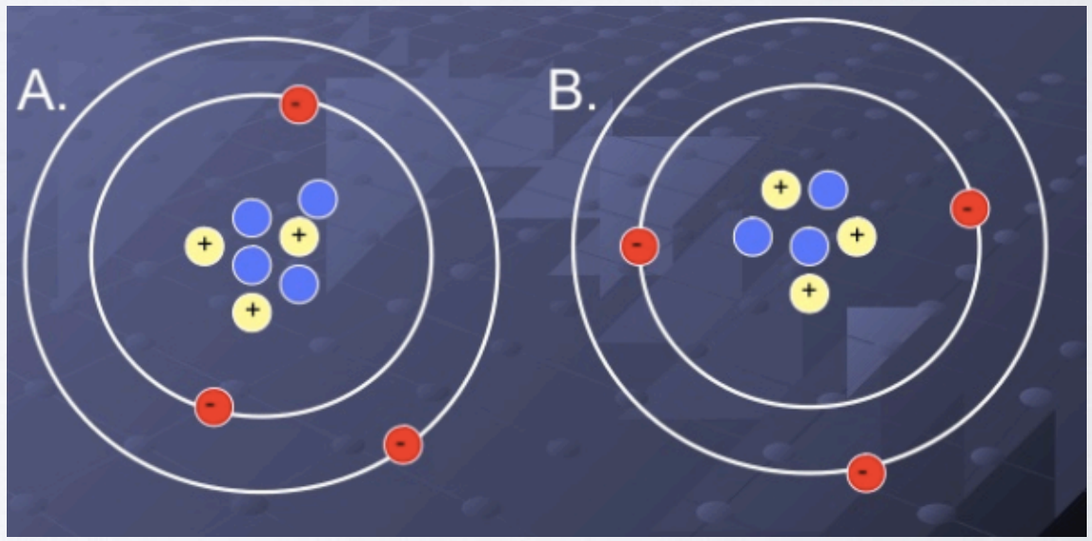
The isotope **indium-115** has a percent natural abundance of **95.7** %.

What is the mass of **indium-115**? _____ amu

ISOTOPIC ABUNDANCE CALCULATION

- The average mass for lithium (Li) is 6.94 g/mol. The isotopes of lithium are ^{6}Li and ^{7}Li with respective masses of 6.0151 amu and 7.0160 amu.

- Given this information, what is the abundance of each of the isotopes?

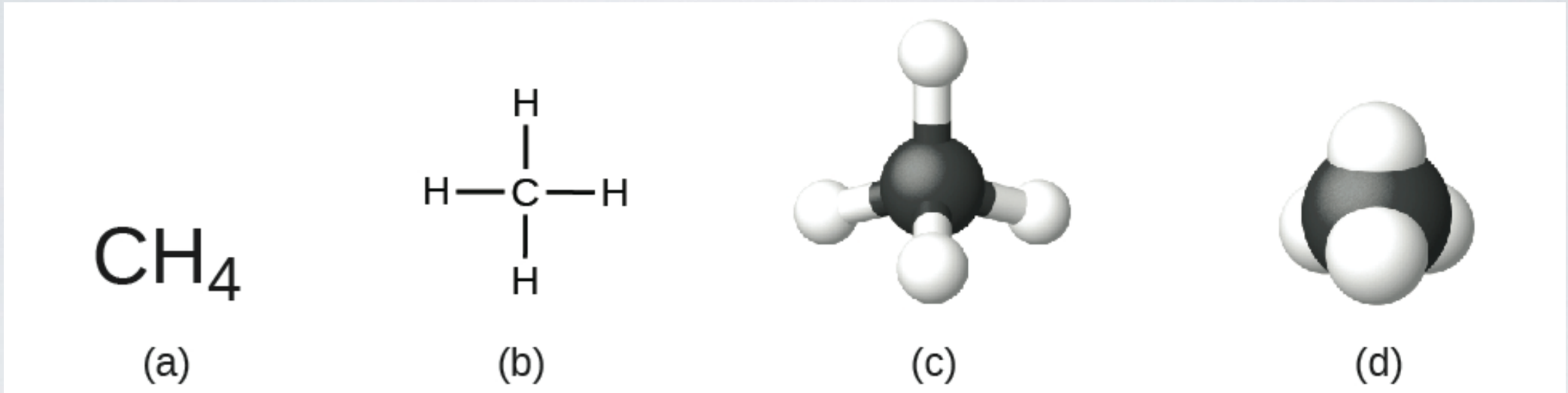


CHEMICAL LANGUAGE

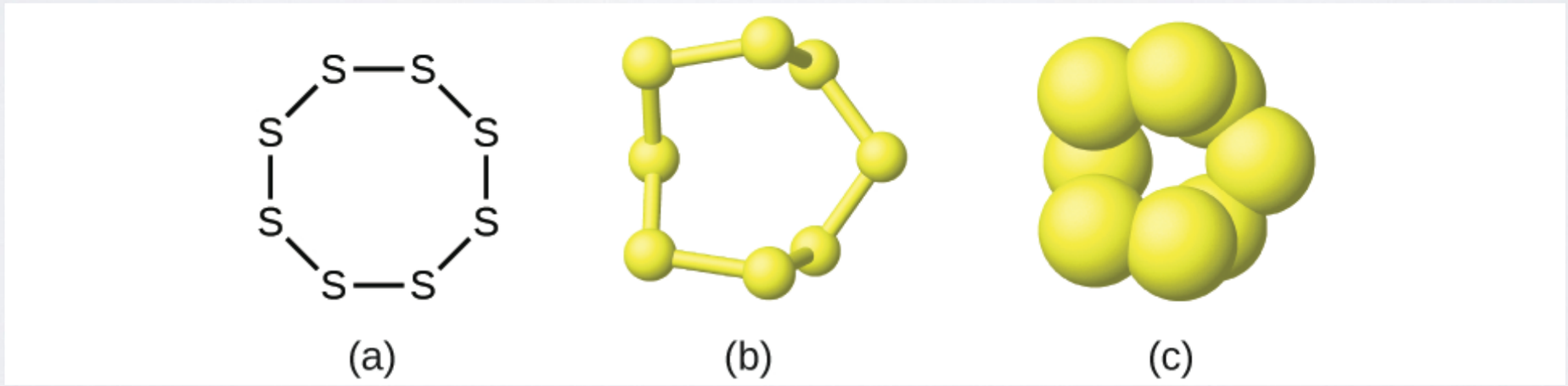
- Chemistry, like most fields of study, has a unique language which conveys significant information to those who understand it.

- Elements (Na, Cl) - letters of the language
- Chemical Formulas (NaCl) - words of the language
- Chemical Equations ($2Na_{(s)} + Cl_{2(g)} \rightleftharpoons 2NaCl_{(s)}$) - sentences of the language

CHEMICAL FORMULAS



A methane molecule can be represented as (a) a molecular formula, (b) a structural formula, (c) a ball-and-stick model, and (d) a space-filling model. Carbon and hydrogen atoms are represented by black and white spheres, respectively.



A molecule of sulfur is composed of eight sulfur atoms and is therefore written as S_8. It can be represented as (a) a structural formula, (b) a ball-and-stick model, and (c) a space-filling model. Sulfur atoms are represented by yellow spheres.

MOLECULAR VS. EMPIRICAL FORMULA

- **The molecular formula** is the actual number of atoms of each type in a molecule.
  - Water: H_2O
  - Hydrogen peroxide: H_2O_2
  - Glucose: $C_6H_{12}O_6$
- **The empirical formula** is the smallest whole number ratio of all atoms in an atom.
  - Water: H_2O
  - Hydrogen peroxide: HO
  - Glucose: CH_2O

EMPIRICAL FORMULA

- The utility of the empirical formula arises in determining the composition of a substance.

- Elemental analysis techniques can tell chemists what mass of a given element is present in a sample.

- But elemental analysis does not give molecular information.

- Glucose ($C_6H_{12}O_6$) and formaldehyde (CH_2O) have the same ratio of atoms (empirical formulas).

QUESTION

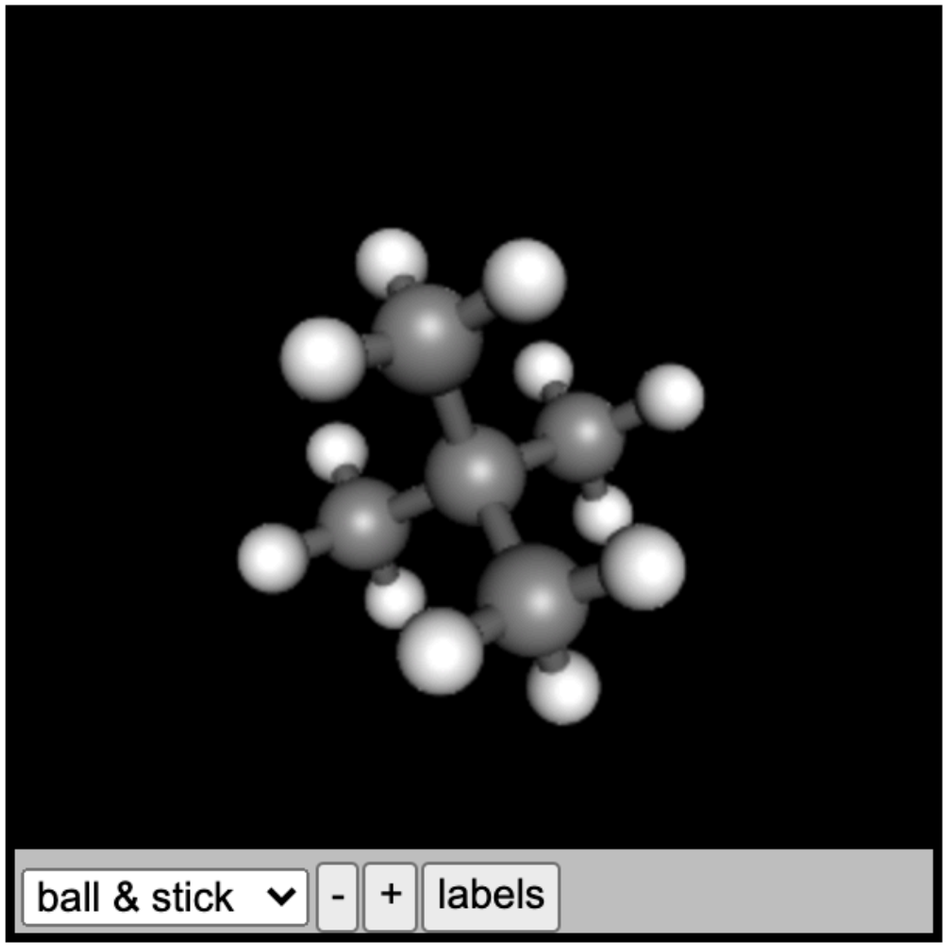
How many atoms of carbon, hydrogen, and oxygen are present in a single molecule of citric acid?

Citric acid: $C_3H_5O(CO_2H)_3$

Carbon	Hydrogen	Oxygen
1 2 3	1 2 3	1 2 3
4 5 **6**	4 5 6	4 5 6
7 8 9	7 **8** 9	**7** 8 9

EMPIRICAL AND MOLECULAR FORMULA

In the following model for the **2,2-dimethylpropane** molecule, carbon is in gray and hydrogen is in white:



The molecular formula for **2,2-dimethylpropane** is:

(Enter the elements in the order: C, H, N, O.)

PERIODIC TABLE OF THE ELEMENTS

Periods

Groups

	1												13	14	15	16	17	18
1	1 H 1.008	2																2 He 4.003
2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	48 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57-70 *	71 Lu 175.0	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po [209]	85 At [210]	86 Rn [220]
7	87 Fr [223]	88 Ra [226]	89-102 **	103 Lr [262]	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [277]	109 Mt [268]								

Metals | Non Metals

* Lanthanoids	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm [145]	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
** Actinoids	89 Ac [227]	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]

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Periodic Table of the Elements

Metals

Metalloids

Non-Metals

Transition Metals

	1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.008																		2 He 4.003
2	3 Li 6.941	4 Be 9.012												5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
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4	19 K 39.10	20 Ca 40.08		21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62		39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc [98]	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	48 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
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Metals | Non Metals

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At is a metalloid

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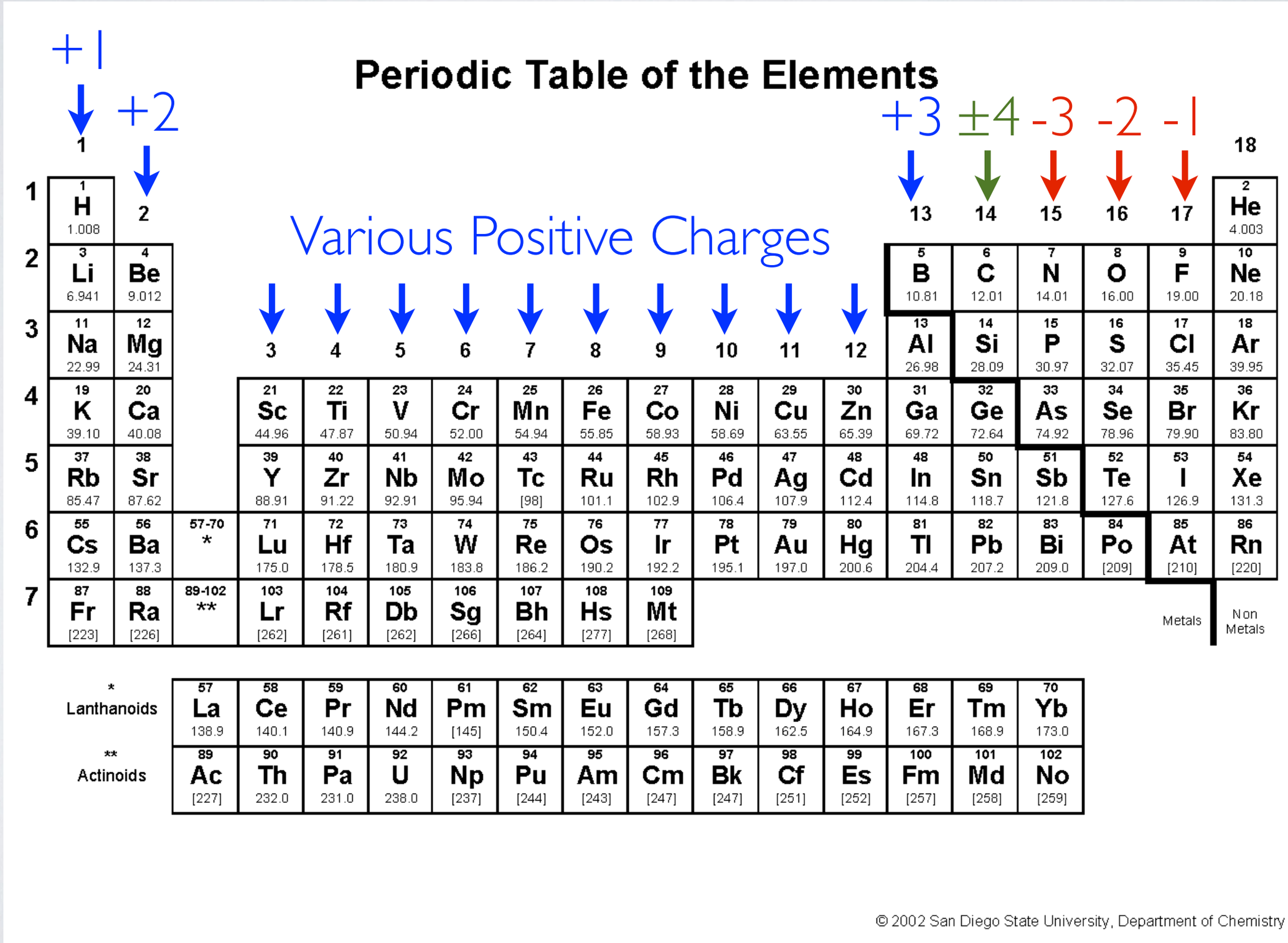
IONIC CHARGES



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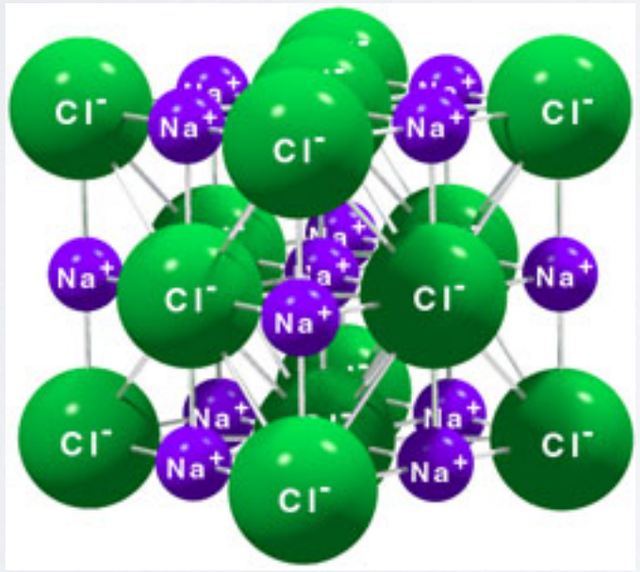
CHEMICAL BONDING

- Bonds form between atoms when they share electrons.
- Not all atoms share electrons in the same way; some are "generous" others are "selfish".
- The types of atoms forming the bond define the type of bond.
- **Ionic compounds** - metal + non-metal - electrons transferred to one element from the other.
- **Covalent compounds** - non-metals only - electrons are shared between atoms.

NAMING IONIC COMPOUNDS

NaCl - Sodium chloride

metal non-metal



http://www.chemistry.wustl.edu

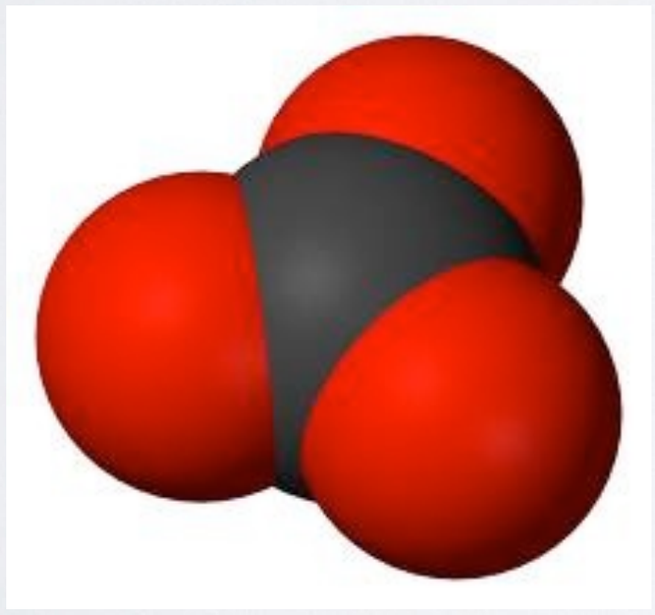
- Na^+ and Cl^- combine in a 1:1 ratio
- NaCl is the only compound that can form from sodium and chlorine

POLYATOMIC IONS

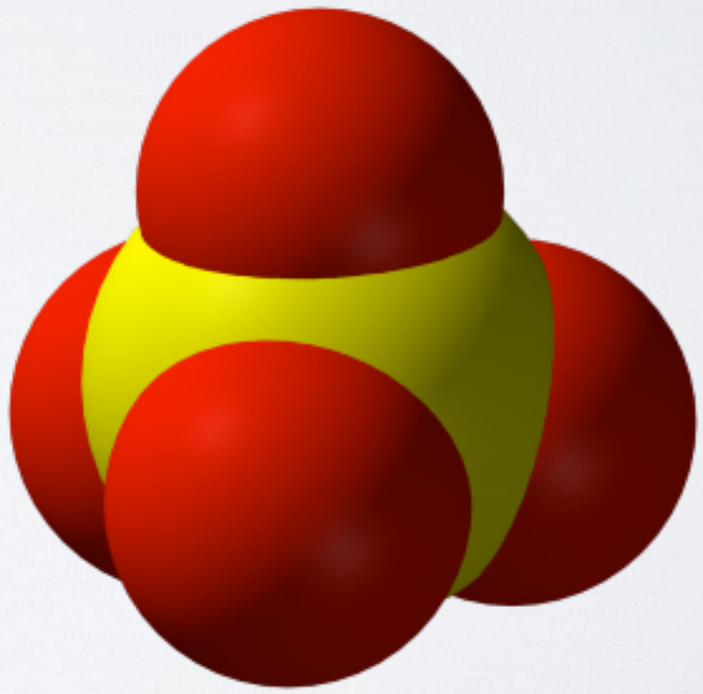
Ions that are comprised of more than one atom;
the atoms remain bound together.

See Canvas for the polyatomic ions you need to know

Carbonate ion: CO_3^{2-}



Sulfate ion: SO_4^{2-}



NAMING COVALENT COMPOUNDS

PCl_3 - Phosphorous trichloride Both non-metals

The naming convention specifies the relative number of atoms - there may be more than one possible ratio of atoms

PCl_5 - Phosphorous pentachloride

S_2Cl_2 - Disulfur dichloride