ap chemistry equations

black: included on formula sheet
red: not on formula sheet (memorize)

1. Welcome to chemistry

$d = \frac{m}{V}$ d = density; m = mass in g; v = volume in mL (=cm^3)

temperature: K = ^oC + 273.15

$^oC = (^oF - 32) \times \frac{5}{9}$ $^oF = \frac{9}{5}{^oC} + 32$

2. Stoichiometry

1 mole = 6.02×10^{23}

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

$\% \text{ error} = \frac{\text{error}}{\text{accepted valued}} \times 100$

% composition

$= \frac{\text{molar mass of each element}}{\text{molar mass of compound}} \times 100\%$

3. Solutions

$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liters of solution}}$

$C_1V_1 = C_2V_2$

c = concentration, v = volume

4. Rates (kinetics)

rate law for A→ B $\text{rate} = \frac{\Delta[A]}{\Delta t} = -\frac{\Delta[B]}{\Delta t}$

order	0^{th}	1^{st}	2^{nd}
rate law	rate = k	rate = k[A]	rate = $k[A]^2$
integrated form	$[A]_t = -kt + [A]_o$	$\ln[A]_t = -kt + \ln[A]_0$	$\frac{1}{[A]_t} = kt + \frac{1}{[A]_o}$
straight line	[A] versus t	ln[A] versus t	1/[A] versus t
half life	$t_{1/2} = \frac{[A]_0}{2k}$	$t_{1/2} = \frac{0.693}{k}$	$t_{1/2} = \frac{1}{k[A]0}$
units for k	M/s	1/s	1/Ms

Arrhenius equation: relates rate to activation energy and temperature

$k = Ae^{E_a/RT}$

better form: $E_a = \frac{(\ln\frac{K_1}{K_2})R}{\frac{1}{T_2} - \frac{1}{T_1}}$

k = rate constant T = Kelvin temperature

E_a = activation energy in J/mol

A = frequency factor (a constant, no units)

$R = \text{gas constant} = \frac{8.314 \text{ J}}{\text{K mol}}$

5. Equilibrium

for aA + bB ⇆ cC + dD

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

omit liquids and solids

K_{eq} = equilibrium constant
[A] = molar concentration of A

$K_p = K_c(RT)^{\Delta n}$

K_p = equilibrium constant (pressure)
K_c = equilibrium constant (concentration)
R = 0.08206 L·atm/mol·K
T = temperature (in Kelvin)
Δn = sum of the coefficients of the gaseous products minus the sum of the coefficients of the gaseous reactants

6. Acids and Bases

$H_2O (l) \leftrightarrows H^+(aq) + OH^-(aq)$; $K_w = [H+][OH^-] = 10^{-14}$

pH = -log[H+]
10^{-pH} = [H+]
pOH = -log[OH-]
10^{-pOH} = [OH-]
pH + pOH = 14

$HA(aq) + H_2O (l) \leftrightarrows H_3O^+(aq) + A^-(aq)$ $k_a = \frac{[H_3O^+][A^-]}{[HA]}$

$B(aq) + H_2O (l) \leftrightarrows BH^+(aq) + OH^-(aq)$ $k_b = \frac{[BH^+][OH^-]}{[B]}$

$K_a \times K_b = K_w = 10^{-14}$

pH sig figs = # of decimal places. Ex: 7.2 = 1, 7.22 = 2, 7.222 = 3

7. Buffers

$K_a = [H^+][A^-]/[HA]$
$K_b = [OH^-][HA]/[A^-]$

Henderson-Hasselbalch equation:

$pH = pK_a + \log[A^-]/[HA]$

$pOH = pK_b + \log [BH+]/[B]$

8. The atom

s = wf e = hf e = hs/w w = hs/e

s = the speed of light = 3×10^8 m/s
w = wavelength in meters
f = frequency, per second.
e = energy in joules
h = Plancks constant = 6.626×10^{-34} j sec

Balmer formula :

$$w_{nm} = \frac{1}{0.01097\left(\frac{1}{inner^2} - \frac{1}{outer^2}\right)}$$

w = wavelength in nanometers
inner = inner shell #; outer = outer shell #.
similarly:

$$e = 2.18 \times 10^{-18} \text{joules}\left(\frac{1}{inner^2} - \frac{1}{outer^2}\right)$$

9. Midterm examination

10. Gases

units

P pressure
V = volume (L)
T = Kelvin Temp (K)
n = # of moles (mol)
R = 0.0821 L atm/mol K
M = molar masses (g/mol)
d = density

1 atm = 14.7 psi = 760 mm Hg or Torr = 101 3 kPa

STP = standard temp and pressure = 1 atm, 273.15 K

formulas

boyles: charles: $\frac{T_1}{V_1} = \frac{T_2}{V_2}$ gay-lussac: $\frac{T_1}{P_1} = \frac{T_2}{P_2}$ combined: $\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$

ideal gas law: PV = nRT must use L atm mol K

22.4 L
= 1 mole gas at STP

density formula $d = \frac{PM}{RT}$

graham's law: $\frac{rate_1}{rate_2} = \sqrt{\frac{M_2}{M_1}}$

partial pressure

$\text{partial pressure of gas a} = \frac{\text{moles of gas a}}{\text{total moles of gas}} \times \text{total pressure}$

11, 12: Bonds and intermolecular forces:

no equations

12. Intermolecular forces

no equations

13. Energy (thermochemistry and thermodynamics)

$q = mc\Delta T$

q = heat, m = mass
c = specific heat (J/g^oC)
= 4.184 J/g °C for H_2O (l)
ΔT = temp change in °C.

1 Nutritional Calorie
= 4184 Joules
= 4 British Thermal Units (BTU)
= 1000 calories
= 0.0016 kilowatt hours

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

ΔG = change in free energy
ΔH = change in enthalpy
T = temperature
ΔS = change in entropy

14. Electrochemistry

$\Delta G = -nFE$

ΔG = free energy in joules
n = number of electrons
F = 96,500 coulombs (J/V mol)
E = cell potential (volts)

$K = e^{En/.0257}$

K = equilibrium constant (no units)
E = cell potential
n = number of electrons

$\Delta G = -RT \ln K$

R = 8.314 J/k mol
T = kelvin temp
K = equilibrium constant (no units)

Ampere = 1 C/s