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7.1 Development of Periodic Table

- 1790s, Antoine Lavoisier compiled a list of 23 elements

- 1860, chemists agreed upon a method for accurately determining the atomic masses of the elements.

- 1864, John Newlands proposed that when the elements were arranged by increasing atomic mass, their properties repeated every eighth element; a pattern such as this is called periodic because it repeats in   a specific manner.

- 1869, Dmitri Mendeleev and Lothar Meyer each demonstrated a connection between atomic mass and elemental properties. Mendeleev is given more credit than Meyer because he published his   organization scheme first and better demonstrated its usefulness.

- 1870, there were approximately 70 known elements;

Mendeleev

- Noticed that when the elements were ordered by increasing atomic mass, there was a periodic pattern in chemical and physical properties.

- Elements in vertical columns showed similar properties. It correctly predicted the existence and properties of undiscovered elements.

- In order to group elements with similar properties in the same columns, Mendeleev had to leave some blanks for the unknown elements

- Mendeleev corrected the atomic masses of many elements
- Mendeleev sometimes broke the pattern of increasing atomic masses in order to keep the elements with similar properties in the same column.
- Made successful prediction of the existence of 3 new elements.

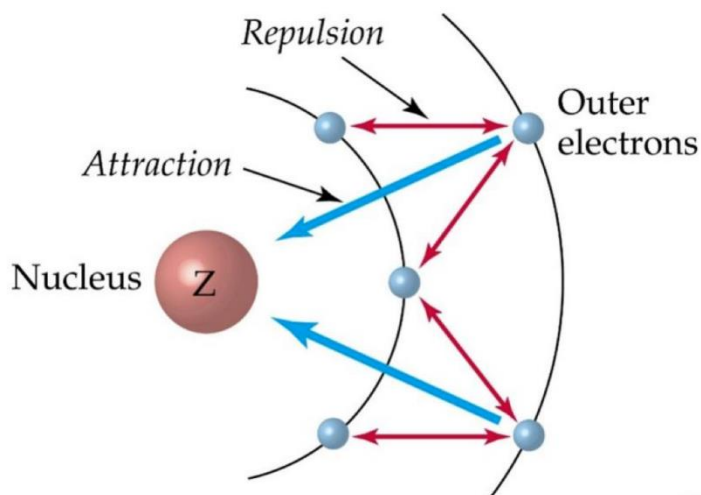| Group	I R₂O H	II RO	III R₂O₃	IV RO₂	V R₂O₅	VI RO₃	VII R₂O₇	VII RO₄
	Li	Be	B	C	N	O	F	
	Na	Mg	Al	Si	P	S	Cl	
	K	Ca	eka-	Ti	V	Cr	Mn	Fe, Co, Ni
	Cu	Zn	eka-	eka-	As	Se	Br	
	Rb	Sr	Yt	Zr	Nb	Mo	—	Ru, Rh, Pd
	Ag	Cd	In	Sn	Sb	Te	I	
	Cs	Ba	Di	Ce	—	—	—	
	—	—	—	—	—	—	—	
	—	—	Er	La	Ta	W	—	Os, Ir, Pt
	Au	Hg	Tl	Pb	Bi	—	—	
	—	—	—	Th	—	U	—	

Modern Periodic Table

- In 1913, Henry Moseley's arrangement of elements by **atomic number** resulted in a clear periodic pattern of properties.

7.2 Effective Nuclear Charge

- In a many-electron atom, electrons are both attracted to the nucleus and repelled by other electrons.
- The **valence electrons** experience less attraction to the nucleus because of repulsions of core electrons
- **Shielding effect**: The repelling effect that inner electrons have on outer (valence) electrons, resulting a decrease in the amount of attraction felt by the valance electrons from the nuclear charge(Z).
- Effective nuclear charge refers to the charge felt by the outermost (valence) electrons of a multi-electron atom after the number of shielding electrons that surround the nucleus is taken into account.
- Z_{eff} felt by outermost electrons is smaller than that felt by inner electrons because of screening by the inner electrons.
- Inner electrons have larger impact on screening than the outermost electrons
- Z_{eff} decreases in the order s, p, d, f, for the electron on the same principal energy level.
- Z_{eff} increases from left to right across any period;

- Going down a column, Z_{eff}, increase slightly, because the more diffuse core electron cloud is less able to screen the valence electrons from the nuclear charge.

7.3 Sizes of Atoms and Ions

- The bonding atomic radius is defined as one-half of the distance between covalently bonded nuclei.

  o **We usually use this bonding radius to determine atomic radius**. Atomic radius cannot be directly measured because atoms do not have a clear edge distinguishing what counts as the atom and what doesn't(electron cloud is diffuse and electrons can move in a large area, cannot be simply defined by a circular border.)

- Extension: the nonbonding radius is one-half the distance between two atoms attracted by intermolecular forces(no bonding in between).

What Affects Atomic Size?

- Nuclear Charge: The attraction from the nucleus (remember that nucleus contains protons, which is positively charged). **The protons attracts the electrons. More protons, more attraction, electrons pulled closer to the nucleus.**

- Electron-electron repulsion/Shielding: The repulsion between electrons. This is not limited to the repulsion of core electrons to valence electrons. Theoretically, valence electrons can also repel valence electrons, and even outer electrons can repel inner electrons. However, in calculation of Z_{eff}, we usually do not take such into consideration. **The core electrons repel the valence electrons, pushing them further away from the nucleus.**

- The principal quatum number: The number of shells. When n=3, the atom has 3 shells. When there is more shells, naturally, the atom is larger.

Trends in Atomic size

- Decreases from left to right across a period

- o   In a same period, the number of core electrons is the same and the number of shells is the same. Thus, the only possible factor affecting the atomic size would be nuclear charge. **Notice that atomic number increases from left to right across a period, meaning the protons increases, and hence nuclear charge increases, pulling electrons closer and closer.**
- Increases down a group
  - o   Higher principal quantum level. More core electrons meaning more e-e repulsion. In general, the valence shell is pushed outwards and further from the nucleus.

Trends in Ion Size
- Isoelectronic Series: the ions/atoms have the same number of electrons in the series.
  - o   e.g. F^-,Ne,Na^+,Mg^{2+}
  - o   In this case, lesser the protons, larger the ion/atom size. In the isoelectronic group above, F^- ion have 9 protons, the least in this group. Hence, it is the largest ion.
- Same element, atom vs ion
  - o   e.g. Al,Al^{3+}
  - o   e.g. F^-,Ne,Na^+,Mg^{2+}
- If cation(+): the ion loses electrons so its smaller. If anion(-): the ion gain electrons so its larger
- Same charge, same group
  - o   e.g. F^-,Cl^-,Br^-
  - o   Larger down a group. Same as atomic trend down a group. e-e repulsion increases.

Chapter 1 Significant Figures
- Number of figure significant used in calculation, affects rounding.
  - o   0s before the **first digit** that is 1-9 is not significant
  - o   0s after the **last digit** that is 1-9 and having no decimal points is not significant. e.g. 900 has 1 sig fig
  - o   0s after the **last digit** that is 1-9 but have decimal points afterward is significant. e.g. 900. has 3 sig figs
  - o   all digits from 1-9 is significant.

Calculation with Sig Figs
- Addition/Subtraction: Compare the smallest digit of the numbers. Round to the larger one after calculation.
  - o   e.g. 3.0 (tenths) + 6.72 (hundredths) we round to tenths. so 3.0+6.72=9.72=9.7
- Multiplication/Division: Compare the number of sig figs. Round to the smaller number of sig figs.

Error and Uncertainty

- Error: how far is the experimental result away from the actual value.(accuracy)
- Uncertainty: degree of how precise is the measurement.(precision)

Error in Experiments

- Random Error : result of poor precision.
    - Depends on the precision of measuring instrument. A ruler with 1cm as smallest unit compared to a ruler with 0.1cm as smallest unit, the 1cm one has less precision and thus yields larger random error.
- Systematic Error
    - Misprocedure during experiment, miscalibrated error, parallax error, zero error.

Calculations with uncertainty and error

- Absolute uncertainty: Scaled measurement: divide least count by 2 Digital: least count

only 1 sig fig

- Error: [measured-correct]absolute value
- Percent uncertainty: divide absolute value by measurement.
- Percent error: divide absolute value by correct value.

Adding and subtracting: add numerical uncertainty

$$c = a + b$$
$$or \qquad\qquad \Delta c = \Delta a + \Delta b$$
$$c = a - b$$

Multiplying or Dividing: add fractional/percentage uncertainty

$$c = a \times b$$
$$or$$
$$c = a/b$$

$$\frac{\Delta c}{c} = \frac{\Delta a}{a} + \frac{\Delta b}{b}$$

$$\frac{\Delta c}{c} \times 100 \ \% = \frac{\Delta a}{a} \times 100 \ \% + \frac{\Delta b}{b} \times 100 \ \%$$

Powers are "multiple multiplications"

$$c = a^N \qquad \frac{\Delta c}{c} = |N| \times \frac{\Delta a}{a}$$

Conversion Factors

- **Infinite number of sig figs**
    - Multiplied to a value in the form x/y while the value equals to 1, so you ain't adding anything more to the original value.
    - Two examples, the bolded value is what we are trying to convert:

- **1m** x (100cm/1m) note that we must have a "1m" in our conversion factor. To cancel it out, put it on the denominator.
- 1g/**1L** x (1L/1000mL) note that we must have a "1L" in our conversion factor. To cancel it out, put it on the numerator.