

Chapter 2: Atoms, Ions, and the Periodic Table

August 29, 2022

Chemistry Department, Cypress College

Lecture and Lab Weekly Agenda

Lab Section

- Lab lockers and safety quiz
- Start Exp 1 - Laboratory Techniques
- Using Bunsen burners

Lecture Section

- Finished Ch 1 - pg 1 – 55
- Go over Ch 2 - pg 56 – 88
- In-class Ch 2 worksheet

Bunsen Burner



- Each student will practice lighting a bunsen burner under supervision
- Safety goggles are available (free)
- Review proper use of bunsen burner - read the lab manual

Corrections to Lecture 3

- There is conservation of energy
- Amount of energy to do work is not 100%
- Scientific notation:

$$1.0 \times 10^{-2} \text{g} - 1.2 \times 10^{-3} \text{g} \quad (1)$$

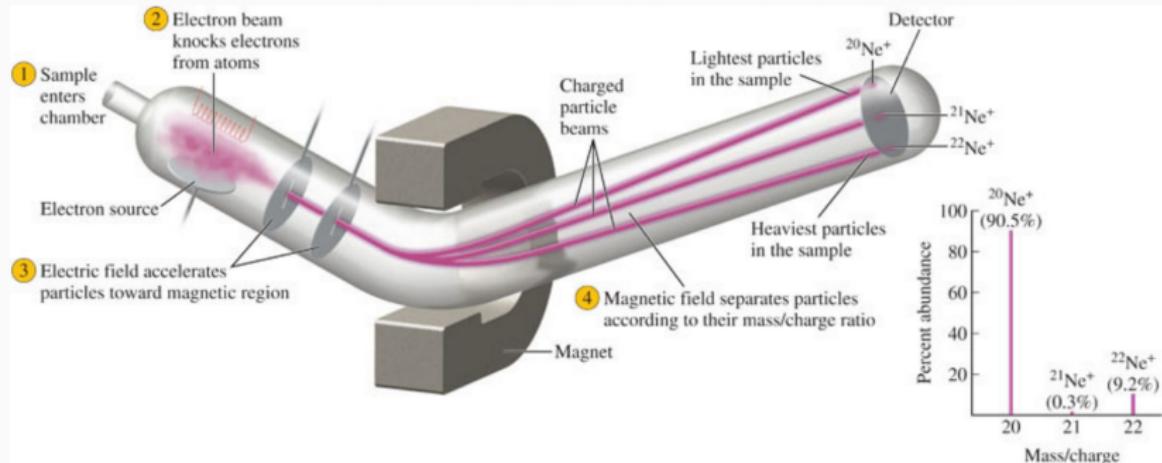
- Quiz - typos and mistakes on the quiz

Outline

Review: Relative Atomic Mass

Periodic Table - Grouped Elements

Experiment: Mass Spectroscopy



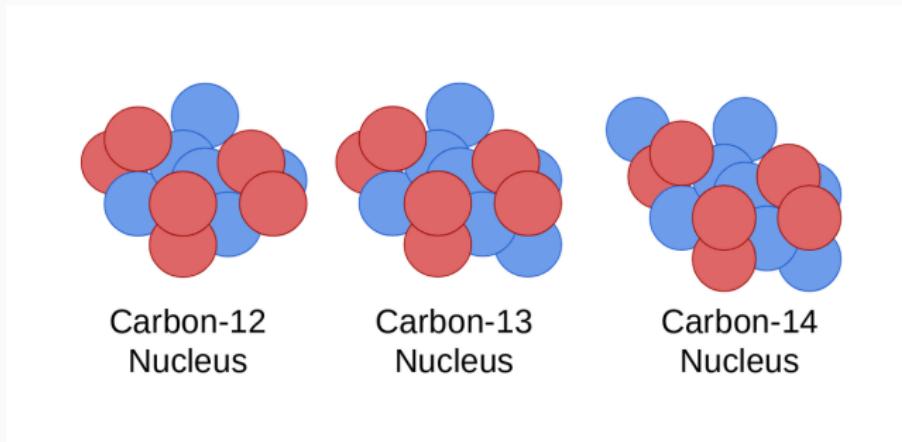
- Ionizes the atom and electric field accelerates atoms
- Time of flight - heavier atoms will travel slower than lighter ones
- Weighted average of atomic masses

Relative Atomic Mass

$$\text{Relative Atomic Mass} = (I_1 \times A_1) + (I_2 \times A_2) + \dots \quad (2)$$

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

Carbon Isotopes



where red is the proton and blue is the neutron

Question: Given the carbon isotopes C-12, C-13, and C-14 that are naturally occurring. Can you make a statement about which isotope is the greatest in abundance?

Outline

Review: Relative Atomic Mass

Periodic Table - Grouped Elements

Review: Modern Periodic Table

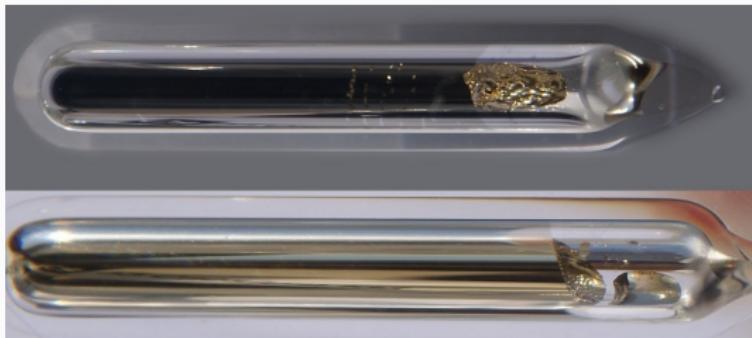
Temperature 

| | | | | | | | | | | | | | | | | | | |
|-----------------------|---------------------------|---------------------------|----|---|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| 32 | 2 | 8 | 18 | 4 | | | | | | | | | | | | | | |
| Ge | | | | | | | | | | | | | | | | | | |
| Germanium | 72.630 | | | | | | | | | | | | | | | | | |
| Series | Metalloids | | | | | | | | | | | | | | | | | |
| Write-up | Germanium | Wikipedia | | | | | | | | | | | | | | | | |
| 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 | 100 W/mK | v | | | | | | | | | | | | | | | | |

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

| | | | | | | | | | | | | | | |
|----------|----------|----------|----------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 57 La | 58 Ce | 59 Pr | 60 Nd | 61 Pm | 62 Sm | 63 Eu | 64 Gd | 65 Tb | 66 Dy | 67 Ho | 68 Er | 69 Tm | 70 Yb | 71 Lu |
| (138.91) | (140.12) | (140.91) | (144.24) | (145.9) | (150.96) | (151.96) | (157.29) | (158.93) | (162.59) | (168.93) | (167.26) | (168.93) | (173.05) | (174.57) |
| 69 Ac | 90 Th | 91 Pa | 92 U | 93 Np | 94 Pu | 95 Am | 96 Cm | 97 Bk | 98 Cf | 99 Es | 100 Fm | 101 Md | 102 No | 103 Lr |
| (227) | (232.04) | (231.04) | (238.03) | (237) | (244) | (243) | (247) | (247) | (251) | (252) | (257) | (258) | (259) | (266) |

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



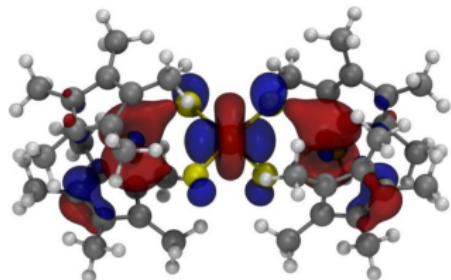
- Easily malleable and great conductors of heat and electricity
- High melting points except mercury (liquid at Room temperature)
- High densities
- Oxidation states (ability to gain/lose electrons) can vary between 1+ to 6+

Actinides and Lanthanides

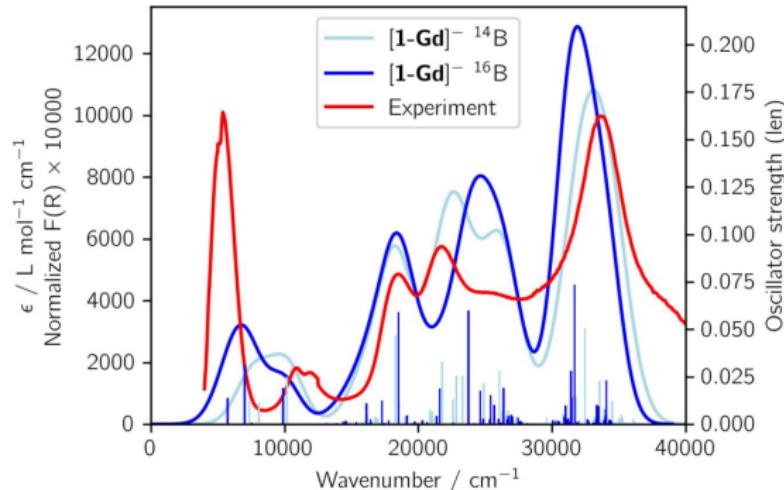


- Radioactive due to instability
- Silvery/silvery-white luster in metallic form
- Potential application to quantum computers and nuclear power
- Oxidation states can range from 2+ to 7+

Materials for Quantum Computing: Lanthanide Complexes

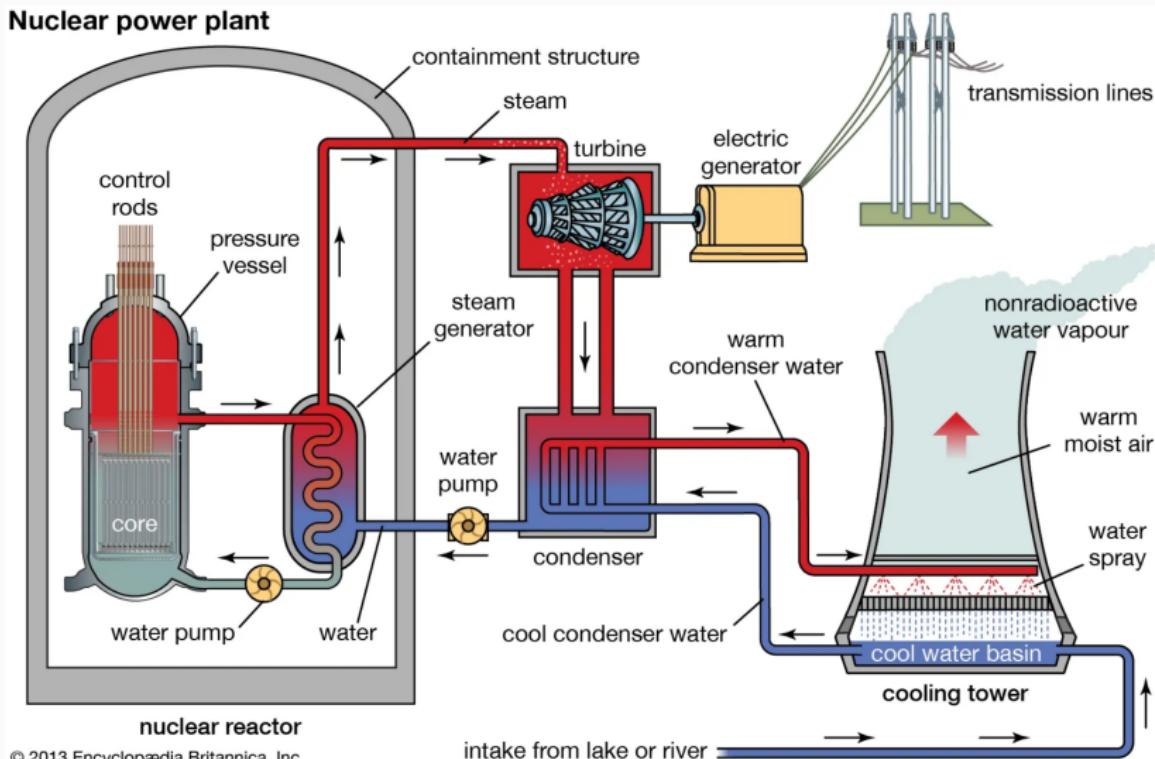


[1-Gd]⁻¹ HOMO



- Understanding the electronic structure
- Hysteresis - electronic spin memory
- Lanthanide MoS₄ research article

Nuclear Power Plants



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Halogens

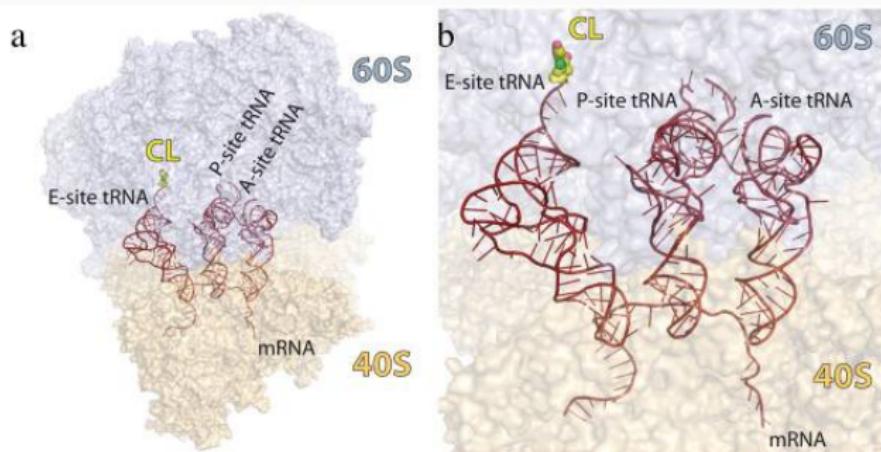
- Fairly toxic and form acids when combined with hydrogen
- Readily react with metals to form salts e.g. NaCl
- Important for drug development due to their “sticky” nature
- Prefers to gain an electron

Cancer Therapeutics



- 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