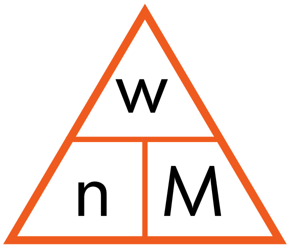
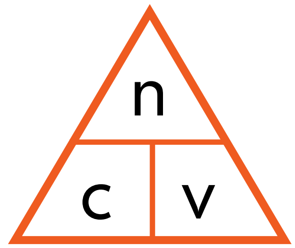
YEAR 1 CHEMISTRY EQUATIONS **(EDEXCEL)**

MOLE CALCULATIONS

number of moles = mass / molar mass
(g) ($g.mol^{-1}$)

number of moles = concentration x volume
($mol.dm^{-3}$) (dm^3)

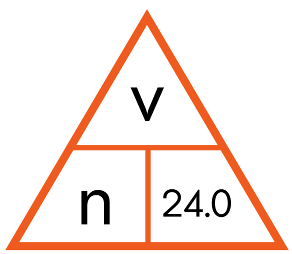




Avogadro's Constant = 6.02 x 10^{23} atoms or molecules = **1 mole**

MOLAR GAS CONSTANT

1 mole of ANY gas occupies 24.0 dm^3 at room temperature & pressure



IDEAL GAS EQUATION

P = Pressure (pa) **V** = volume (m^3) **n** = no. of moles

R = Gas Constant (8.31 $J.K^{-1}.mol^{-1}$) **T** = Temperature (K)

$$PV = nRT$$

$$P = \frac{nRT}{V} \qquad V = \frac{nRT}{P} \qquad n = \frac{PV}{RT} \qquad T = \frac{PV}{nR}$$

For changes in conditions:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

MASS SPECTROSCOPY

$$\text{Relative Atomic Mass (Ar)} = \frac{(\text{mass isotope 1 x abundance}) + (\text{mass isotope 2 x abundance}) + \ldots}{\sum \text{abundance}}$$

OTHER EQUATIONS

$$\text{\% by mass} = \frac{\text{mass of element in 1 mole}}{\text{Mr}}$$

$$\text{Empirical formula} = \frac{\text{M1}}{\text{Mr1}} : \frac{\text{M2}}{\text{Mr2}} : \frac{\text{M3}}{\text{Mr2}}$$

Where M1, M2 etc is the mass or % composition of element 1, 2 etc

then divide each by the smallest number to give empirical formula

$$\text{\% Atom Economy} = \frac{\text{mass of desired product}}{\text{total mass of all products}} \times 100$$

You can use mass or number of moles here!

$$\text{\% Yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

You can replace masses with Mr values here too!

ENTHALPY

Q = energy transferred (J)
m = mass of **solution** (g)
c = specific heat capacity ($J.K^{-1}.mol^{-1}$)
$\triangle T$ = **change** in temperature (°C **or** K)

$$Q = m.c.\triangle T$$

$$\triangle H = \frac{Q}{n}$$

($J.mol^{-1}$)

Don't forget to add a sign for $\triangle H$!

Divide by 1000 for $kJ.mol^{-1}$

$$\triangle H \text{ reaction} = \sum \text{reactant mean bond enthalpies} - \sum \text{product mean bond enthalpies}$$

($kJ.mol^{-1}$) ($kJ.mol^{-1}$) ($kJ.mol^{-1}$)

EQUILIBRIA

$$aA + bB \rightleftharpoons cC + dD$$

$$Kc = \frac{[C]^c\ [D]^d}{[A]^a\ [B]^b}$$

Where:
[A] = concentration ($mol.dm^{-3}$)
a = no. of moles from equation

COMMON IONS

POSITIVE

GROUP 1 = +

GROUP 2 = 2+

H^{+}

Ag^{+}

Zn^{2+}

Pb^{2+}

Al^{3+}

(Transition metals are variable)

e.g. Fe^{2+}, Fe^{3+}

NEGATIVE

GROUP 7 = -

GROUP 6 = 2-

GROUP 5 = 3-

MOLECULAR IONS

NH_4^{+} ammonium	OH^{-} hydroxide	NO_3^{-} nitrate	CN^{-} cyanide
H_3O^{+} hydronium	CO_3^{2-} carbonate	SO_4^{2-} sulfate	PO_4^{3-} phosphate

ACIDS & BASES

ACIDS

HCl	hydrochloric acid
HNO_3	nitric acid
H_2SO_4	sulphuric acid
H_3PO_4	phosphoric acid
CH_3COOH	ethanoic acid

BASES

NaOH	sodium hydroxide
KOH	potassium hydroxide
$Ca(OH)_2$	calcium hydroxide
CuO	copper (II) oxide

COMMON OXIDATION STATES

POSITIVE

GROUP 1 = +I
GROUP 2 = +II
H = +I
Ag = +I
Zn = +II
Pb = +II or +IV
Al = + III
(Transition metals are variable)
Fe = +II or +III
Cu = +II (sometimes +I)
C = +II or +IV

NEGATIVE

F = -I
O = -II
Cl = -I
Br = -I
I = -I
N = -III
S = -II
P = -III

(Cl, Br, I, N, S, P:) Most common oxidation states, but may be positive when covalently bonded to more highly electronegative elements. i.e. F or O

GROUP 1 SALTS: ALL SOLUBLE

NITRATE SALTS = ALL SOLUBLE

GROUP 2 SALTS:
HYDROXIDES INCREASE IN SOLUBILITY DOWN THE GROUP
SULFATES DECREASE IN SOLUBILITY DOWN THE GROUP
CARBONATES ARE NOT SOLUBLE

Ag SALTS: ALL INSOLUBLE EXCEPT $AgNO_3$

Pb SALTS ALL INSOLUBLE EXCEPT $Pb(NO_3)_2$

GROUP 7 SALTS: ALL SOLUBLE EXCEPT AgX and PbX_2

CO_3 SALTS: ALL INSOLUBLE EXEPT GROUP 1

YEAR 1 CHEMISTRY PRACTICALS (EDEXCEL)

No.	Practical	Detail	Done?
1	Moles Determination	Use apparatus to record the volume of a gas	
2	Prepare a Standard Solution & Titration	Prepare a standard solution from a solid acid and use it to find the concentration of a solution of sodium hydroxide	
3	Titration	Use titration tofu the concentration of a solution f hydrochloric acid	
4	Rates of Reaction	Investigate the rates of hydrolysis of haloalkanes	
5	Oxidation of ethanol	Use reflux and distillation techniques to oxidise and alcohol and isolate the product	
6	Nucleophilic Subsctitution	Chlorination of a 2-methylpropan-2-ol using conc. hydrochloric acid	
7	Testing for inorganic and organic substances	Use chemical tests to identify: - Group 2, Group 7, OH^-, CO_3^{2-} and SO_4^{2-} ions in solution. - A carboxylic acid, an alcohol and an aldehyde.	
8	Enthalpy Changes	Determine the enthalpy change of a reaction using Hess' law. i.e. Determine the $\triangle$H experimentally for two reactions and apply to Hess' Law to find another unknown $\triangle$H.	

THERMODYNAMICS

$$\Delta H^{\ominus}_{solution} = \Delta H^{\ominus}_{latt\ diss} + \sum \Delta H^{\ominus}_{hydration}$$

(ENDOTHERMIC) (EXOTHERMIC)

$$\Delta S_{system} = \sum \Delta S_{products} - \sum \Delta S_{reactants}$$

($J.K^{-1}.mol^{-1}$)

$$\Delta S_{surroundings} = \frac{-\Delta H}{T}$$

$$\Delta S_{total} = \Delta S_{system} + \Delta S_{surroundings}$$

$$\Delta G = \Delta H - T\Delta S$$

($kJ.mol^{-1}$)

Always divide ΔS by 1000 to match your units!

$$T = \frac{\Delta H}{\Delta S}$$

When calculating the temperature at which a reaction becomes / ceases being feasible

$$\Delta G = -\Delta S\,T + \Delta H$$

For the ΔG Vs T Graph! Equivalent to: y = mx + c

$$\Delta G = -RT\ln K$$

Links Gibbs Free Energy and the Equilibrium Constant "K"

$$\ln K = \frac{\Delta G}{-RT}$$

$$T = \frac{\Delta G}{-R\ln K}$$

RATE EQUATIONS & ARRHENIUS

$$\text{Rate} = k\,[A]^{order}\,[B]^{order}$$

(mol.dm^{-3}.s^{-1})

$$K = \frac{\text{Rate}}{[A]^{order}\,[B]^{order}}$$

$$K = A\,e^{\left(\frac{-Ea}{RT}\right)}$$

Standard Arrhenius

OR

$$\ln K = \left(\frac{-Ea}{RT}\right) + \ln A$$

Natural Log of Arrhenius

OR

$$\ln K = \frac{-Ea}{R} \times \frac{1}{T} + \ln A$$

For the lnK Vs 1/T Graph!

Equivalent to:
y = mx + c

ELECTROCHEMISTRY

$$EMF_{(V)} = \text{Most Positive } E^{\circ} - \text{Most Negative } E^{\circ}$$

OR

$$EMF = E^{\circ} \text{ Cell being Reduced} - E^{\circ} \text{ Cell being Oxidised}$$

ACIDS & BASES

$$pH = -\log [H^+] \quad \text{and} \quad [H^+] = 10^{-pH}$$

$$Ka = \frac{[H^+][X^-]}{[HX]}$$

$$Kw = [H^+][OH^-]$$

$Kw = 1.00 \times 10^{-14}\ mol^2.dm^{-6}$ at 298K

ACID BUFFERS

Ka of Weak Acid

Weak Acid Concentration

$$[H^+] = Ka \times \frac{[HX]}{[X^-]}$$

Salt Concentration

$$\text{Then } pH = -\log [H^+]$$

YEAR 2 TRANSITION METALS (EDEXCEL)

COMMON OXIDATION STATES

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
+III	+IV	+II, +III +IV, +V	+II, +III +VI	+II, +III +IV, +VI +VII	+II, +III	+II, +III	+II	+I, +II	+II

COMMON COMPLEX COLOURS

	$+H_2O$	+ limited $OH^-_{(aq)}$ or $NH_{3(aq)}$	+ Excess $OH^-_{(aq)}$	+ Excess $NH_{3(aq)}$	+ conc. $HCl_{(aq)}$
Iron II	$[Fe(H_2O)_6]^{2+}_{(aq)}$ GREEN SOLUTION	$[Fe(H_2O)_4(OH)_2]_{(s)}$ GREEN PRECIPITATE (may oxidise to brown)	NVR	NVR	NVR
Iron III	$[Fe(H_2O)_6]^{3+}_{(aq)}$ YELLOW SOLUTION	$[Fe(H_2O)_3(OH)_3]_{(s)}$ BROWN PRECIPITATE	NVR	NVR	$FeCl_4^-$ YELLOW SOLUTION
Cobalt	$[Co(H_2O)_6]^{2+}_{(aq)}$ PINK SOLUTION	$[Co(H_2O)_4(OH)_2]_{(s)}$ BLUE/GREEN PRECIPITATE	NVR	$[Co(NH_3)_6]^{2+}_{(aq)}$ BROWN SOLUTION	$CoCl_4^-$ BLUE SOLUTION
Copper	$[Cu(H_2O)_6]^{2+}_{(aq)}$ LIGHT BLUE SOLUTION	$[Cu(H_2O)_4(OH)_2]_{(s)}$ BLUE PRECIPITATE	NVR	$[Cu(H_2O)_2(NH_3)_4]^{2+}_{(aq)}$ ROYAL BLUE SOLUTION	$CuCl_4^{2-}$ YELLOW / GREEN SOLUTION
Chromium	$[Cr(H_2O)_6]^{3+}_{(aq)}$ *VIOLET SOLUTION	$[Cr(H_2O)_3(OH)_3]_{(s)}$ GREY/GREEN PRECIPITATE	$[Cr(OH)_6]^{3-}_{(aq)}$ GREEN SOLUTION	$[Cr(NH_3)_6]^{3+}_{(aq)}$ PURPLE SOLUTION	NVR

*** Officially violet in colour, but is green when produced from the oxidation of alcohols using acidified potassium dichromate**

VANADIUM

H^+ / Zn can reduce vanadium in $VO_3^-{}_{(aq)}$

Species	VO_3^-	VO_2^+	VO^{2+}	V^{3+}	V^{2+}
Oxidation State	+V	+V	+IV	+III	+II
Colour of solution	YELLOW	YELLOW	BLUE	GREEN	PURPLE

WHY COMPLEXES ARE COLOURED

$$\Delta E = h.f$$

△E = Difference in energy between d orbitals

h = Planck's Constant (6.63×10^{-34} $J.S^{-1}$)   **f** = Frequency (Hz)

$$c = \lambda.f$$

c = Speed of light (3.00×10^{8} $m.s^{-1}$)

λ = Wavelength (nm) **f** = Frequency (Hz)

No.	Practical	Detail	Done?
9	pH Curve: Find the Ka for a Weak Acid	Investigate how pH changes when a weak acid reacts with a strong base and determine the Ka for the weak acid	
10	Set up an electrochemical cell	Set up an electrochemical cell and measure EMF	
11	REDOX Titration	Use the REDOX to determine the concentration of an unknown solution	
12	Preparation of a Transition Metal Complex	Produce transition metal complexes via the addition of $NaOH_{(aq)}$ and $NH_{3(aq)}$	
13	Measure rate by initial rate method	The “Iodine Clock” Reaction Iodide (V) + H_2O_2	
14	Find the Activation Energy of a Reaction	Measure the rate of reaction. Use Arrhenius to determine the activation energy for that reaction	
15	Analysis of Unknowns	Use test tube reactions to determine the identity of some organic and inorganic unknowns	
16	Preparation of an organic solid	Produce a pure sample of an organic solid (e.g. Aspirin) and test its purity	