

3.1 Physical Chemistry

includes:

- atomic structure
- amount of substance
- structure and bonding
- energetics
- kinetics
- equilibria
- redox

(the following are A2 only)

- thermodynamics
- rate equations
- Kp
- electrode potentials
- acids and bases

3.1.1 Atomic Structure

Section: Completed?

fundamental particles yes

mass number, isotopes no

electron configuration yes

Fundamental Particles

plum pudding model a sphere of positive charge with balls of negative charge embedded within: essentially looks like a plum pudding

electron shell model small, dense positive charged nucleus with protons and neutrons; electrons orbit in shells

Rutherford's gold foil experiment (Geiger-Marsdon experiment)

shot alpha particles through thin gold foil

- vast majority pass through

- few deflected by large angles

- ~1/10000 deflected back to side it came from

Rutherford's conclusions

- nucleus is small, positive, dense, massive (heavy)

- most of the atom is empty space

relative mass proton/neutron = 1; electron = 1/1840

relative charge proton = +1; neutron = 0; electron = -1

Electron Configuration (1.1)

four atomic orbitals s, p, d, f

s orbitals are spherical

p orbitals are dumbbell shaped

(go practice some of [these questions](#) on paper)

spin electrons in same orbital have opposite spin

first ionisation energy *energy required to remove 1mol of electrons from 1mol of gaseous atoms*

always refer to "1 mole"

lower ionisation energy = easier to form ion

general equation (ionisation energy) $X_{(g)} \rightarrow X^+_{(g)} + e^-$

state symbols are important!!

factors affecting ionisation energy:

> nuclear charge more protons = more positively charged = stronger e^- attraction = higher ionisation energy

> distance from nucleus e^- closer to nucleus = stronger attraction = higher ionisation energy

> shielding higher num orbitals between nucleus and outer e^- = weaker attraction = lower ionisation energy

trends in ionisation energy

down a group: decreases

> each element down a group has an extra e^- shell

Electron Configuration (1.1) (cont)

- extra inner shells shield outer e^- from attraction to nucleus

- extra shells also mean outer e^- are further from nucleus

across a period generally increases

> proton num increasing

- which means there's a stronger nuclear attraction

> little extra shielding or nuclear distance

- as all elements across period have same number of shells

(across a period cont) focusing on period three elements

dip between group 2 and 3 ie between Mg and Al

Mg is $1s^2 2s^2 2p^6 3s^2$

Al is $1s^2 2s^2 2p^6 3s^2 3p^1$

Al outer e^- is in 3p orbital

- 3p has a slightly higher energy level so is slightly further from nucleus

- shielded by 3s orbital

so ionisation energy drops slightly

provides evidence for electron subshell theory

dip between group 5 and 6 ie P and S

P is $1s^2 2s^2 2p^6 3s^2 3p^3$

S is $1s^2 2s^2 2p^6 3s^2 3p^4$

Electron Configuration (1.1) (cont)

e^- from S is being removed from orbital with two e^-

repulsion between e^- in same orbital means e^- are easier to remove

(P has single occupied orbital so no added repulsion)

equations and associated calculations

Mass num, Isotopes (1.1)

mass num (A) = num protons + num neutrons

=

atomic num (Z) = num protons

=

isotope atom with same number of protons but a different number of neutrons

mass spectrometry

stage 1: ionisation

the sample can be ionised by either *electrospray* or *electron impact*

electrospray Sample (X) is dissolved in violent solvent; injected through a hypodermic needle to produce a fine mist; tip of needle is attached to positive terminal of high voltage power supply; ionised by gaining a proton; solvent evaporates; XH^+ ions attracted to negative plate - accelerated

electron impact sample (X) is vaporised; high energy electron fired from electron gun - knocks off one outer shell electron from each particle; 1^+ ions attracted to negative plate - accelerated

stage 2: acceleration



Mass num, Isotopes (1.1) (cont)

positive ions accelerated using electric field so all ions have the same kinetic energy (E_k)

$$E_k = \frac{1}{2}mv^2 \quad (E_k = \frac{1}{2} * \text{mass} * \text{velocity}^2)$$

lighter ion = higher velocity

stage 3: flight tube (drift region)

lighter ions move faster than heavier ones (E_k is the same)

lighter ions reach the detector first

$$s = vt \quad (\text{distance} = \text{velocity} * \text{time})$$

stage 4: detection

positive ion hits negatively charged plate

ion gains an electron

why use mass spec?

moles, Avagadro const

Avogadro constant number of particles in a mole

empirical and molecular formula

empirical formula simplest whole number ratio of atoms of each element in a compound

molecular formula actual number of atoms of each element in a compound

3.1.2 Amount of Substance

Section:	Completed?
Mr, Ar	yes
moles, Avogadro const	no
ideal gas equation	no
empirical and molecular formula	no
equations and associated calculations	no

Ar, Mr (1.2)

relative atomic mass (Ar) mean mass of an atom of an element divided by $\frac{1}{12}$ mean mass of atom of C^{12} isotope

relative molecular mass (Mr) mean mass of molecule of a compound divided by $\frac{1}{12}$ of mean mass of an atom of C^{12}

known as relative formula mass for ionic compounds

ideal gas equation

equation: $pV = nRT$

3.1.3 bonding

Section:	Completed?
ionic	no
covalent, dative covalent	no
metallic	no
physical properties	no
shapes of molecules and ions	no
bond polarity	no
forces between molecules (imf)	no

