Reactions and Stoichiometry Cheat Sheet

by yams-miny via cheatography.com/124058/cs/23637/

Formulae

Relative Isotopic Mass

> Mass of 1 atom of an isotope of an element / 1/12 the mass of 1 atom of carbon-12 isotope

Relative Atomic Mass

> Avg mass of 1 atom of an element / 1/12 the mass of 1 atom of carbon-12 isotope

Relative Molecular/Formula Mass

> Avg mass of 1 molecule/formula unit of a substance / 1/12 the mass of 1 atom of carbon-12 isotope

Mr

> Sum of Ar of atoms in the molecular formula

Empirical Formula

> Simplest formula which shows ratio of atoms of different elements in the compound

Molecular Formula

> Formula which shows actual number of atoms of each element in one molecule of the compound

Relative formula mass is used for ionic compounds
Relative masses have no units as they are ratios of 2 masses

Calculations using Volume of Gases

Avogadro's Law:
Equal volume of all gases, under the same temperature and pressure, contain the same number of particles (atoms or molecules)
Gases in a balanced equation: Volume ratio = Mole ratio
Molar Volume, Vm:
Volume occupied by 1 mole of the gas at a specific T&P
Standard T&P : 273K (0 degree celsius), 1 bar (100 kPa), 22.7dm^3/mol
Room T&P: 293K (20 degree celsius), 1 atm (101 kPa), 24 dm^3/mol

Volumes of gases are dependent on T&P hence these conditions must be specified

Stoichiometry

Stoichiometry: Quantitative aspects of chemical formulae & reactions
Limiting reactants are completely consumed in the reaction and limit how much products can form.
Percentage Yield =

Stoichiometry (cont)

Actual yield/mass or amount of product formed /
Theoretical yield/mass or amount of product formed
x 100%

Types of Reactions

Precipitation Reaction	Reactions which involve formation of insoluble solid (ppt) from reaction of 2 solutions

Types of Reactions

Precipitation Reaction	Reactions which involve formation of insoluble solid (ppt) from reaction of 2 solutions, Separation by filtration or decanting
Thermal Decomposition	Chemical reaction caused by heat, Compounds break down into 2 or more substances
Acid-Base	Elaboration in a later segment
Redox	Elaboration in a later segment

Calculations using Concentrations

When a solute is dissolved in a solvent, a solution is formed
If the solvent is water, an aqueous solution is formed
The concentration of a solution (mol dm^-3) shows the amt of solute dissolved in a given volume of solution
Standard solution: Solution whose concentration is accurately known
[X] - Amt of X (mol) / V of solution (dm^3)
No of moles of solute, n:
- [solute] (mol $dm^{-3)}$ X Volume (dm^3)
- Mass of X (g) / Molar mass of X (g/mol)
When a solution is **diluted** (by adding more solvent), the concentration of the solution decreases but no. of moles of solute in the diluted solution remains unchanged

$1dm^3$ = $1000cm^3$

Acid-Base Reactions

Arrhenius Theory of Acids & Bases

- An acid is a substance that dissociates in water to produce H_3O^+(aq)
- A base is a substance that dissociates in water to produce OH^- (aq)

Neutralisation: H^+ (aq) + OH^-(aq) -> H_2O (l)

Limitation: Aqueous solutions only

Bronsted-Lowry Theory of Acids & Bases

- An acid is defined as any species which donates a proton, H^+. It must thus contain Hi n its formula
- A base is defined as any species which accepts a proton, H^+. It must contain a lone pair of electrons to bind the H^+ ions

Bronsted-Lowry acid-base reaction involves the transfer of a proton from an acid to a base. They do no occur only in aq solutions but also between gases and non-aq systems.

Acid-Base Reactions (cont)

Limitation: Does not address why substances such as BF_3 or $AlCl_3$ do not contain any H atom but are known to behave as acids

Lewis Theory of Acid & Bases

- An acid is a species that accepts an electron pair, e.g. BF_3
- A base is a species that donates an electron pair, e.g. NH_3

Lewis acid-base reaction can be viewed as a transfer of a pair of electrons from the base to the acid

Limitation: Too general

The 3 models can be used to interpret different acid-base systems

BL and L theories - Describe specific acid-base reactions

Arr theory - Whether isolated substances are acids, bases, or neither

In aqueous solution, H^+ does not exist on its own. It forms a dative bond with a water molecule to form H_3O^+, called hydronium or hydroxonium ion. Chemists often use H^+ and H_3O^+ interchangeably o refer to the elevated H^+ ion.

Best to use Bronsted-Lowry theory wherever possible for an acid-base reaction, and apply Lewis theory only when reaction does not involve proton transfer

Redox Reactions

Redox Reaction	Reaction that involves reduction and oxidation simultaneously
Reduction	Process whereby a substance gains electrons, resulting in a decrease in OSN
Oxidation	Process whereby a substance loses electrons, resulting in an increase in OSN
Reducing agent (reductant)	Substance that gives electrons to another, itself being oxidised in the process
Oxidising agent (oxidant)	Substance that takes in electrons from another, itself being reduced in the process
Disproportionation	Redox reaction in which the same substance is both oxidised and reduced

Redox Reactions (cont)

Oxidation Number (OSN)	Number of electrons to be added or subtracted from an atom in a combined state to convert it to elemental form

Acronym: OIL RIG

When writing the OSN, +/- signs must be stated before the number

Rules of Assigning OSN

Oxidation Numbers

- **Rules for Assigning Oxidation States**
- The oxidation state of an atom in an uncombined element is 0.
- The oxidation state of a monatomic ion is the same as its charge.
- Oxygen is assigned an oxidation state of –2 in most of its covalent compounds. Important exception: peroxides (compounds containing the O2 2- group), in which each oxygen is assigned an oxidation state of –1)
- In its covalent compounds with nonmetals, hydrogen is assigned an oxidation state of +1
- For a compound, sum total of ON s is zero.
- For an ionic species (like a polyatomic ion), the sum of the oxidation states must equal the overall charge on that ion.

Balancing Redox Reactions

Method 1

1. Balance elements that were oxidised or reduced
2. Balance O with H_2O
3. Balance H with H^+
4. Balance charges with electrons

Method 2

1. Balance elements that were oxidised or reduced
2. Add electrons (OSN x No of that element)
3. Balance O with H_2O

Balancing Redox Reactions (cont)

4. Balance H with H+

Method 3

1. Balance elements that were oxidised or reduced
2. Electrons gained = Electrons lost

- a x 7e = b x 2 x 1e
- Same on LHS and RHS, figure out what a and b are, multiply the relevant coefficients

3. Balance O with H2O
4. Balance H with H+

Balancing Redox Reactions

Method 1

1. Balance elements that were oxidised or reduced
2. Balance O with H2O
3. Balance H with H+
4. Balance charges with electrons

Method 2

1. Balance elements that were oxidised or reduced
2. Add electrons (OSN x No of that element)
3. Balance O with H2O
4. Balance H with H+

Method 3

1. Balance elements that were oxidised or reduced
2. Electrons gained = Electrons lost

Balancing Redox Reactions (cont)

- a x 7e = b x 2 x 1e
- Same on LHS and RHS, figure out what a and b are, multiply the relevant coefficients

3. Balance O with H2O
4. Balance H with H+