(2) Atomic Structure Notes

Basics

$^{A}_{Z}X$ → A = Mass Number, X = element symbol, Z = Proton Number

Date No.

Mass No: Total number of neutrons and protons
Proton No: Total number of protons in an atom
Isotope → an atom with a different number of neutrons than an atom of the same element, but same proton + electron number. Diff physical but same chemical properties

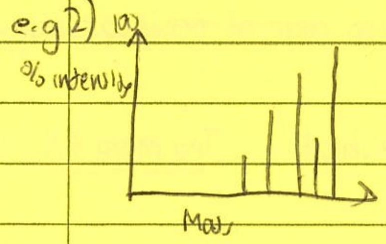
Isotopes

→ Different physical properties (e.g mass/density / rate of diffusion) because isotopes vary in mass
→ Same chemical properties because electrons define chemical properties
→ Calculating Relative Atomic Mass

e.g 1) Rb has 72.1% of Rb-85 and 27.9% of Rb-87. Find the RAM of Rb

72.1% (85) + 27.9% (87) = 85.5

e.g 2)



1) add up all % intensities
~~2) Divide each mass by intensity~~
2) Divide sum of masses by total intensity

Uses of Radioisotopes

1) Carbon Dating → C14 is in organic matter, number of C-14 atoms present related to half life of C-14 will provide the age of the matter
2) Treating Cancer → Co-60 produces gamma rays. Can cause mutations and deaths of healthy cells
3) Tracing → I-125 is used to test thyroid activity. I-131 kills thyroid tissue

Mass Spectrometry

→ a tool that allow chemists to compare the masses of 2 different particles and measure ~~of~~ the abundance of the particles

Electron shells

→ As you go up shells, energy increases, as the shells converge
→ Electrons in a shell = $2n^2$
→ Applying heat/electricity/light to an electron causes it to jump up to a higher shell of higher energy. After energy is lost, the electron moves down to its ground state (original shell), releasing energy as an electromagnetic wave (photon)

Date No.

→ If enough energy is applied, the electron goes to N ∞ (out of atom), ionising the atom in the process → gap between shells non-existent

<u>First Ionisation Energy</u>: Energy needed to remove 1 mole of electrons from a mole of an atom in gaseous state.

<u>Factors affecting FIE</u>

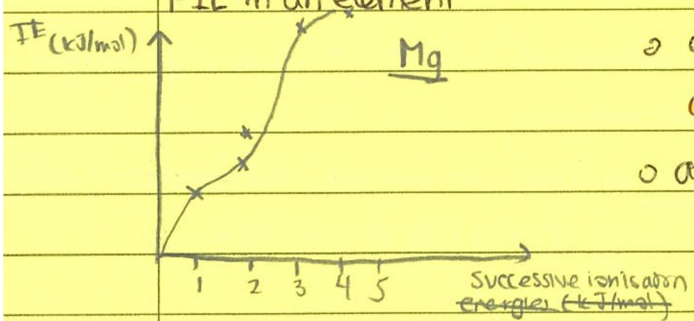
1) Number of protons → ↑ proton no, ↑ FIE because stronger forces of attraction hold the electron to be lost in place, hence more energy must be used to break the forces of attraction holding the electron in place

2) Distance from Nucleus, ↓ ionic radius, ↑ FIE, less dist from area of positive charge density (nucleus), hence forces of attraction increase, ∴ ↑ FIE

3) Shell that valence electron is in. ↑ n, ↓ FIE, more dist from area of positive charge density hence forces of attraction ~~increase~~ decrease, ↓ FIE

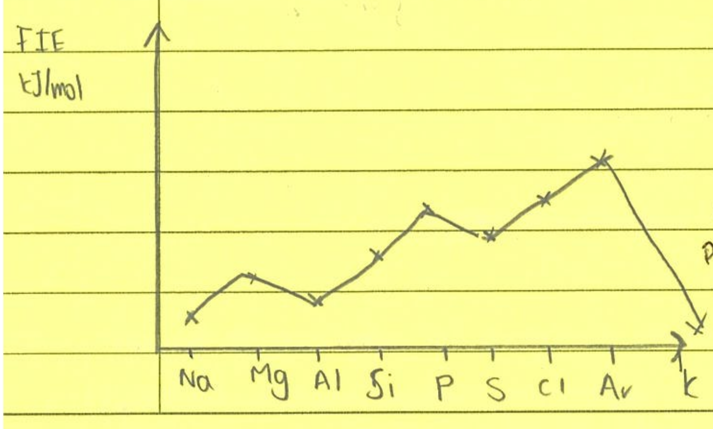
4) Shielding: Repulsive effect from electrons of same spin repelling each other. The more full shells you have, ↑ shielding, ↑ repulsion, ∴ ↓ FIE

<u>FIE in an element</u>



- at FIE (2) → increase because now electron removed from cation, ↑ attractive forces. Also ↓ ionic radius, ∴ ↑
- at FIE (3) → big jump because at n=2 now, lower energy level where electron closer to nucleus

FIE across Period 3



- G... FIE
- Pr... n nucleus, n=4 ↓
  aff...
- De... rther from positive nuc... weaker
- De... ectrons of
  ~~sa~~...

Decrease at S because the p subshell have 3 electrons of the same spin that generate a repulsive effect on the electron to be lost, culminating in a reduced FIE

Drop at Al because ~~have~~ 1 e^- lost from p, further from nucleus, ↓ forces of attraction

Date No.

Calculating FIE

$E = h\nu$ ← frequency (1/s)

↑ energy ↖ Planck's constant (6.63×10^{-34})

only for FIE ↓

$$E = \frac{hcL}{\lambda} = \frac{6.63\times10^{-34} \times 3\times10^{8} \times 6.02\times10^{23}}{\text{wavelength}} = \frac{\text{Planck} \times \text{speed of the flash} \times \text{Avogadro}}{\text{wavelength}}$$

$c = \nu\lambda$ ← wavelength

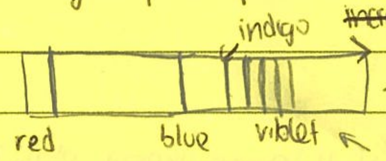
↑ 3×10^{8} ↑ frequency

Emission Spectrum / Absorption Spectrum

→ When electromagnetic radiation (clow) is passed through a collection of atoms, the electrons move to higher shells and when they return to ground state, varying electromagnetic waves are released and a spectrometer analyses it ~~back~~ relative to incident radiation (absorption spectrum produced)

→ hydrogen absorption spectrum
→ black lines on a continuous visible light ~~background~~ spectrum

→ When ~~to~~ white light is passed through hydrogen gas, an emission spectrum is produced when high voltage is ~~plac~~ produced.



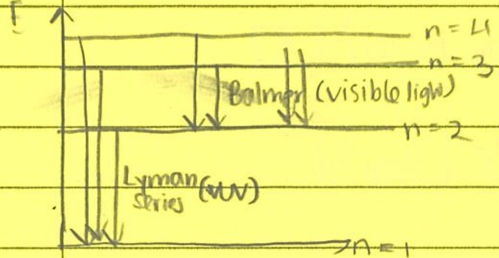
~~increasing~~ decreasing wavelength

→ emission spectrum for H_2

→ black background with coloured, converging lines

↖ light of shorter wavelength converges due to increased photon energy

Made of ~~discreet~~ discrete lines, is because the atoms are made of ~~de~~ discrete energy levels and lines converge to the end, representative of the converging electron shells also because data is quantised



← lines converge because energy levels converge

Lyman → anything to n=1

Balmer → anything to n=2

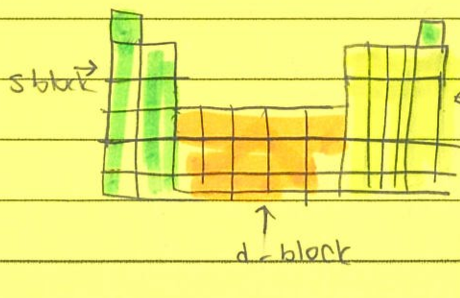
Sublevels

S – ~~2~~ 1 orbitals

P – 3 orbitals

d – 5 orbitals

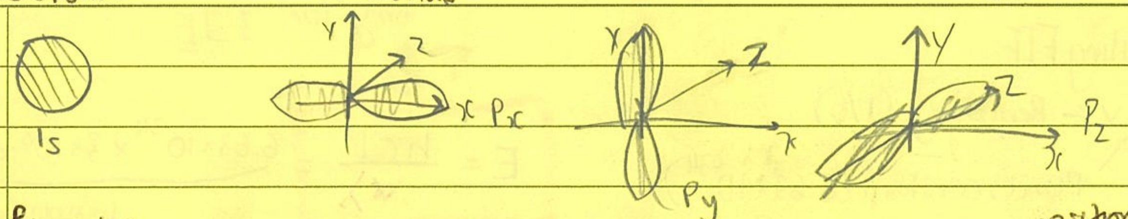
f – 7 orbitals



→ elements where S is being filled

→ elements with p orbitals being filled

S orbital P orbitals Date No.



Principles

1) Heisenberg's Uncertainty Principle → we cannot know both the speed or ~~condition~~ position of a body without changing one of those properties
2) Pauli Exclusion Principle – No 2 electrons can have the same quantum numbers, hence 2 electrons can be in the same orbital but have opposite spins
3) Hunds Law: For degenerate orbitals (equal energy), lowest energies are obtained when the number of electrons having the same spin is maximised
4) Aufbau Principle: Electrons fill orbitals from lowest to highest energy levels.

Electronic Configuration

- In boxes with ↑ arrow representing +spin and ↓ arrow = −spin
- For Magnesium → $1s^2 2s^2 2p^6 3s^2$ or 1s [↑↓] 2s [↑↓] 2p [↑↓|↑↓|↑↓] 3s [↑↓] or Ne $[3s^2]$

For Oxygen → $1s^2 2s^2 2p^4$ → 1s [↑↓] 2s [↑↓] [↑↓|↑|↑] 2p

Exceptions

Copper is ~~4~~ [Ar] $4s^1 3d^{10}$ because a full d shell lowers energy, stabilising the atom. Chromium is [Ar] $4s^1 3d^5$ because all d orbitals have at least 1 electron, ↑ stability

Continuous vs ~~Discrete~~ Line Spectra

→ Continuous: contains all colours [wavelengths, frequencies energies] of VI

→ Discrete: quantised data

Note: transition metals ~~m~~ lose $\bar{e}$ from 4s first [higher E], then 3d