

1 1A	2 2A	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
hydrogen <b>H</b> 1.008	helium <b>He</b> 4.003	scandium <b>Sc</b> 44.96	titanium <b>Ti</b> 47.88	vanadium <b>V</b> 50.94	chromium <b>Cr</b> 52.00	manganese <b>Mn</b> 54.94	iron <b>Fe</b> 55.85	cobalt <b>Co</b> 58.93	nickel <b>Ni</b> 58.69	copper <b>Cu</b> 63.55	zinc <b>Zn</b> 65.39	boron <b>B</b> 10.81	carbon <b>C</b> 12.01	nitrogen <b>N</b> 14.01	oxygen <b>O</b> 16.00	hydrogen <b>H</b> 1.008	helium <b>He</b> 4.003
lithium <b>Li</b> 6.941	beryllium <b>Be</b> 9.012	yttrium <b>Y</b> 88.91	zirconium <b>Zr</b> 91.22	niobium <b>Nb</b> 92.91	molybdenum <b>Mo</b> 95.94	technetium <b>Tc</b> (98)	ruthenium <b>Ru</b> 101.1	rhodium <b>Rh</b> 102.9	palladium <b>Pd</b> 106.4	silver <b>Ag</b> 107.9	cadmium <b>Cd</b> 112.4	aluminum <b>Al</b> 26.98	silicon <b>Si</b> 28.09	phosphorus <b>P</b> 30.97	sulfur <b>S</b> 32.07	fluorine <b>F</b> 19.00	neon <b>Ne</b> 20.18
sodium <b>Na</b> 22.99	magnesium <b>Mg</b> 24.31	strontium <b>Sr</b> 87.62	hafnium <b>Hf</b> 178.5	tantalum <b>Ta</b> 180.9	tungsten <b>W</b> 183.8	rhenium <b>Re</b> 186.2	osmium <b>Os</b> 190.2	iridium <b>Ir</b> 192.2	platinum <b>Pt</b> 195.1	gold <b>Au</b> 197.0	mercury <b>Hg</b> 200.6	germanium <b>Ge</b> 72.59	tin <b>Sn</b> 118.7	antimony <b>Sb</b> 121.8	selenium <b>Se</b> 78.96	chlorine <b>Cl</b> 35.45	argon <b>Ar</b> 39.95
potassium <b>K</b> 39.10	calcium <b>Ca</b> 40.08	barium <b>Ba</b> 137.3	thallium <b>Tl</b> 204.4	lead <b>Pb</b> 207.2	thallium <b>Tl</b> 204.4	mercury <b>Hg</b> 200.6	copernicium <b>Cn</b> (285)	roentgenium <b>Rg</b> (272)	copernicium <b>Cn</b> (285)	flerovium <b>Fl</b> (289)	tennessine <b>Ts</b> (294)	gallium <b>Ga</b> 69.72	indium <b>In</b> 114.8	tin <b>Sn</b> 118.7	polonium <b>Po</b> (210)	bromine <b>Br</b> 79.90	krypton <b>Kr</b> 83.80
rubidium <b>Rb</b> 85.47	strontium <b>Sr</b> 87.62	cesium <b>Cs</b> 132.9	actinium <b>Ac</b> (227)	dubnium <b>Db</b> (268)	seaborgium <b>Sg</b> (263)	bohrium <b>Bh</b> (262)	hassium <b>Hs</b> (265)	meitnerium <b>Mt</b> (266)	darmstadtium <b>Ds</b> (269)	roentgenium <b>Rg</b> (272)	copernicium <b>Cn</b> (285)	germanium <b>Ge</b> 72.59	indium <b>In</b> 114.8	tin <b>Sn</b> 118.7	polonium <b>Po</b> (210)	iodine <b>I</b> 126.9	xenon <b>Xe</b> 131.3
francium <b>Fr</b> (223)	radium <b>Ra</b> (226)	actinium <b>Ac</b> (227)	actinium <b>Ac</b> (227)	dubnium <b>Db</b> (268)	seaborgium <b>Sg</b> (263)	bohrium <b>Bh</b> (262)	hassium <b>Hs</b> (265)	meitnerium <b>Mt</b> (266)	darmstadtium <b>Ds</b> (269)	roentgenium <b>Rg</b> (272)	copernicium <b>Cn</b> (285)	germanium <b>Ge</b> 72.59	indium <b>In</b> 114.8	tin <b>Sn</b> 118.7	polonium <b>Po</b> (210)	astatine <b>At</b> (210)	radon <b>Rn</b> (222)

cesium <b>Ce</b> 140.1	praseodymium <b>Pr</b> 140.9	neodymium <b>Nd</b> 144.2	promethium <b>Pm</b> (147)	samarium <b>Sm</b> 150.4	europlum <b>Eu</b> 152.0	gadolinium <b>Gd</b> 157.3	terbium <b>Tb</b> 158.9	dysprosium <b>Dy</b> 162.5	holmium <b>Ho</b> 164.9	erbium <b>Er</b> 167.3	thulium <b>Tm</b> 168.9	ytterbium <b>Yb</b> 173.0	lutetium <b>Lu</b> 175.0
thorium <b>Th</b> 232.0	protactinium <b>Pa</b> (231)	uranium <b>U</b> 238.0	neptunium <b>Np</b> (237)	plutonium <b>Pu</b> (244)	americium <b>Am</b> (243)	curium <b>Cm</b> (247)	berkelium <b>Bk</b> (247)	californium <b>Cf</b> (251)	einsteinium <b>Es</b> (252)	fermium <b>Fm</b> (257)	mendelevium <b>Md</b> (258)	nobelium <b>No</b> (259)	lawrencium <b>Lr</b> (257)

## Information Handout – Constants, Conversion Factors, Equations, and Other Data

### Physical Constants:

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1} \quad (\text{i.e. } 1 \text{ mol} = 6.022 \times 10^{23})$$

$$g \text{ (gravitational constant)} = 9.807 \text{ m/s}^2$$

$$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$c \text{ (speed of light)} = 2.998 \times 10^8 \text{ m/s}$$

$$R = 0.08206 \text{ (L}\cdot\text{atm)/(K}\cdot\text{mol)} = 8.314 \text{ J/(K}\cdot\text{mol)}$$

### Water:

$$\text{specific heat of water} = 4.184 \text{ J/(g}\cdot\text{K)}$$

$$\text{density of water} = 1.0 \text{ g/mL}$$

### Nomenclature Prefixes

Number	Prefix	Number	Prefix
1 (sometimes omitted)	mono-	6	hexa-
2	di-	7	hepta-
3	tri-	8	octa-
4	tetra-	9	nona-
5	penta-	10	deca-

Table 2.10

### Abbreviations and Prefixes:

amu atomic mass unit

lb pound

mi mile

in inch

ft foot

yd yard

min minute

hr hour

yr year

Prefix	Symbol	Factor	Example
femto	f	$10^{-15}$	1 femtosecond (fs) = $1 \times 10^{-15}$ s (0.000000000000001 s)
pico	p	$10^{-12}$	1 picometer (pm) = $1 \times 10^{-12}$ m (0.000000000001 m)
nano	n	$10^{-9}$	4 nanograms (ng) = $4 \times 10^{-9}$ g (0.000000004 g)
micro	$\mu$	$10^{-6}$	1 microliter ( $\mu$ L) = $1 \times 10^{-6}$ L (0.000001 L)
milli	m	$10^{-3}$	2 millimoles (mmol) = $2 \times 10^{-3}$ mol (0.002 mol)
centi	c	$10^{-2}$	7 centimeters (cm) = $7 \times 10^{-2}$ m (0.07 m)
deci	d	$10^{-1}$	1 deciliter (dL) = $1 \times 10^{-1}$ L (0.1 L)
kilo	k	$10^3$	1 kilometer (km) = $1 \times 10^3$ m (1000 m)
mega	M	$10^6$	3 megahertz (MHz) = $3 \times 10^6$ Hz (3,000,000 Hz)
giga	G	$10^9$	8 gigayears (Gyr) = $8 \times 10^9$ yr (8,000,000,000 Gyr)
tera	T	$10^{12}$	5 terawatts (TW) = $5 \times 10^{12}$ W (5,000,000,000,000 W)

### Conversion

#### Factors:

#### mass

$$1 \text{ lb} = 453.6 \text{ g}$$

$$1 \text{ amu} = 1.66 \times 10^{-24} \text{ g}$$

$$1 \text{ ton} = 2000 \text{ lb}$$

#### length

$$1 \text{ inch} = 2.54 \text{ cm (exact)}$$

$$1 \text{ yard} = 3 \text{ feet}$$

$$1 \text{ angstrom (\AA)} = 1 \times 10^{-10} \text{ m}$$

$$1 \text{ foot} = 12 \text{ inches}$$

$$1 \text{ mile} = 1.609 \text{ km}$$

#### volume

$$1 \text{ cm}^3 = 1 \text{ mL}$$

$$1 \text{ gallon} = 3.785 \text{ L}$$

$$1 \text{ m}^3 = 1000 \text{ L}$$

$$1 \text{ mL} = 0.033814 \text{ fl oz}$$

$$1 \text{ gallon} = 4 \text{ quarts} = 8 \text{ pints} = 16 \text{ cups} = 128 \text{ fl oz}$$

$$1 \text{ ft}^3 = 28.3168 \text{ L}$$

#### time

$$1 \text{ minute} = 60 \text{ seconds}$$

$$1 \text{ day} = 24 \text{ hours}$$

$$1 \text{ hour} = 60 \text{ minutes}$$

$$1 \text{ year} = 365.25 \text{ days}$$

#### pressure

$$760 \text{ mm Hg} = 760 \text{ torr} = 1 \text{ atm} = 1.01325 \text{ bar} = 101,325 \text{ Pa} = 101.325 \text{ kPa} = 14.73 \text{ psi absolute}$$

#### energy

$$1 \text{ cal} = 4.184 \text{ J (exact)}$$

$$1 \text{ food Calorie} = 1000 \text{ cal} = 1 \text{ kcal}$$

$$1 \text{ L}\cdot\text{atm} = 101.3 \text{ J}$$

**miscellaneous conversion units**

1 warhol = 15 minutes

1 bird/hand = 2 birds/bush

1 kardashian = 72 days = 6912 warhols

2000 mockingbirds = 2 kilomockingbird

**Selected Formulas and Equations:****unit definitions**

$$1 \text{ N} = 1 \text{ kg m s}^{-1}$$

$$1 \text{ J} = 1 \text{ kg m}^2 \text{ s}^{-2}$$

$$1 \text{ Pa} = 1 \text{ N m}^{-2} = 1 \text{ kg m}^{-1} \text{ s}^{-2}$$

**temperature conversions**

$$T \text{ (in } ^\circ\text{F)} = \frac{9}{5} T \text{ (in } ^\circ\text{C)} + 32$$

$$T \text{ (in } ^\circ\text{C)} = \frac{5}{9} [T \text{ (in } ^\circ\text{F)} - 32]$$

$$T \text{ (in K)} = T \text{ (in } ^\circ\text{C)} + 273.15$$

**equations for volume**

$$V_{\text{sphere}} = \frac{4}{3}\pi r^3$$

$$V_{\text{box}} = lwh$$

$$V_{\text{cube}} = s^3$$

$$V_{\text{cone}} = \frac{1}{3}\pi r^2 h$$

$$V_{\text{cylinder}} = \pi r^2 h$$

**other equations**

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

$$w = F \times d$$

$$q = mC_s\Delta T = C\Delta T$$

$$PV = nRT$$

$$C_g = kP_g$$

$$\ln \frac{P_2}{P_1} = \frac{\Delta H_{\text{vap}}}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right)$$

$$P_A = X_A P_A^{\circ}$$

$$P_{\text{solution}} = X_{\text{solvent}} P_{\text{solvent}}^{\circ}$$

$$\Delta T_f = iK_f m$$

$$\Delta T_b = iK_b m$$

$$\Pi = iMRT$$

$$k = A e^{-E_a/RT}$$

$$\ln \frac{k_1}{k_2} = \frac{1}{R} \left( \frac{E_{a2}}{T_2} - \frac{E_{a1}}{T_1} \right)$$

first order (rate =  $k[A]$ ):

$$\ln[A]_t = \ln[A]_0 - kt$$

or

$$\ln \frac{[A]_t}{[A]_0} = -kt$$

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

second order (rate =  $k[A]^2$ ):

$$\frac{1}{[A]_t} = \frac{1}{[A]_0} + kt$$

or

$$[A]_t = \frac{[A]_0}{1 + kt[A]_0}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

zero order (rate =  $k[A]^0 = k$ ):

$$[A]_t = [A]_0 - kt$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$[\text{H}^+][\text{OH}^-] = K_w = 1.0 \times 10^{-14} \text{ at } 25^\circ\text{C}$$

$$K_a \times K_b = K_w = 1.0 \times 10^{-14} \text{ at } 25^\circ\text{C}$$

$$p(\text{“anything”}) = -\log(\text{“that thing”})$$

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

$$\text{pOH} = -\log[\text{OH}^-]$$

$$\text{pK} = -\log K$$

$$\text{pH} + \text{pOH} = 14.00 \text{ at } 25^\circ\text{C}$$

$$\text{pH} = \text{pK}_a + \log \frac{[\text{conj base}]}{[\text{acid}]}$$

$$S = k \ln W$$

$$S = k \ln \frac{W_f}{W_i}$$

$$\Delta S_{\text{univ}} = \Delta S_{\text{sys}} + \Delta S_{\text{surr}}$$

$$\Delta S_{\text{rxn}}^\circ = \sum n S^\circ (\text{products}) - \sum m S^\circ (\text{reactants})$$

$$\Delta H_{\text{rxn}}^\circ = \sum n \Delta H_f^\circ (\text{products}) - \sum m \Delta H_f^\circ (\text{reactants})$$

$$\Delta G_{\text{rxn}}^\circ = \sum n \Delta G_f^\circ (\text{products}) - \sum m \Delta G_f^\circ (\text{reactants})$$

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

$$\Delta G = \Delta G^\circ + RT \ln Q$$

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

$$K = e^{-\Delta G^\circ/RT}$$

$$E = E_{\text{cathode}} - E_{\text{anode}}$$

$$\Delta G = -nFE$$

$$F = 96,485 \text{ C/mol } e^-$$

$$E^\circ = \frac{RT}{nF} \ln K$$

$$E^\circ = \frac{0.02569}{n} \ln K$$

$$E^\circ = \frac{0.05916}{n} \log K$$

$$E = E^\circ - \frac{RT}{nF} \ln Q$$

$$E = E^\circ - \frac{0.02569}{n} \ln Q$$

$$E = E^\circ - \frac{0.05916}{n} \log Q$$

## Figures and Tables

Common Polyatomic Ions	
ammonium	$\text{NH}_4^+$
mercury(I)	$\text{Hg}_2^{2+}$
acetate	$\text{C}_2\text{H}_3\text{O}_2^-$
azide	$\text{N}_3^-$
cyanide	$\text{CN}^-$
hydroxide	$\text{OH}^-$
chlorate	$\text{ClO}_3^-$
bromate	$\text{BrO}_3^-$
iodate	$\text{IO}_3^-$
nitrate	$\text{NO}_3^-$
sulfate	$\text{SO}_4^{2-}$
phosphate	$\text{PO}_4^{3-}$
carbonate	$\text{CO}_3^{2-}$
chromate	$\text{CrO}_4^{2-}$
dichromate	$\text{Cr}_2\text{O}_7^{2-}$
manganate	$\text{MnO}_3^-$