THE EQUATION SHEET

Constants:

Avagadro's Number (N_A)	6.02×10^{23}
Universal Gas Constant (R)	8.314 J/mol·K or 0.0821L·atm/mol·K
Planck's constant (h)	6.626×10^{-34} J·s
Rydberg Constant (R_H)	$2.18 \times$ 10-18 J
Speed of Light (c)	$3.00 \times$ 108 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	5.25×10^{18} kg
Specific Heat Capacity of Water (C)	4.18J/g·mol
Ionic Product Constant of Water (Kw) at 25°C	1.00×10^{-14} $(mol/L)^2$

Basic Equations:

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

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

$n_{gas} = \frac{V}{22.4 mol/L} \quad K_{SP} = K_c$ (Aqueous)

Conversion factors:

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

1nm = 10^{-9}m — 0°C = 273 K

Acid-Base Chemistry:

$$pH = -\log[H_3O^+]$$
$$[H_3O^+] = 10^{-pH}$$
$$K_w = K_a \times K_b$$
$$pK_a + pK_b = pK_w$$
$$pK_a = -\log K_a$$
$$pK_b = -\log K_b$$
$$pK_b = 14 - pK_a$$
$$pH + pOH = 14$$
$$pOH = -\log[OH^-]$$
$$[OH^-] = 10^{-pOH}$$
$$pH_{Buffer} = pKa - \log\left(\frac{[HA]}{[A^-]}\right)$$

Thermodynamics:

$$\Delta H_{rxn} = H_P - H_R$$
$q = \Delta H$ at constant pressure
$$\Delta H^o = \frac{-Q}{\# mol}$$
$$M_{Enthalpy} = \sum(E_k + E_p)$$
$$E_k = \frac{1}{2}v^2$$
$$C = \frac{Q}{\Delta T}$$
$$Q = mc\Delta T$$
$$\Delta H^o_{rxn} = \sum[\Delta H^o_{f(P)}] - \sum[\Delta H^o_{F(R)}]$$
$$\Delta H^o_{rxn} = \sum D(broken) - \sum D(formed)$$
$$\Delta S = k \ln W = \frac{q}{T} = \frac{\Delta H}{T} = S_{System} + S_{Surrounding}$$
$$\Delta S^o_{rxn} = \sum S^o_{(P)} - \sum S^o_{(R)}$$
$$\Delta G^o = \Delta H^o - T\Delta S^o$$
$$\Delta G^o_{rxn} = \sum \Delta G^o_{(P)} - \sum \Delta G^o_{(R)}$$

Chemical Kinetics:

$$Rate_{Reaction} = \frac{\Delta c}{\Delta t}$$
$$t_{1/2} = \frac{0.693}{k}$$
$$Rate_{Reaction} = k[A]^m[B]^n$$
$$E_A = -\frac{\ln\left(\frac{k}{A}\right)}{RT}$$
$t_{1/2} = \frac{1}{k[A]_o}$ 2nd order

$t_{1/2} = \frac{1}{k}\ln 2$ 1st order
$$k = Ae^{-Ea/RT}$$
$$[A]_t = -kt + [A]_o$$
$$\ln[A]_t = -kt + \ln[A]_o$$
$$K_C = \frac{[Prodtcts]^{nB}}{[Reactants]^{nA}}$$
$$K_P = K_C(RT)^{\Delta n}$$

Quantum Mechanics:

$$\Delta E = \frac{hc}{l}$$
$$c = lv$$
$$\Delta E = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$
$$E = hf$$

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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:

$$PV = nRT$$

Redox:

$$Charge = Current \times$$
$$E^o_{cell} = E^o_{cathode} - E$$

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. $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(s)} + H_2O$
3. Acid + Metal Carbonate = CO_2 + H_2O + Salt
   Ex. $CaCO_{3(s)} + HCl_{(aq)} \rightarrow H_2O + CO_{2(g)} + CaCl$
4. Metal Oxide + Acid → Salt + Water
   Ex. $MgO_{(s)} + HCl_{(aq)} \rightarrow MgCl_{2(s)} + H_2O$

History	
1864 John Neulands: Law of ‘Octaves’ 1869 Mendeleev: Developed the first periodic table 1900 Max Planck: The exchange of energy in quantized numbers 1905 Albert Einstein: Explain Heat Capacity of Solids, with Planck's Law 1913 Niels Bohr: Model of the Atom that circled the core 1913 Henry Moseley: Redid more accurate period table with 92 elements 1924 Louis-Victor De Broglie: Electrons act as particles and waves	1925 Werner Heisenberg: Can’t find an electron, only probable 1926 Erwin Schrödinger: Wave equation resulted in electron cloud model 1926 WolfGang Pauli: Only two electrons per Quantize level, opposite spin 1926 Friedrich Hund: Stable Electrons have parallel spins, then opposite 1930 Sydney Chapman: Modeled the Ozone Layer 1954 Linus Pauling: Electrons increase, and period decreases

Polyatomic Ions:

Acetate	CH_3COO^- or $C_2H_3O_2^-$	*Hydronium*	H_3O^+
Aluminate	AlO_2^-, $Al_2O_4^{2-}$	*Hydroxide*	OH^-
Amide	NH_2^-	*Hypobromite*	BrO^-
Ammonium	NH_4^+	*Hypochlorite*	ClO^-
Antimonate	SbO_4^{3-}	*Hypoiodite*	IO^-
Antimonite	SbO_3^{3-}	*Hypophosphite*	PO_2^{3-}
Arsenate	AsO_4^{3-}	*Hyposulfite*	SO_2^{2-}
Arsenite	AsO_3^{3-}	*Iodate*	IO_3^-
Bicarbonate (hydrogen carbonate)	HCO_3^-	*Iodite*	IO_2^-
Bromate	BrO_3^-	*Manganate*	MnO_4^{2-}
Bromite	BrO_2^-	*Nitrate*	NO_3^-
Carbide	C_2^{2-}	*Nitrite*	NO_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 carbonate (bicarbonate)	HCO_3^-	*Sulfite*	SO_3^{2-}
Hydrogen arsenate	$HAsO_4^{2-}$	*Superoxide*	O_2^-
Hydrogen phosphate	HPO_4^{2-}	*Tartrate*	$(CH(OH)COO)_2^{2-}$
Hydrogen phosphite	HPO_3^{2-}	*Tellurite*	TeO_3^{2-}
Hydrogen sulfate	HSO_4^-	*Thiocyanate*	SCN^-
Hydrogen sulfite	HSO_3^-	*Thiosulfate*	$S_2O_3^{2-}$