

# **Chapter 2: Atoms, Ions, and the Periodic Table**

---

Sept 8, 2022

Chemistry Department, Cypress College

## Class Announcements

- When uploading assignments, be certain that the file is in a readable format e.g. docx, png, jpeg, and pdf
- This week only, any late HW assignments will not be penalized 50%; submit late assignments by the Sept 8th at 11:59pm
- Quiz #2 released this Fri, Sept 9 at 11am and due Tues, Sept 12 at 11am
- Homework #2 released this Fri, Sept 9 at 11am and due Fri, Sept 16 at 11am

## Lecture Weekly Agenda

- Finished Ch 2 - pg 56 – 88
- In-class Ch 2 worksheet
- Time permits, begin Ch 3

# Outline

Review: Scientific Notation and Unit Conversion

Review: Relative Atomic Mass

Periodic Table - Grouped Elements

# Scientific Notation

$$2.78 \times 10^{-8} - 5.689 \times 10^{-9} =$$

$$\frac{7.18 - 6.729}{2.51 \times 7.343} =$$

$$\frac{7.9 \times 10^{34}}{8.235 \times 10^{23}} =$$

# Unit Conversion

## Volume Conversion

$9.2\text{m}^3$  to  $\text{mm}^3$

$581.74\text{ mL}$  to  $\text{m}^3$

$0.53\text{ g/cm}^3$  to  $\text{kg/m}^3$

# Outline

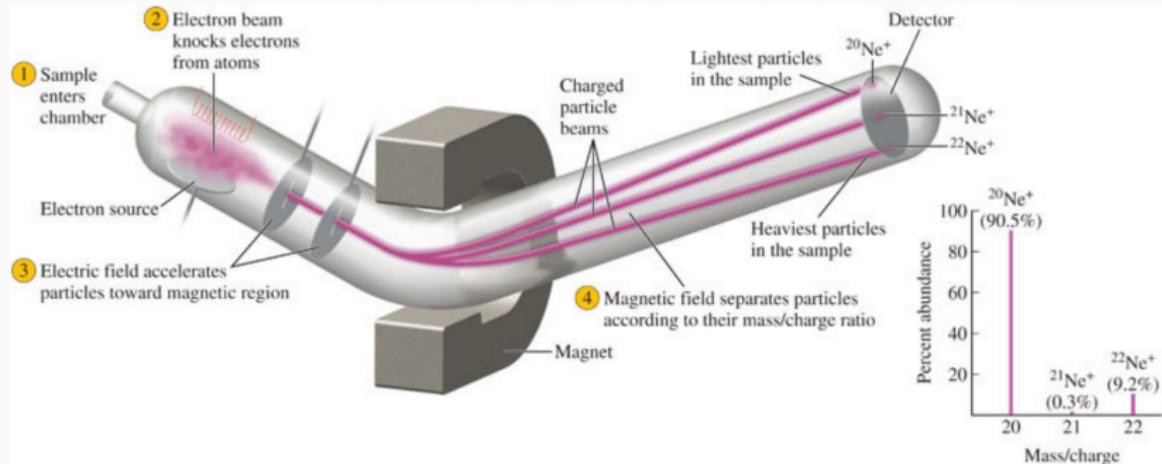
---

Review: Scientific Notation and Unit Conversion

Review: Relative Atomic Mass

Periodic Table - Grouped Elements

# Experiment: Mass Spectroscopy



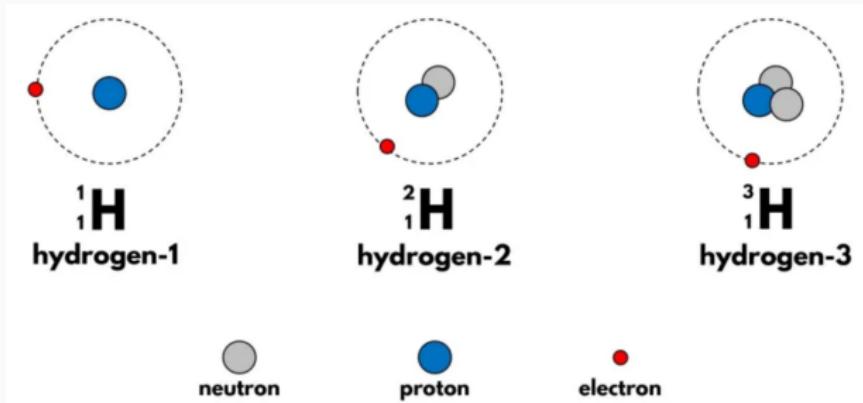
- Ionizes the atom and electric field accelerates atoms
- Time of flight - heavier atoms will travel slower than lighter ones
- Weighted average of atomic masses

## Relative Atomic Mass

$$\text{Relative Atomic Mass} = (I_1 \times A_1) + (I_2 \times A_2) + \dots \quad (1)$$

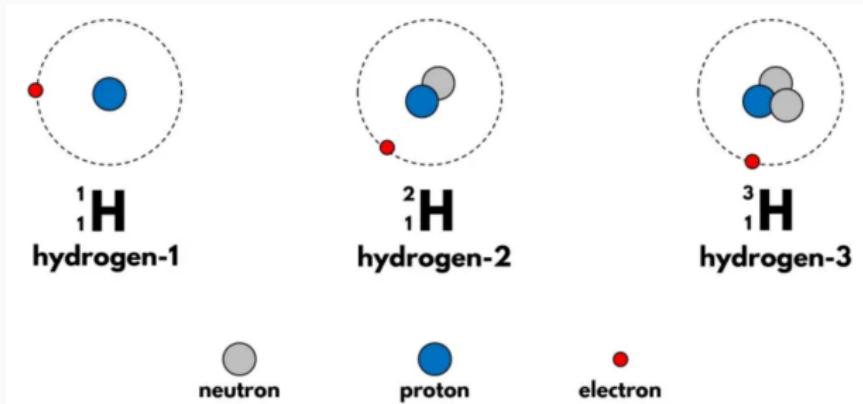
where  $I$  is the mass of the isotope, and  $A$  is the relative abundance between 0 and 1

# Hydrogen Isotopes and Applications



- Hydrogen ( $^1_1\text{H}$ ), deuterium ( $^2_1\text{D}$ ), and tritium ( $^3_1\text{T}$ ) have relative abundances of 99.84%, 0.0156%, and trace amounts, respectively
- **Q:** Which hydrogen isotope is the highest in abundance?

# Hydrogen Isotopes and Applications



## Applications

- Semiconductor production enhancing Si-H bond by preventing chemical erosion and Hot Carrier Effect
- Chemical labeling to track chemical reactions
- Medicinal chemistry - FDA approved the first deuterium-labeled drug (reference)

# Outline

---

Review: Scientific Notation and Unit Conversion

Review: Relative Atomic Mass

Periodic Table - Grouped Elements

# Review: Modern Periodic Table

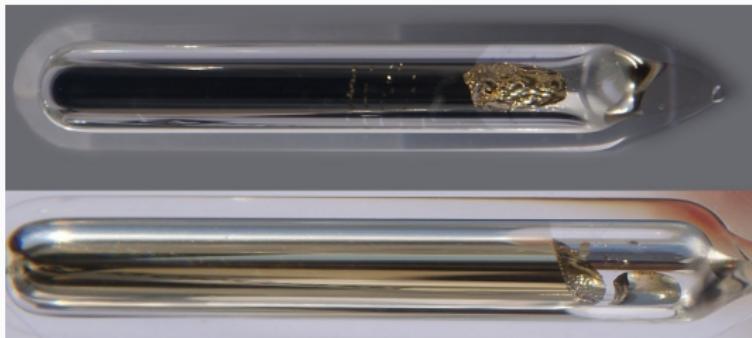
Temperature: 0 °C 32 °F 273 K

32	2	8	18	4															
<b>Ge</b>																			
Germanium	72.630																		
Series	Metalloids																		
Write-up	<a href="#">Germanium</a>	<a href="#">Wikipedia</a>																	
State at	0 °C	Solid																	
Weight	72.63	u																	
Energy levels	2, 8, 18, 4																		
Electronegativity	2.01																		
Melting point	938.25 °C	v																	
Boiling point	2,820 °C	v																	
Electron affinity	119 kJ/mol	v																	
Ionization, 1st	762 kJ/mol	v																	
Radius, calculated	125 pm	v																	
Hardness, Brinell	N/A MPa	v																	
Modulus, bulk	N/A GPa	v																	
Density, STP	5,323 kg/m³	v																	
Conductivity, thermal	0.030 W/mK	v																	

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71			
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
Lanthanum (138.91)	Cerium (140.12)	Neodymium (140.91)	Praseodymium (144.24)	Neptunium (145)	Samarium (150.96)	Europium (151.96)	Terbium (157.29)	Dysprosium (158.93)	Holmium (164.93)	Thulium (167.26)	Erbium (168.93)	Terbium (168.93)	Ytterbium (173.05)	Yttrium (174.57)			
6																	
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103			
Ac	Th	Protactinium (231.04)	Uranium (238.03)	Neptunium (237)	Plutonium (244)	Americium (243)	Curium (247)	Berkelium (247)	Californium (251)	Einsteinium (252)	Fermium (257)	Mendelevium (258)	No邦ium (259)	Lawrencium (266)			
7																	

# Alkali Metal



- Lower densities than other metals
- Extremely soft metals
- Highly reactive e.g. forming  $H_2$  when in contact with water
- Prefer to lose an electron

# Alkaline Earth Metal



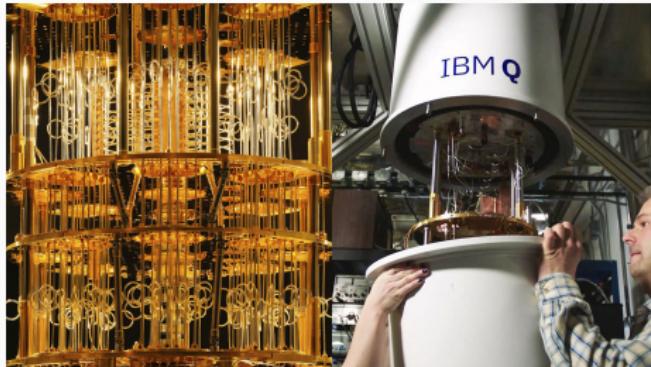
- Fairly reactive metals
- Can form solutions with a pH greater than 7 (more basic or alkaline)
- Calcium and magnesium important for life
- Prefer to lose 2 electrons

# Transition Metals



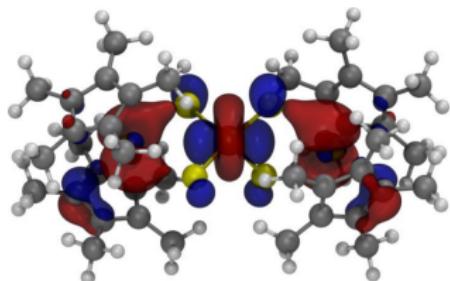
- Easily malleable and great conductors of heat and electricity
- High melting points except mercury (liquid at Room temperature)
- High densities
- Oxidation states (ability to gain/lose electrons) can vary between 1+ to 6+

# Actinides and Lanthanides

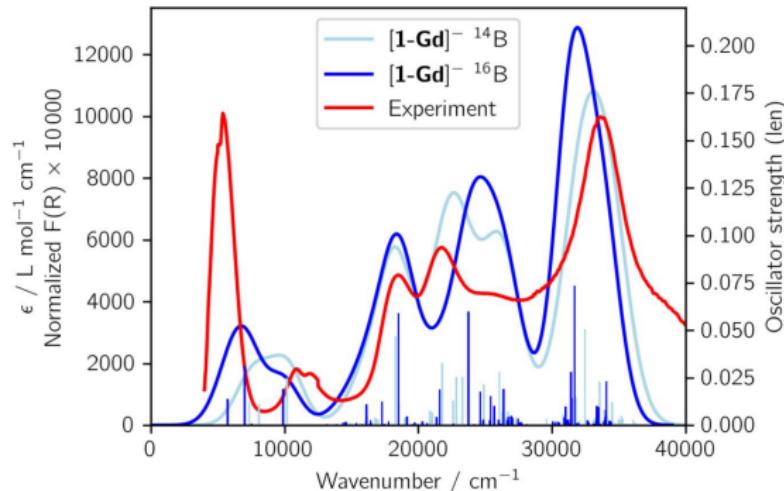


- Radioactive due to instability
- Silvery/silvery-white luster in metallic form
- Potential application to quantum computers and nuclear power
- Oxidation states can range from 2+ to 7+

# Materials for Quantum Computing: Lanthanide Complexes

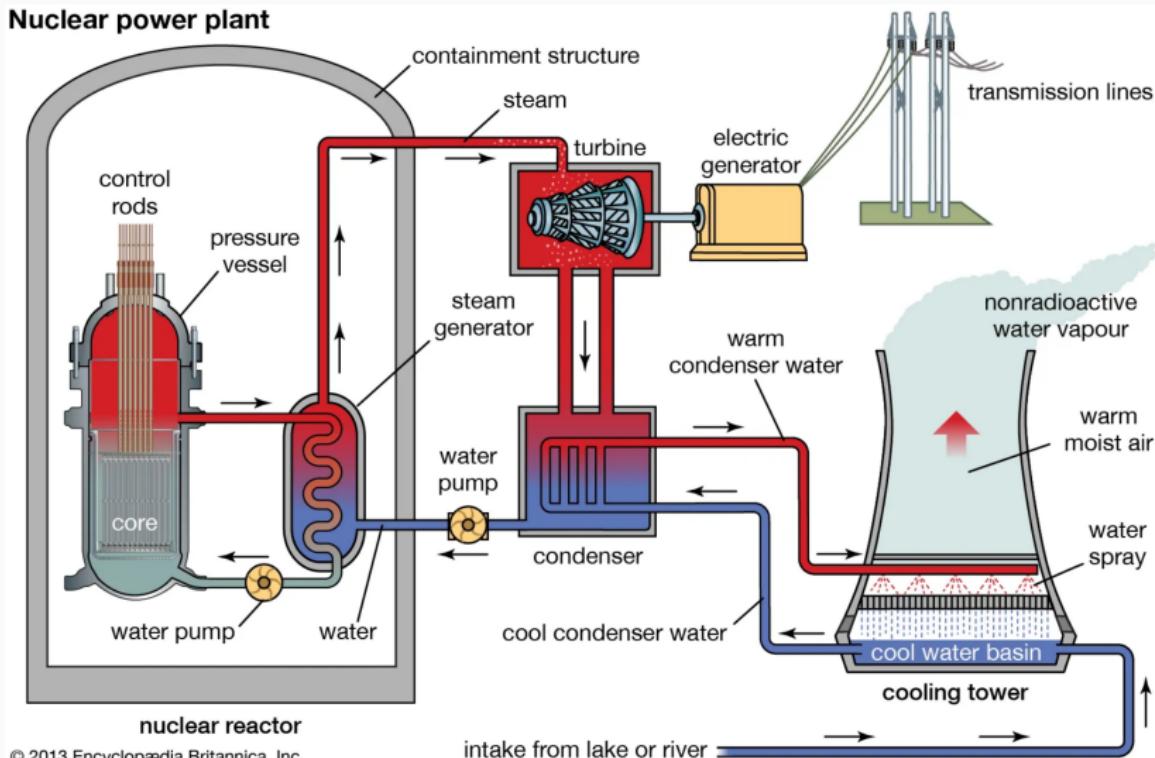


[1-Gd]<sup>-1</sup> HOMO



- Understanding the electronic structure
- Hysteresis - electronic spin memory
- Lanthanide MoS<sub>4</sub> research article

# Nuclear Power Plants



© 2013 Encyclopædia Britannica, Inc.

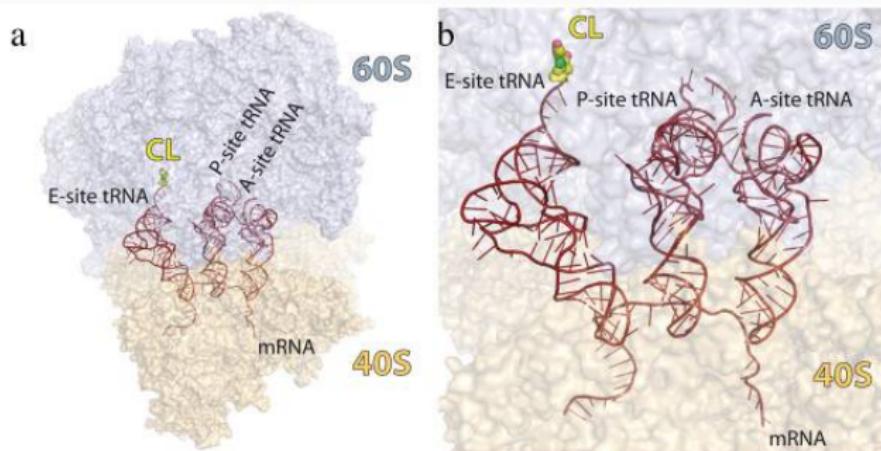
# Halogens

- Fairly toxic and form acids when combined with hydrogen
- Readily react with metals to form salts e.g. NaCl
- Important for drug development due to their “sticky” nature
- Prefers to gain an electron



- Chlorolissoclimide is a potent cancer drug that is naturally found in sea squirts
- Understanding the structure–activity relationships e.g. interactions between drug and ribosome

# My Research Project: Chlorolissoclimide



- Chlorolissoclimide research article

# Noble Gases



- Colorless, odorless, tasteless, and non-flammable under standard conditions
- Extremely non-reactive and most stable elements
- Do not like to gain or lose electrons

## Practice: Periodic Table

Group the elements into the following groups

- Br
- K
- Mg
- Al
- Mn
- Ar
- U

## Practice

What is the charge of the ions for each of the following elements?

- Al
- P
- Br
- S