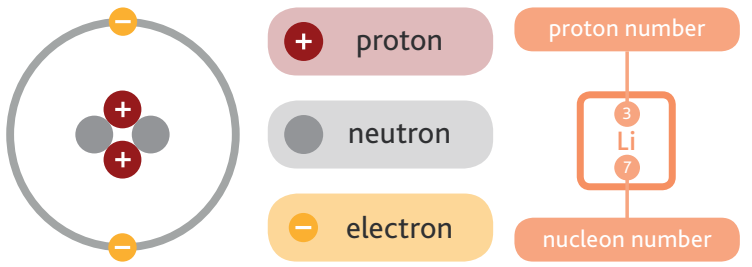
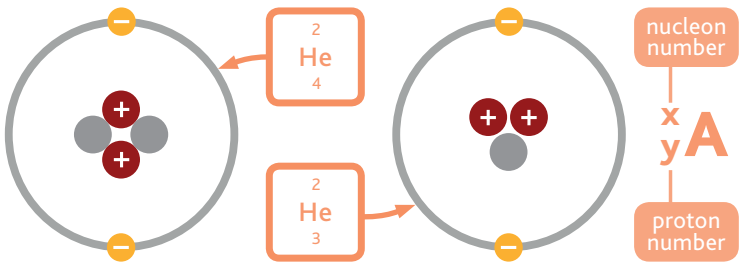
1 Particles

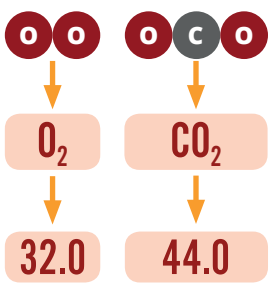


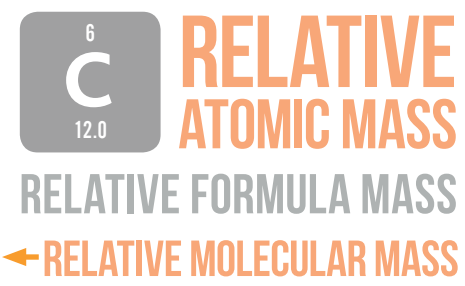
2.1 Particles in the atom KC

Subatomic particles

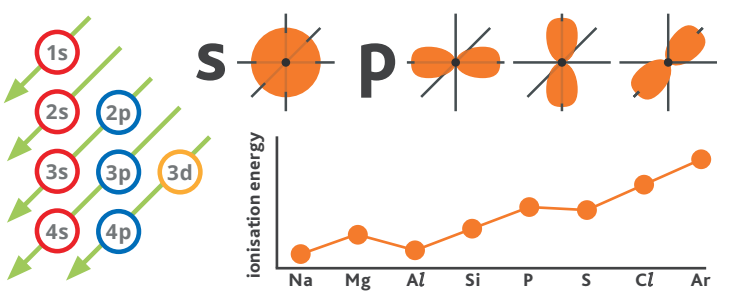


2.2 The nucleus of the atom KC

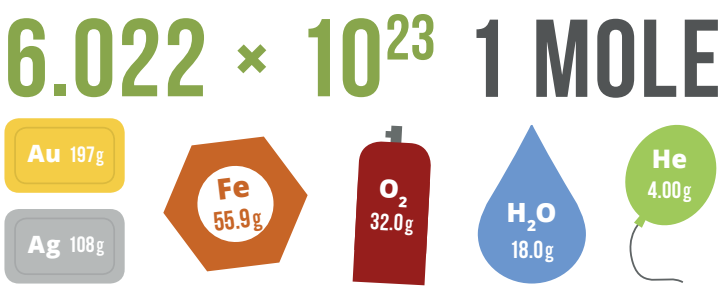




1.1 Relative masses of atoms and molecules KC

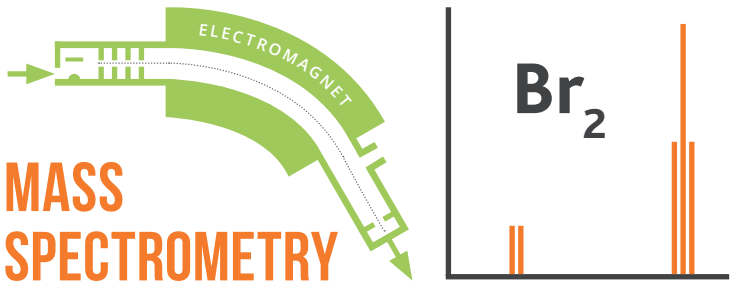


2.3 Electrons: energy levels, atomic orbitals, ionisation energy, electron affinity KC

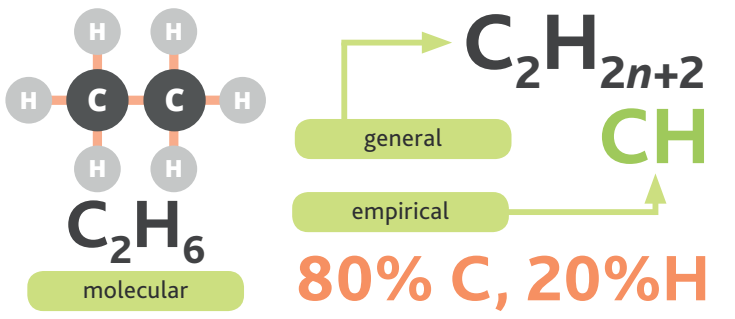


1.2 The mole and the avogadro constant KC

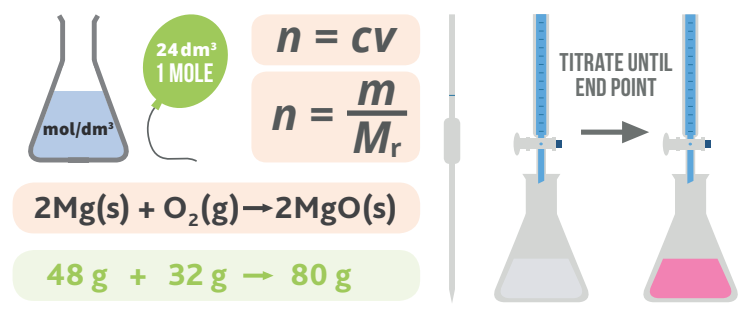
Formula mass, relative atomic mass, and moles



1.3 The determination of relative atomic masses, A_r KC



1.4 The calculation of empirical and molecular formula KC



1.5 Reacting masses and volumes (of solutions and gases) KC

Key: KC1 KC2 KC3 KC4 KC5

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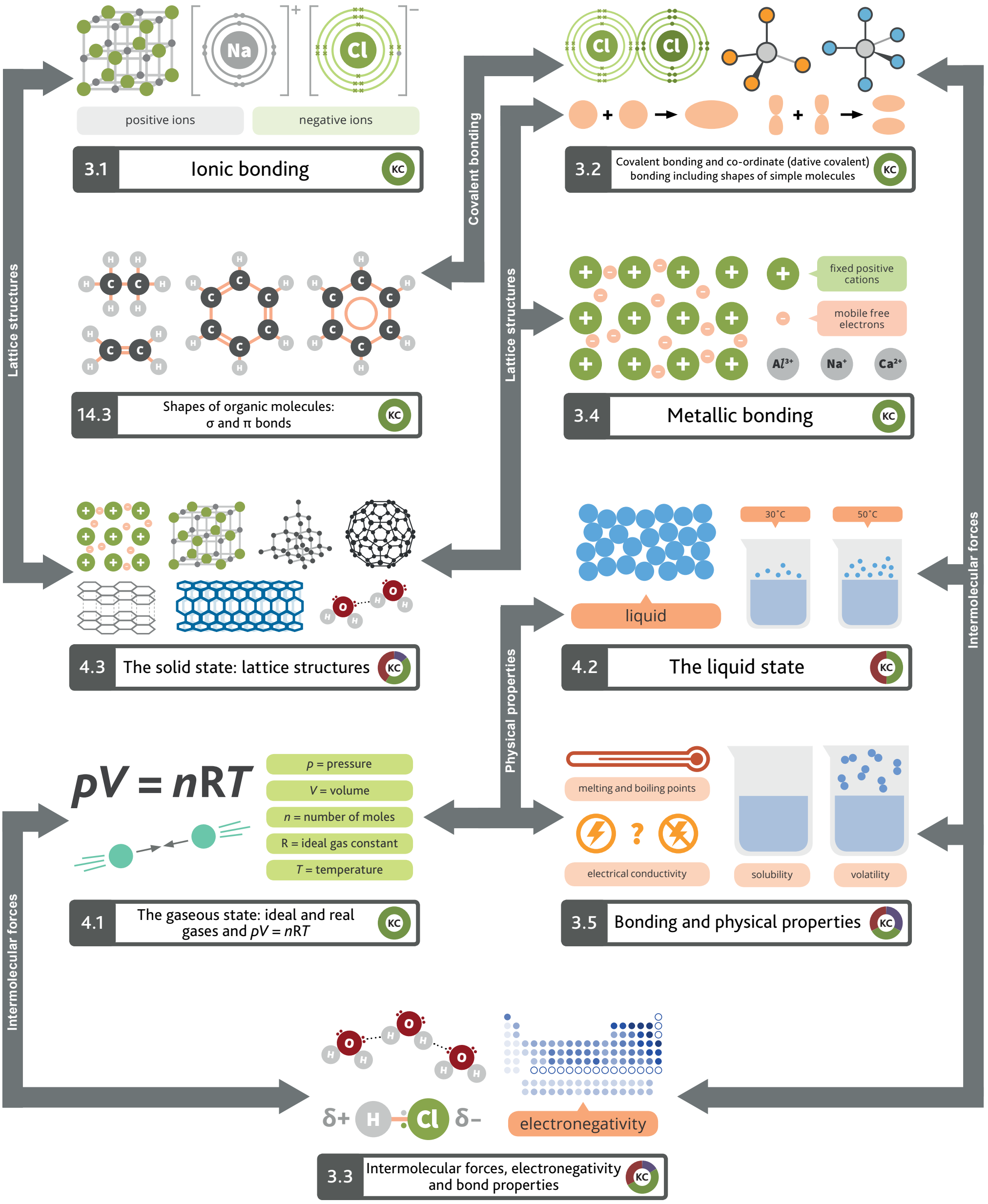
2 Bonding and structure



Key: KC 1 KC 2 KC 3 KC 4 KC 5

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3 Controlling reactions 1

Enthalpies of combustion

Bond making/breaking

Enthalpy changes

Bonds and properties

Enthalpy calculations

Fuels

Redox

Rate

Catalysts

Temperature effects

Reversible reactions

Acids

5.1 Enthalpy change, ΔH KC

3.5 Bonding and physical properties KC

3.3 Intermolecular forces, electronegativity and bond properties KC

5.2 Hess' law, including Born-Haber cycles KC

15.3 Hydrocarbons as fuels KC

13.2 Sulfur: the formation of atmospheric sulfur dioxide, its role in acid rain

6.1 Redox processes: electron transfer and changes in oxidation number (oxidation state) KC

8.1 Simple rate equations, orders of reaction and rate constants KC

8.3 Homogenous and heterogenous catalysts including enzymes KC

8.2 Effect of temperature: on reaction rates and rate constants and the concept of activation energy KC

7.1 Chemical equilibria: reversible reactions, dynamic equilibrium KC

7.2 Ionic equilibria KC

Key: KC1 KC2 KC3 KC4 KC5

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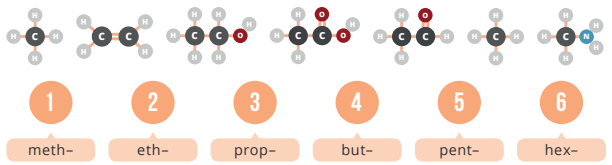
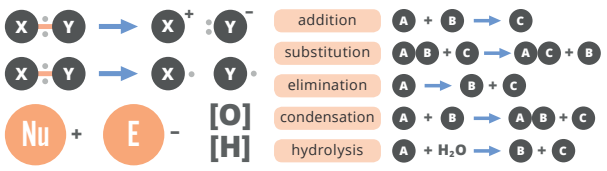
4 Organic chemistry 1



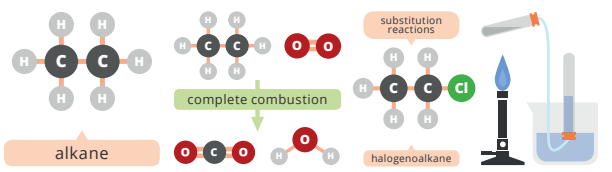
14.1 Formulae, functional groups, and the naming of organic compounds KC



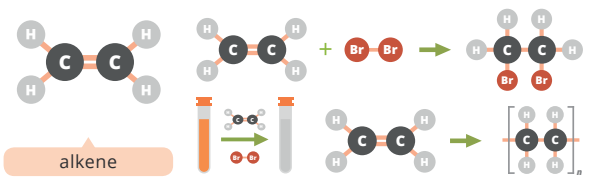
14.2 Characteristic organic reactions KC

Naming compounds

Substitution

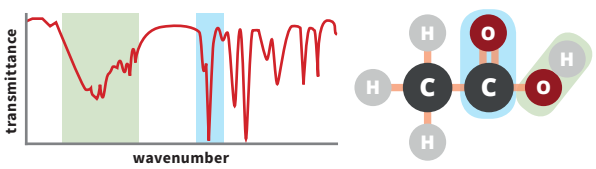


15.1 Alkanes KC

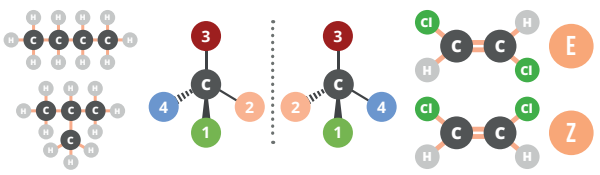


15.2 Alkenes KC

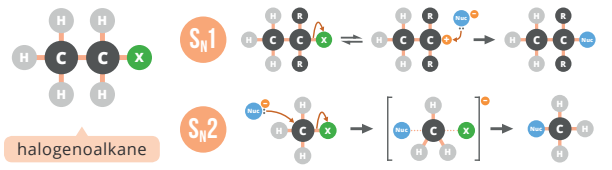
Stereoisomerism



22.2 Infrared spectroscopy KC

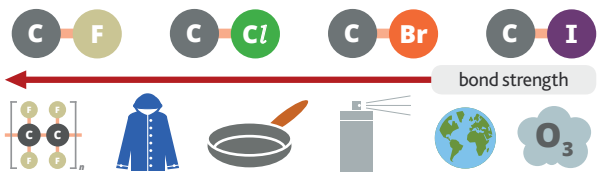


14.4 Isomerism: structural and stereoisomerism KC

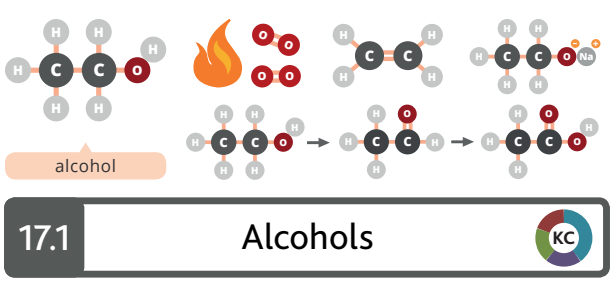


16.1 Halogenoalkanes KC

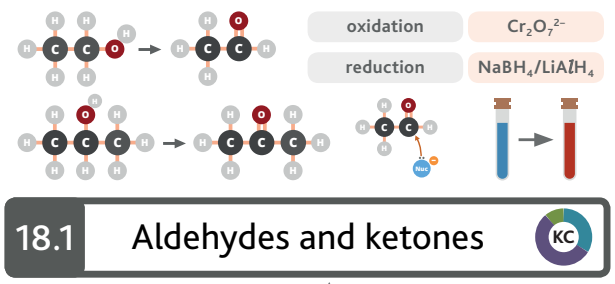
The C–Hal bond



16.2 Relative strength of the C-Hal bond KC

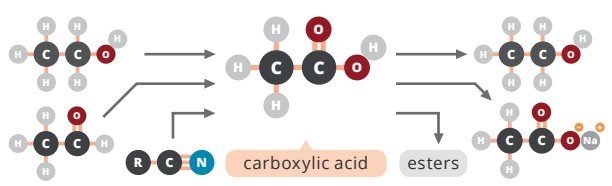


17.1 Alcohols KC



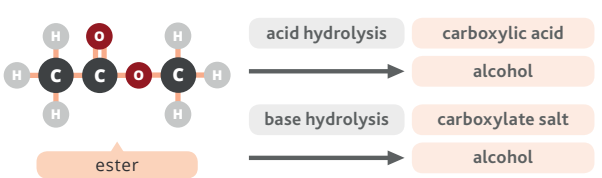
18.1 Aldehydes and ketones KC

Oxidation and reduction



19.1 Carboxylic acids KC

Esterification



19.3 Esters KC

Key: KC 1 KC 2 KC 3 KC 4 KC 5

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5 Chemical trends

Period 3

Na Mg Al Si P S Cl Ar

atomic radius

conducts electricity ✓ ✓ ✓ ✓ ✗ ✗ ✗ ✗

melting point (°C) 98 650 660 1423 44 120 –101 –189

9.1 Periodicity of physical properties of the elements in Period 3 KC

Periodic trends

ionisation energy — increases

Na Mg Al Si P S Cl Ar

2.3 Electrons: energy levels, atomic orbitals, ionisation energy, electron affinity KC

O O → Na_2O MgO Al_2O_3 P_4O_{10} SO_2 SO_3

Cl Cl → NaCl $MgCl_2$ Al_2Cl_6 $SiCl_4$ PCl_5

H O H → NaOH $Mg(OH)_2$ ACID Al_2O_3 BASE

9.2 Periodicity of chemical properties of the elements in Period 3 KC

Rb Sr Ga Ge As Se Br Kr

9.3 Chemical periodicity of other elements KC

Hydroxides

MO $M(OH)_2$ MCO_3

thermal stability: $BeCO_3$ $MgCO_3$ $CaCO_3$ $SrCO_3$ $BaCO_3$

solubility: $Be(NO_3)_2$ $Mg(NO_3)_2$ $Ca(NO_3)_2$ $Sr(NO_3)_2$ $Ba(NO_3)_2$ $Be(OH)_2$ $Mg(OH)_2$ $Ca(OH)_2$ $Sr(OH)_2$ $Ba(OH)_2$ $Be(SO_4)$ $Mg(SO_4)$ $Ca(SO_4)$ $Sr(SO_4)$ $Ba(SO_4)$

HCl

10.1 Similarities and trends in the properties of the Group 2 metals, magnesium to barium, and their compounds KC

Group 2 compounds

$CaCO_3$ $Ca(OH)_2$ soil pH

10.2 Some uses of Group 2 compounds KC

Agriculture

F F fluorine; Cl Cl chlorine; Br Br bromine; I I iodine

volatility

van der Waals' forces

11.1 Physical properties of the Group 17 elements KC

F F Cl Cl Br Br I I — oxidising ability

+ H H → H F; H Cl; H Br; H I — thermal stability; bond energies

11.2 The chemical properties of the elements and their hydrides KC

Group 17

Cl Br I — Ag^+ & NH_3: white ppt; cream ppt; yellow ppt

H_2SO_4: HCl; HBr, Br_2, SO_2; HI, I_2, SO_2, S, H_2S

11.3 Some reactions of the halide ions KC

cold $Cl_2 + 2NaOH \rightarrow NaCl + NaClO + H_2O$ (0 → −1, +1)

hot $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$ (0 → −1, +5)

11.4 The reactions of chlorine with aqueous sodium hydroxide KC

Environmental concerns

Cl Cl; C Cl Cl C Cl Cl $_n$; CFCs HCFCs

11.5 Some important uses of the halogens and of halogen compounds KC

N N; N H H H; nitrates; eutrophication of water; NITRATES; O N O

13.1 Nitrogen KC

Key: KC 1 KC 2 KC 3 KC 4 KC 5

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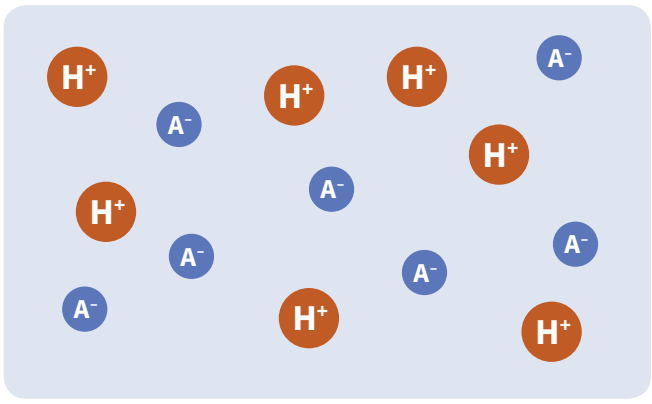
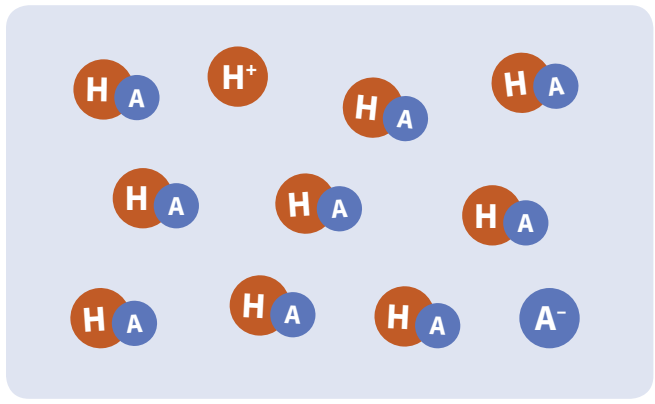
6 Acids and bases

acid → H^+ — proton donor

base ← H^+ — proton acceptor



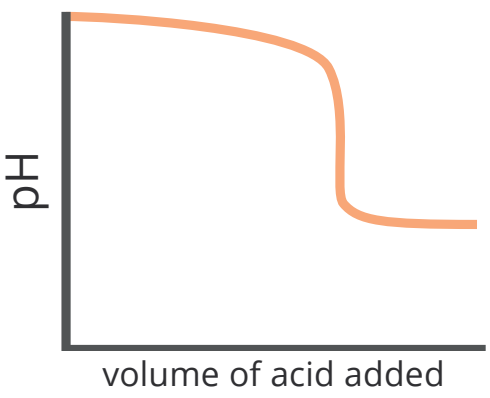
STRONG ACID

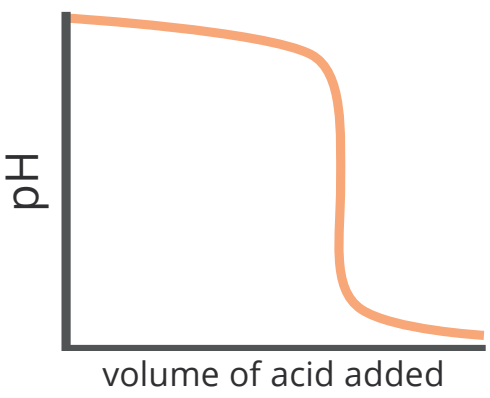


WEAK ACID

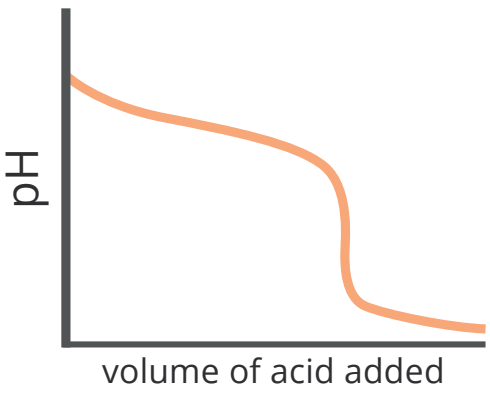
$HA \rightleftharpoons H^+ + A^-$

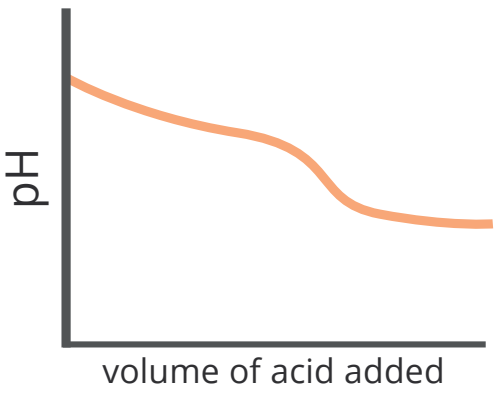
$pH = -\log[H^+(aq)]$





HCO_3^-





K_W K_{SP} K_a pK_a

7.2 Ionic equilibria

KC

Key: KC1 KC2 KC3 KC4 KC5

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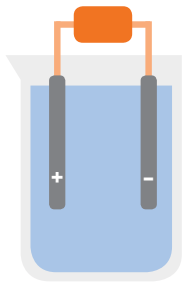
7 Electricity and metals



$F = Le$ -1.602×10^{-19} C

\+ anode metal OR H_2

− cathode halogen OR O_2

6.2 Electrolysis KC

Cell potentials

OXIDISING

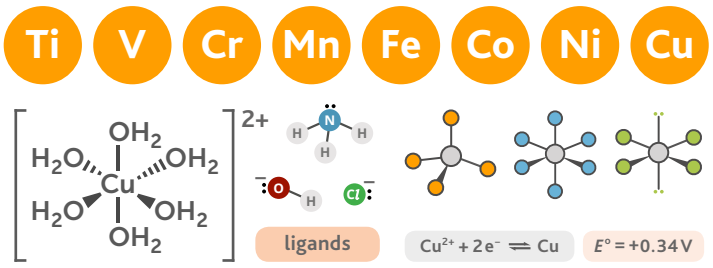
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	$E^\circ = +0.34$ V
$2H^+ + 2e^- \rightleftharpoons H_2$	$E^\circ = 0.00$ V
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	$E^\circ = -0.44$ V

REDUCING

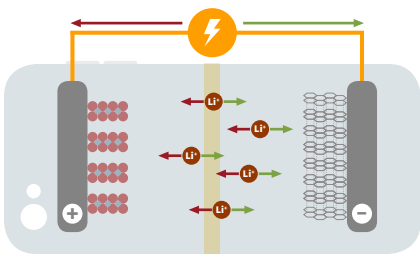
Nernst equation $E = E^\circ + (0.059/z) \log \frac{[\text{oxidised species}]}{[\text{reduced species}]}$

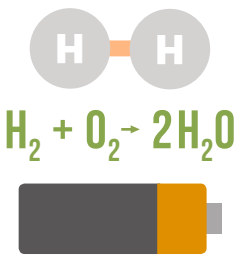
6.3 Standard electrode potential $E^\ominus$; standard cell potentials $E^\ominus_{cell}$ and the Nernst equation KC

Ti V Cr Mn Fe Co Ni Cu



12.2 General characteristic chemical properties of the first set of transition elements, titanium to copper KC

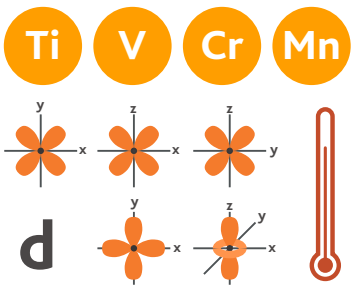




6.4 Batteries and fuel cells KC

ligands

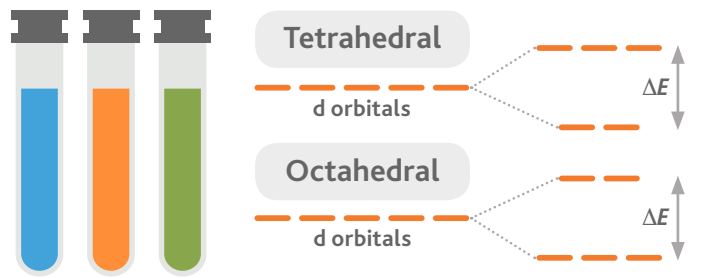
Ti V Cr Mn Fe Co Ni Cu



$[Ar]3d^24s^2$ (Ti) … (Cu) $[Ar]3d^{10}4s^1$

12.1 General physical properties of the first set of transition elements, titanium to copper KC

d orbitals



12.3 Colour of complexes KC

ligand substitution reaction

$[Cu(H_2O)_6]^{2+} + 4\,NH_3 \rightleftharpoons [Cu(NH_3)_4(H_2O)_2]^{2+} + 4\,H_2O$

$$K_{stab} = \frac{[\text{products}]}{[\text{reactants}]} = \frac{[Cu(NH_3)_4(H_2O)_2^{2+}]}{[Cu(H_2O)_6^{2+}] + [NH_3]^4}$$

12.5 Stability constants, K_{stab} KC

Key: KC1 KC2 KC3 KC4 KC5

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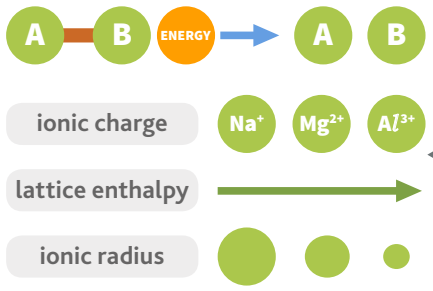
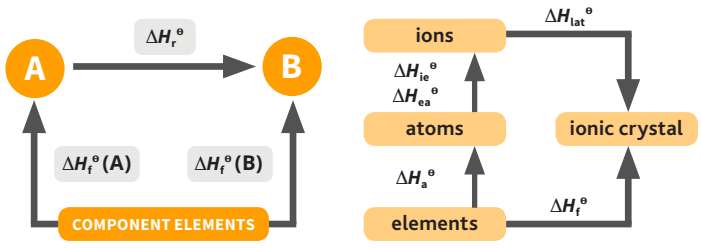
8 Controlling reactions 2

Enthalpy changes

ΔH_f formation
ΔH_c combustion
ΔH_a atomisation
ΔH_{hyd} hydration
ΔH_{sol} solution

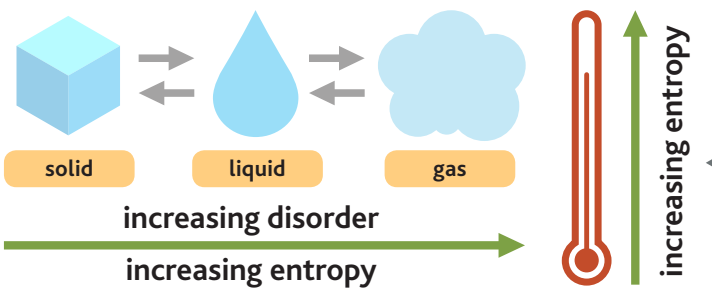


5.1 Enthalpy change, ΔH KC

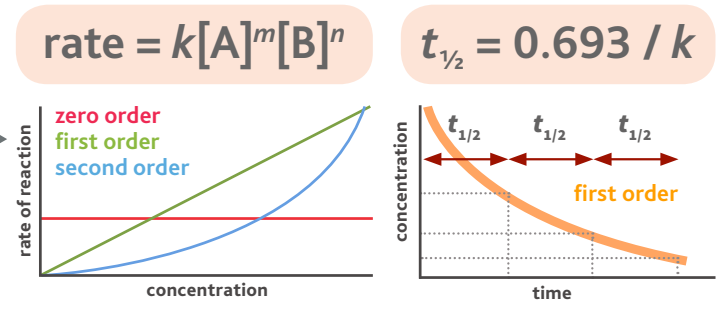


5.2 Hess' law, including Born-Haber cycles KC

Calculations



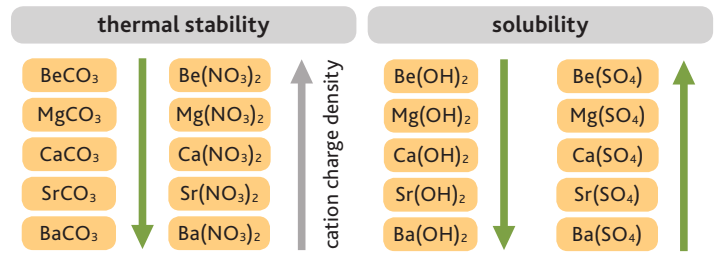
5.3 Entropy change, ΔS KC



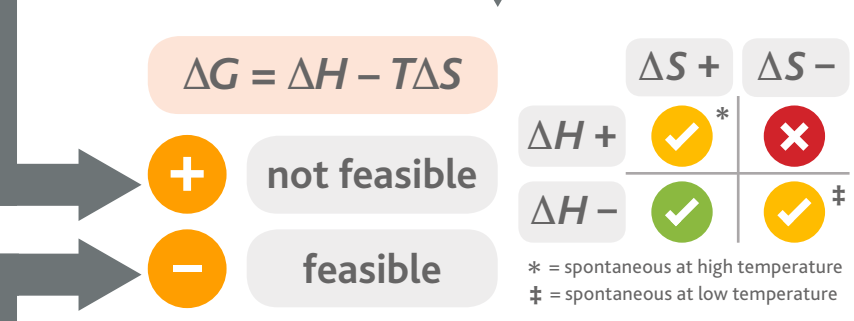
$rate = k[A]^m[B]^n$ $t_{½} = 0.693 / k$

8.1 Simple rate equations, orders of reaction and rate constants KC

Reaction feasibility

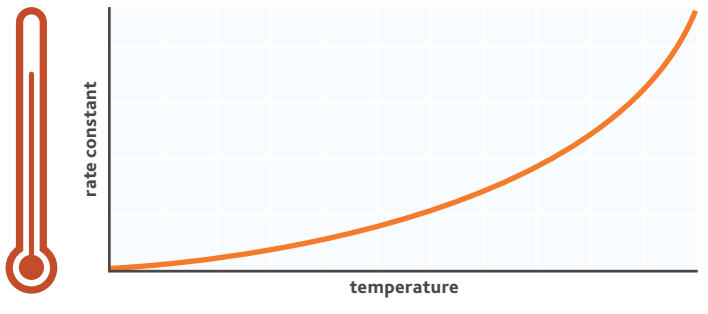


10.1 Similarities and trends in the properties of the Group 2 metals, magnesium to barium, and their compounds KC



5.4 Gibbs free energy change, ΔG KC

The effect of temperature



8.2 Effect of temperature: on reaction rates and rate constants and the concept of activation energy

Key: KC1 KC2 KC3 KC4 KC5

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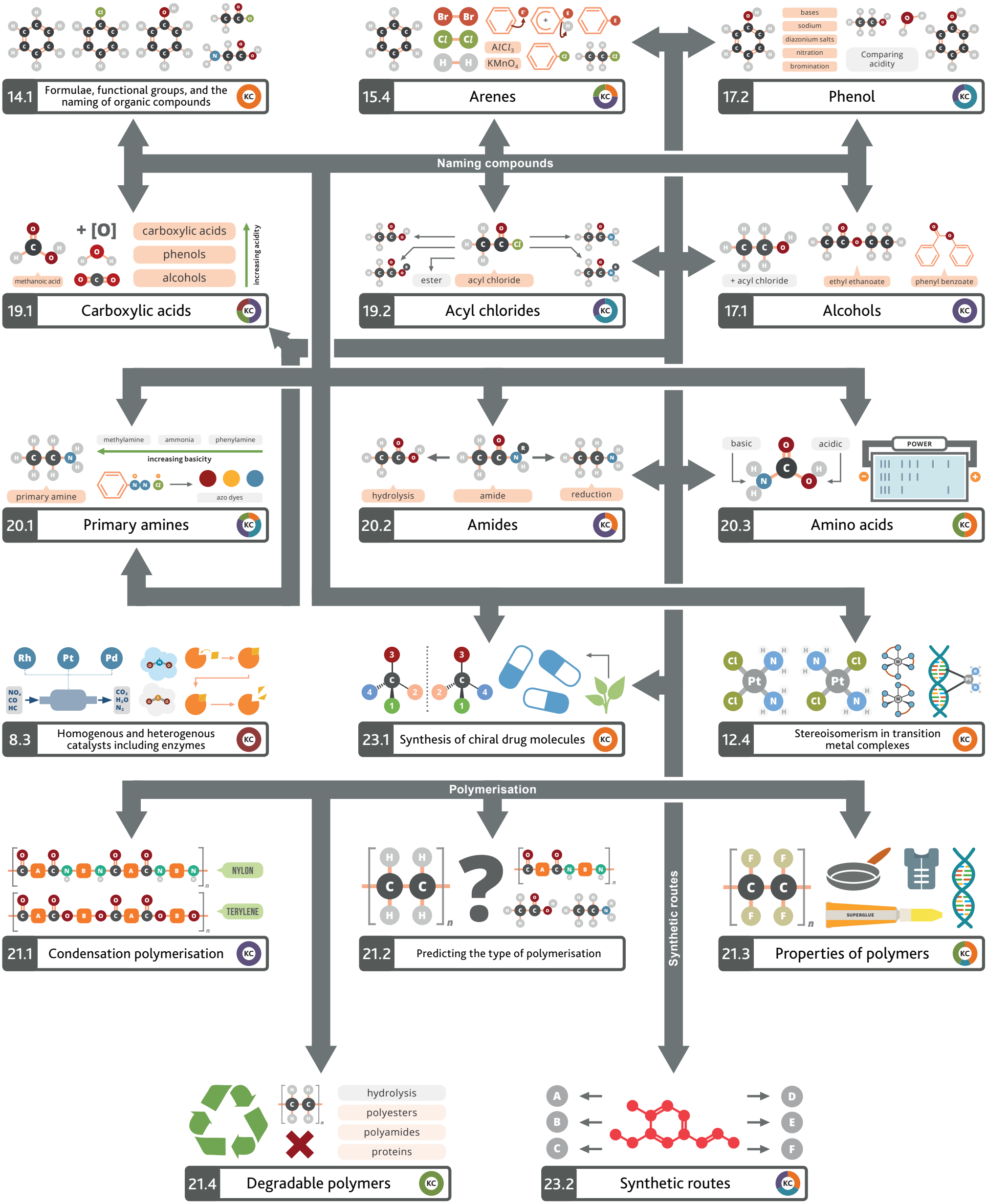
9 Organic chemistry 2



Key: KC1 KC2 KC3 KC4 KC5

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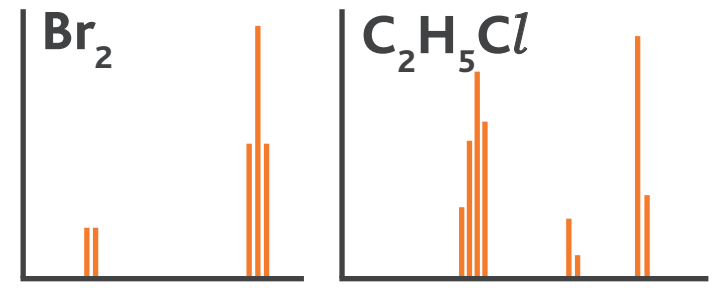
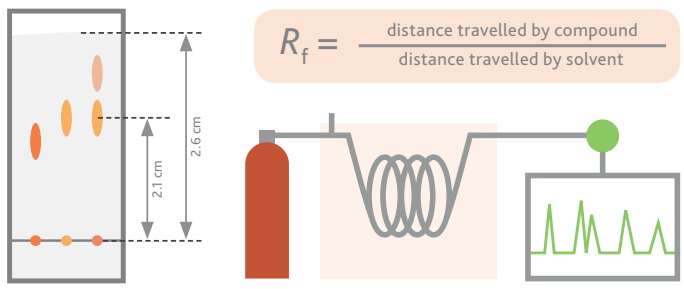
10 Analysis



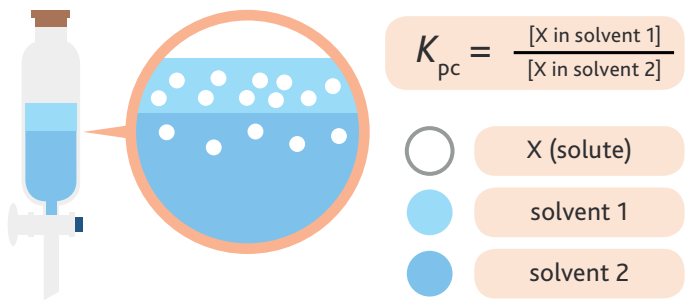
22.3 Mass spectrometry KC



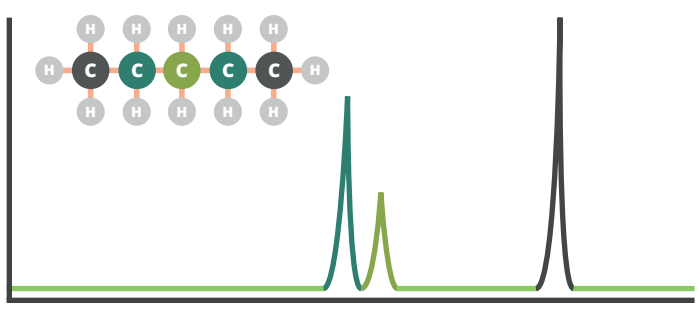
22.1 Chromatography KC

Structure determination

Separating mixtures

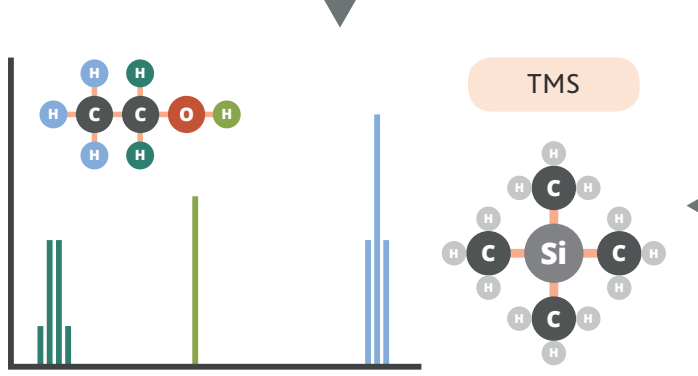


7.3 Partition coefficients KC



22.4 Carbon-13 NMR spectroscopy KC

NMR



22.5 Proton (^{1}H) NMR spectroscopy KC

Key: KC 1 KC 2 KC 3 KC 4 KC 5

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