Periodic Trends and a Medical Mystery

1. What properties of elements can be determined from the periodic table?
2. How do trends in the periodic table explain George Decker's death?

4-1 What Makes a Family of Elements?

Objectives:

- Describe how the modern periodic table is organized.
- State the periodic law. Explain why elements in the same family of the periodic table have similar properties.
- Describe the characteristics of the alkali metals, alkaline-earth metals, transition metals, actinides, lanthanides, halogens, and noble gases.
- Relate the properties of various elements to their electron configurations.

FAMILIES OF ELEMENTS

Dimitri Mendeleev invented the periodic table

The Modern periodic table is based on the periodic law.

Periodic law - properties of elements tend to change with increasing atomic number in a periodic way

The periodic table can be used to determine the electron configuration of each element.

FAMILY CHARACTERISTICS

Group 18 elements are the noble gases

Noble gases - consists of gaseous, unreactive elements.

Examples: Helium, Neon, Argon, Krypton, Xenon, Radon

Group 1 is also known as the alkali metals

Alkali metals - highly reactive metallic elements which form *alkaline* solutions in water, burn in air, and belong to group 1 of the periodic table.

Examples: Lithium, Sodium, Potassium, Rubidium, Cesium, Francium

Physical Properties of Alkali Metals

Element	Melting Point ^{o}C	Boiling Point ^{o}C	Density g/cm^3	Atomic Radius
lithium	179	1336	0.53	152
sodium	98	883	0.97	186
potassium	64	758	0.86	227
rubidium	39	700	1.53	248
cesium	28	670	1.90	265
francium	27	677	unknown	unknown

Group 2 is also known as the alkaline-earth metals

Alkaline-earth metals - reactive, metallic elements which belong to group 2 of the periodic table

Examples: Beryllium, Magnesium, Calcium, Strontium, Barium, Radium

Groups 3 through 12 contain the transition elements

Transition Elements - metallic elements that have varying properties and belong to group 3 through 12 of the periodic table

Examples:

Galvanize - to coat with a protective layer of the metal zinc (prevents rusting).

Lanthanides - shiny, metallic elements with atomic numbers 57 through 71 that fill the 4f orbitals.

Actinides - metallic elements with atomic numbers 89 through 103 that fill the 5f orbitals

Coinage metals - copper, silver, gold

Main block elements include groups 13 through 18

Main block elements - elements that represent the entire range of chemical properties and belongs to groups 1,2, and 13 through 18 in the periodic table.

Halogens - elements that *combine with most metals to form salts* and that belong to group 17 of the periodic table.

One element forms its own chemical family

Hydrogen

4-2 What Trends are Found in the Periodic Table?

Objectives:

- Describe the trends seen in the periodic table with respect to atomic radius, ionization energy, electron affinity, and electronegativity.
- Relate trends of the periodic table to the atomic structures of the elements.

PERIODIC TRENDS

The periodic table contains vertical and horizontal trends

Laser Disk: Lithium Sodium Potassium

Atomic radius increases within a family

Atomic radius - one-half the distance from center to center of two like atoms

Atomic radius increases as you progress down through the elements in each group

Comparing Atomic Radi

Shielding Effect - the reduction of the attractive force between a nucleus and its outer electrons due to the blocking effect of inner electrons.

Atomic size decreases from left to right across a period

Ionization energy follows a periodic trend

Electron affinity decreases within a family and increases within a period

Electronegativity decreases within a family and increases within a period

4-3 How are Elements Created?

Objectives:

- Distinguish between naturally occuring and synthetic elements.
- Describe how the naturally occuring elements are formed.
- Explain the term nuclear reaction.
- Explain how scientists use particle accelerators to create synthetic elements.

THE ORIGINS OF NATURALLY OCCURING ELEMENTS

Natural and synthetic elements are created in different ways

Elements are created through nuclear <u>fusion</u> *vs. nuclear <u>fission</u>*

Nuclear reaction -

$E = m c^2$

THE ORIGINS OF SYNTHETIC ELEMENTS

The first artificial isotope was created in 1919

What are artificial isotopes used for?

4-4 Can Atoms Be Counted or Measured?

Objectives:

- Explain the relationship between atomic mass and atomic mass units.
- Use a periodic table to determine the average atomic mass for an element.
- Use the mole as a counting unit for large numbers of atoms.
- Solve problems with conversions between moles, Avogadro's number, and molar mass.
- Calculate the mass of a single atom.

FINDING MASS MEASUREMENTS IN THE PERIODIC TABLE

Atomic mass is expressed in atomic mass units *(amu's)*

Atomic mass unit - one-twelfth the mass of the carbon-12 isotope

Atomic mass - the mass of an atom in atomic mass units

The periodic table lists average atomic mass

Sample Problem 4A: *Calculating Average Atomic Mass*

4A: Copper has two naturally occurring isotopes: copper-63 and copper-65. The relative abundance of Cu-63 is 69.17%; the atomic mass of Cu-63 is 62.94 amu. The relative abundance of Cu-65 is 30.83%: its atomic mass is 64.93 amu. Determine the average atomic mass of copper.

63.55 amu

THE MOLE

The mole is a huge number

Mole - the fundamental SI unit used to measure the amount of a substance

Avagadro's number - 6.022×10^{23}, the number of particles in a mole

Moles can be converted to number of atoms and vice versa

Sample Problem 4B: *Converting moles to numbers of atoms*

4B: Determine how many atoms are present in 2.5 moles of silicon.

- List what you know

- Set up the problem

- Calculate and verify

Exercise 1. How many atoms are present in 3.7 moles of sodium?

Exercise 2. How many atoms are present in 155 moles of arsenic?

Sample Problem 4C: *Converting number of atoms to moles*

4C: Convert 3.01×10^{23} atoms of silicon to moles of silicon.

- List what you know

- Set up the problem

- Calculate and verify

Exercise 3. How many moles of xenon are equivalent to 5.66×10^{26} atoms?

Exercise 4. How many moles of silver are equivalent to 2.888×10^{15} atoms?

Moles can be converted to mass and vice versa

Sample Problem 4D: *Converting moles to mass*

4D: Determine the mass in grams of 3.50 moles of the element copper.

- List what you know

- Set up the problem

- Calculate and verify

Exercise 5. 3.8 moles of F

Exercise 6. 8.95 moles of Ba _____

Exercise 7. 0.655 mole of Fe _____

Sample Problem 4E: *Converting mass to moles* _____

4E: Determine the number of moles represented by 237 g of copper.

- List what you know

- Set up the problem

- Calculate and verify

Exercise 8. Find the mass in grams of 8.6 moles of bromine.

Exercise 9. Find the mass in grams of 7.55 moles of silicon. _____

Exercise 10. How many moles are in 38 g of carbon? _____

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Exercise 11. How many moles are in 2 g of hydrogen?

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The average mass of atoms can be calculated from molar mass

Sample Problem 4F: *Finding the mass of an atom*

4F: Find the mass of a single silicon atom.

- List what you know

- Set up the problem

- Calculate and verify

Exercise 12. Find the average mass of hydrogen atoms in grams.

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Exercise 13. Find the average mass of europium atoms in grams.

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