THE EQUATION SHEET

Constants:

Avogadro's Number (***N_A***)	6.02×10^{23}
Universal Gas Constant (***R***)	8.314 J/mol·K or 0.0821 L·atm/mol·K
Planck's constant (***h***)	6.626×10^{-34} J·s
Rydberg Constant (***R_H***)	2.18×10^{-18} J
Speed of Light (***c***)	3.00×10^{8} m/s
Charge of an Electron (***q***)	1.602×10^{-19}
Boltzmann Constant (***k_B***)	1.381×10^{-23} J/K
Molar Volume (***V_{mol}***)	22.4 L/mol
Mass of Earth	5.97×10^{24} kg
Specific Heat Capacity of Water (***C***)	4.18 J/gK or 4.18 kJ/kgK
Ionic Product Constant of Water (***Kw***)	1.00×10^{-14} (mol/L)^2 at 298 K (25°C)
Faraday's constant (***F***)	96 500 C/mol
STP conditions	273 K and 100 kPa

Basic Equations:

$$n = \frac{m}{M_R} \qquad n = cV \qquad PV = nRT$$

$$Order\ of\ reaction = m + n \qquad c_1V_1 = c_2V_2$$

$$n_{gas} = \frac{V}{22.4 mol/L} \qquad K_{SP} = K_C \text{ (Aqueous)}$$

$$\%\ atom\ economy = \frac{molar\ mass\ of\ desired\ product}{molar\ mass\ of\ all\ reactants} \times 100\%$$

Conversion factors:

1L atm = 101.3 J — 1atm = 760 torr = 760 mm Hg

1nm = 10^{-9} m — 0°C = 273 K

1dm^3 = 1L — 1 amu = 1.66×10^{-27} kg

Acid-Base Chemistry:

$$pH = -\log\left[H_3O^+\right]$$

$$\left[H_3O^+\right] = 10^{-pH}$$

$$K_w = K_a \times K_b$$

$$pK_a + pK_b = pK_w$$

$$pK_a = -\log K_a$$

$$pK_b = -\log K_b$$

$$pK_b = 14 - pK_a$$

$$pH + pOH = 14$$

$$pOH = -\log\left[OH^-\right]$$

$$\left[OH^-\right] = 10^{-pOH}$$

$$pH_{Buffer} = pKa - \log\left(\frac{[HA]}{[A^-]}\right)$$

Thermodynamics:

$$\Delta H_{rxn} = H_P - H_R$$

$q = \Delta H$ at constant pressure

$$\Delta H^o = \frac{-Q}{\#\,mol}$$

$$M_{Enthalpy} = \sum(E_k + E_p)$$

$$E_k = \frac{1}{2}mv^2$$

$$C = \frac{Q}{\Delta T}$$

$$Q = mc\Delta T$$

$$\Delta H^o_{rxn} = \sum\left[\Delta H^o_{f(P)}\right] - \sum\left[\Delta H^o_{F(R)}\right]$$

$$\Delta H^o_{rxn} = \sum D(broken) - \sum D(formed)$$

$$\Delta S = k \ln W = \frac{q}{T} = \frac{\Delta H}{T} = S_{System} + S_{Surrounding}$$

$$\Delta S^o_{rxn} = \sum S^o_{(P)} - \sum S^o_{(R)}$$

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

$$\Delta G^o_{rxn} = \sum \Delta G^o_{(P)} - \sum \Delta G^o_{(R)}$$

Chemical Kinetics:

$$Rate_{Reaction} = \frac{\Delta c}{\Delta t}$$

$$Rate_{Reaction} = k[A]^m[B]^n$$

$$E_A = -RT \ln\left(\frac{k}{A}\right)$$

$$t_{1/2} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{1}{k[A]_o}$$

$$k = Ae^{-Ea/RT}$$

$$[A]_t = -kt + [A]_o$$

$$\ln[A]_t = -kt + \ln[A]_o$$

$$\ln\frac{k_1}{k_2} = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$K_C = \frac{[Products]^{nB}}{[Reactants]^{nA}}$$

$$K_P = K_C(RT)^{\Delta n}$$

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

Quantum Mechanics:

$$\Delta E = \frac{hc}{\lambda}$$

$$c = \lambda\nu$$

$$\Delta E = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

$$E = hf$$

$$n\lambda = 2d\sin\theta$$

Nuclear Chemistry:

$$E = mc^2$$

$$^{238}_{92}U = ^{234}_{+0}Th + ^{4}_{2}He$$

$$^{1}_{0}n \rightarrow ^{1}_{1}H + ^{0}_{-1}e$$

Gas:

$$PV = nRT$$

$$\frac{Rate_1}{Rate_2} = \sqrt{\frac{M_2}{M_1}}$$

Redox:

$$Charge = Current \times Time$$

$$E^o_{cell} = E^o_{cathode} - E^o_{Anode}$$

$$\Delta G^o = -nFE^o$$

Extras

Solubility:

Q_c	K_c	Q	K_{sp} (Precipitate)
<	Prod Fav	<	No
=	EQ	=	No
>	React Fav	>	Yes (Super Saturated)

Aufbau Principle: Build up electrons one by one.

1K(2)2L(8)3M(18)4N(32)5O(50)6P(72)7Q(98)

Formations:

1. Acid + Metal = Salt + Hydrogen Gas
   Ex. $2HCl_{(aq)} + Zn_{(s)} \rightarrow ZnCl_{2(s)} + H_{2(g)}$
2. Acid + Base = Salt + Water
   Ex. $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(s)} + H_2O_{(l)}$
3. Acid + Metal Carbonate = $CO_2 + H_2O$ + Salt
   Ex. $CaCO_{3(s)} + HCl_{(aq)} \rightarrow H_2O_{(l)} + CO_{2(g)} + CaCl_{(s)}$
4. Metal Oxide + Acid → Salt + Water
   Ex. $MgO_{(s)} + HCl_{(aq)} \rightarrow MgCl_{2(s)} + H_2O_{(l)}$

Periodic Table of Electronegativities

H 2.20																	He n.a.
Li 0.98	Be 1.57											B 2.04	C 2.55	N 3.04	O 3.44	F 3.98	Ne n.a.
Na 0.93	Mg 1.31											Al 1.61	Si 1.90	P 2.19	S 2.58	Cl 3.16	Ar n.a.
K 0.82	Ca 1.00	Sc 1.36	Ti 1.54	V 1.63	Cr 1.66	Mn 1.55	Fe 1.83	Co 1.88	Ni 1.91	Cu 1.90	Zn 1.65	Ga 1.81	Ge 2.01	As 2.18	Se 2.55	Br 2.96	Kr 3.00
Rb 0.82	Sr 0.95	Y 1.22	Zr 1.33	Nb 1.60	Mo 2.16	Tc 1.90	Ru 2.20	Rh 2.28	Pd 2.20	Ag 1.93	Cd 1.69	In 1.78	Sn 1.96	Sb 2.05	Te 2.10	I 2.66	Xe 2.60
Cs 0.79	Ba 0.89	La 1.10	Hf 1.30	Ta 1.50	W 2.36	Re 1.90	Os 2.20	Ir 2.20	Pt 2.28	Au 2.54	Hg 2.00	Tl 1.62	Pb 2.33	Bi 2.02	Po 2.00	At 2.20	Rn n.a.
Fr 0.70	Ra 0.89	Ac 1.10	Rf n.a.	Db n.a.	Sg n.a.	Bh n.a.	Hs n.a.	Mt n.a.	Ds n.a.	Rg n.a.	Uub n.a.	—	Uuq n.a.	—	—	—	—

Polyatomic Ions:

Acetate	CH_3COO^- or $C_2H_3O_2^-$	*Hydroxide*	OH^-
Aluminate	AlO_2^-, $Al_2O_4^{2-}$	*Hypobromite*	BrO^-
Amide	NH_2^-	*Hypochlorite*	ClO^-
Ammonium	NH_4^+	*Hypoiodite*	IO^-
Antimonate	SbO_4^{3-}	*Hypophosphite*	PO_2^{3-}
Antimonite	SbO_3^{3-}	*Hyposulfite*	SO_2^{2-}
Arsenate	AsO_4^{3-}	*Iodate*	IO_3^-
Arsenite	AsO_3^{3-}	*Iodite*	IO_2^-
Bicarbonate (hydrogen carbonate)	HCO_3^-	*Manganate*	MnO_4^{2-}
Bromate	BrO_3^-	*Nitrate*	NO_3^-
Bromite	BrO_2^-	*Nitrite*	NO_2^-
Carbide	C_2^{2-}	*Oxalate*	$C_2O_4^{2-}$
Carbonate	CO_3^{2-}	*Ozonide*	O_3^-
Chlorate	ClO_3^-	*Perbromate*	BrO_4^-
Chlorite	ClO_2^-	*Perchlorate*	ClO_4^-
Chromate	CrO_4^{2-}	*Periodate*	IO_4^-
Chromite	CrO_2^-	*Permanganate*	MnO_4^-
Cyanate	OCN^-	*Peroxide*	O_2^{2-}
Cyanide	CN^-	*Phosphate*	PO_4^{3-}
Dichromate	$Cr_2O_7^{2-}$	*Phosphite*	PO_3^{3-}
Dihydrogen arsenate	$H_2AsO_4^-$	*Plumbate*	PbO_3^{2-}
Dihydrogen phosphate	$H_2PO_4^-$	*Plumbite*	PbO_2^{2-}
Dihydrogen phosphite	$H_2PO_3^-$	*Stannate*	SnO_3^{2-}
Disulfide	S_2^{2-}	*Stannite*	SnO_2^{2-}
Ferrate	FeO_4^{2-}	*Sulfate*	SO_4^{2-}
Hydrogen arsenate	$HAsO_4^{2-}$	*Sulfite*	SO_3^{2-}
Hydrogen carbonate (bicarbonate)	HCO_3^-	*Superoxide*	O_2^-
Hydrogen phosphate	HPO_4^{2-}	*Tartrate*	$(CH(OH)COO)_2^{2-}$
Hydrogen phosphite	HPO_3^{2-}	*Tellurate*	TeO_4^{2-}
Hydrogen sulfate	HSO_4^-	*Tellurite*	TeO_3^{2-}
Hydrogen sulfite	HSO_3^-	*Thiocyanate*	SCN^-
Hydronium	H_3O^+	*Thiosulfate*	$S_2O_3^{2-}$