1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
hydrogen 1 **H** 1.008																hydrogen 1 **H** 1.008	helium 2 **He** 4.003
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.012											boron 5 **B** 10.81	carbon 6 **C** 12.01	nitrogen 7 **N** 14.01	oxygen 8 **O** 16.00	fluorine 9 **F** 19.00	neon 10 **Ne** 20.18
sodium 11 **Na** 22.99	magnesium 12 **Mg** 24.31											aluminum 13 **Al** 26.98	silicon 14 **Si** 28.09	phosphorous 15 **P** 30.97	sulfur 16 **S** 32.07	chlorine 17 **Cl** 35.45	argon 18 **Ar** 39.95
potassium 19 **K** 39.10	calcium 20 **Ca** 40.08	scandium 21 **Sc** 44.96	titanium 22 **Ti** 47.88	vanadium 23 **V** 50.94	chromium 24 **Cr** 52.00	manganese 25 **Mn** 54.94	iron 26 **Fe** 55.85	cobalt 27 **Co** 58.93	nickel 28 **Ni** 58.69	copper 29 **Cu** 63.55	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.72	germanium 32 **Ge** 72.59	arsenic 33 **As** 74.92	selenium 34 **Se** 78.96	bromine 35 **Br** 79.90	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.47	strontium 38 **Sr** 87.62	yttrium 39 **Y** 88.91	zirconium 40 **Zr** 91.22	niobium 41 **Nb** 92.91	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** (98)	ruthenium 44 **Ru** 101.1	rhodium 45 **Rh** 102.9	palladium 46 **Pd** 106.4	silver 47 **Ag** 107.9	cadmium 48 **Cd** 112.4	indium 49 **In** 114.8	tin 50 **Sn** 118.7	antimony 51 **Sb** 121.8	tellurium 52 **Te** 127.6	iodine 53 **I** 126.9	xenon 54 **Xe** 131.3
cesium 55 **Cs** 132.9	barium 56 **Ba** 137.3	lanthanum 57 **La** 138.9	hafnium 72 **Hf** 178.5	tantalum 73 **Ta** 180.9	tungsten 74 **W** 183.8	rhenium 75 **Re** 186.2	osmium 76 **Os** 190.2	iridium 77 **Ir** 192.2	platinum 78 **Pt** 195.1	gold 79 **Au** 197.0	mercury 80 **Hg** 200.6	thallium 81 **Tl** 204.4	lead 82 **Pb** 207.2	bismuth 83 **Bi** 209.0	polonium 84 **Po** (210)	astatine 85 **At** (210)	radon 86 **Rn** (222)
francium 87 **Fr** (223)	radium 88 **Ra** (226)	actinium 89 **Ac** (227)	rutherfordium 104 **Rf** (265)	dubnium 105 **Db** (268)	seaborgium 106 **Sg** (263)	bohrium 107 **Bh** (262)	hassium 108 **Hs** (265)	meitnerium 109 **Mt** (266)	darmstadtium 110 **Ds** (269)	roegtgenium 111 **Rg** (272)	copernicium 112 **Cn** (285)	113 **	flerovium 114 **Fl** (289)	115 **	livermorium 116 **Lv** (293)	117 **	118 **

cesium 58 **Ce** 140.1	praseodymium 59 **Pr** 140.9	neodymium 60 **Nd** 144.2	promethium 61 **Pm** (147)	samarium 62 **Sm** 150.4	europium 63 **Eu** 152.0	gadolinium 64 **Gd** 157.3	terbium 65 **Tb** 158.9	dysprosium 66 **Dy** 162.5	holmium 67 **Ho** 164.9	erbium 68 **Er** 167.3	thulium 69 **Tm** 168.9	ytterbium 70 **Yb** 173.0	lutetium 71 **Lu** 175.0
thorium 90 **Th** 232.0	protactinium 91 **Pa** (231)	uranium 92 **U** 238.0	neptumium 93 **Np** (237)	plutonium 94 **Pu** (244)	americium 95 **Am** (243)	curium 96 **Cm** (247)	berkelium 97 **Bk** (247)	californium 98 **Cf** (251)	einsteinium 99 **Es** (252)	fermium 100 **Fm** (257)	mendelevium 101 **Md** (258)	nobelium 102 **No** (259)	lawrencium 103 **Lr** (257)

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

Save this handout to use when you are working homework problems. You will receive an updated handout with each exam.

Physical Constants:

$N_A = 6.022 \times 10^{23}$ mol^{-1} (i.e. 1 mol = 6.022×10^{23})
g (gravitational constant) = 9.807 m/s^2
$h = 6.626 \times 10^{-34}$ J·s
c (speed of light) = 2.998×10^8 m/s
R = 0.08206 (L·atm)/(K·mol) = 8.314 J/(K·mol)

Water:

specific heat of water = 4.184 J/(g·K)
density of water = 1.0 g/mL

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

Conversion Factors:

mass

1 lb = 453.6 g
1 amu = 1.66×10^{-24} g
1 ton = 2000 lb

length

1 inch ≡ 2.54 cm (exact)
1 yard = 3 feet
1 foot = 12 inches
1 mile = 1.609 km

volume

1 cm^3 = 1 mL
1 cup = 8 ounces
1 quart = 2 pints
1 gallon = 3.785 L
1 m^3 = 1000 L
1 pint = 2 cups
1 gallon = 4 quarts = 8 pints = 16 cups
1 cubic foot = 28.3168 L

time

1 minute = 60 seconds
1 day = 24 hours
1 hour = 60 minutes
1 year = 365.25 days

pressure

760 mm Hg = 760 torr = 1 atm = 1.01325 bar = 101,325 Pa = 101.325 kPa = 14.73 psi absolute

energy

1 cal ≡ 4.184 J (exact)
1 food Calorie = 1000 cal = 1 kcal

1 L·atm = 101.3 J

Selected Formulas and Equations:

unit definitions

1 N = 1 kg m s^{-1}

1 J = 1 kg m^2 s^{-2}

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

1 C · 1 V = 1 J

temperature conversions

T (in °F) = $^9/_5$ T (in °C) + 32

T (in °C) = $^5/_9$ [T (in °F) – 32]

T (in K) = T (in °C) + 273.15

equations for volume

$V_{sphere} = {}^4/_3\pi r^3$

$V_{box} = lwh$

$V_{cube} = s^3$

$V_{cone} = {}^1/_3\pi r^2 h$

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

math equations

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

y = mx + b

Statistics:

$$E_y = \sqrt{\sum_i E_{x_i}^2}$$

$$s_y = \sqrt{\sum_i s_{x_i}^2}$$

$$E_{r,y} = \sqrt{\sum_i (E_{r,x_i})^2}$$

$$\frac{s_y}{y} = \sqrt{\sum_i \left(\frac{s_i}{x_i}\right)^2}$$

(see table on next page for alternate versions of the above equations in terms of standard deviation)

$$\bar{x} = \frac{\sum_i x_i}{N}$$

$$s = \sqrt{\frac{\sum_i (x_i - \bar{x})^2}{N-1}}$$

$$\sigma = \sqrt{\frac{\sum_i (x_i - \mu)^2}{N}}$$

$$\text{CL for } \mu = \bar{x} \pm \frac{ts}{\sqrt{N}}$$

$$t_{calculated} = \frac{\left|\bar{x}_1 - \bar{x}_2\right|}{s_{pooled}\sqrt{\frac{N_1 + N_2}{N_1 N_2}}}$$

$$s_{pooled} = \sqrt{\frac{s_1^2(N_1 - 1) + s_2^2(N_2 - 1)}{N_1 + N_2 - 2}}$$

$$s_{pooled} = \sqrt{\frac{\sum_i (x_i - \bar{x}_1)^2 + \sum_j (x_j - \bar{x}_2)^2 + \sum_k (x_k - \bar{x}_3)^2 + \cdots}{N_1 + N_2 + N_3 + \cdots - N_t}}$$

$$s_d = \sqrt{\frac{\sum (d_i - \bar{d})^2}{N-1}}$$

$$t_{\text{calculated}} = \frac{|\bar{d}|}{\bar{s}_d}\sqrt{N}$$

$$Q_{\text{calculated}} = \frac{\text{gap}}{\text{range}}$$

Ionic Strength and Activity:

$$\mu = \frac{1}{2}(c_1 z_1^2 + c_2 z_2^2 + \cdots) = \frac{1}{2}\sum_i c_i z_i^2$$

$$A_{\text{C}} = [\text{C}]\gamma_{\text{C}}$$

$$\log\ \gamma = \frac{-0.51\, z^2 \sqrt{\mu}}{1 + \alpha B\sqrt{\mu}}$$

Acid-Base Chemistry:

$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$

$pH = -\log[H^+]$

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

$pH + pOH = 14.00$

$$[\text{H}^+] = \frac{-K_\text{a} \pm \sqrt{K_\text{a}^{\,2} - 4K_\text{a} c_{\text{HA}}}}{2}$$

$$[\text{H}^+] = \sqrt{K_\text{a} c_{\text{HA}}}$$

$$\text{pH} = \text{pK}_\text{a} + \log\frac{[\text{base}]}{[\text{acid}]}$$

$$\text{pH} = \text{pK}_\text{a} + \log\frac{[\text{A}^-]}{[\text{HA}]}$$

$$\text{pH} = \text{pK}_\text{a} + \log\frac{[\text{B}]}{[\text{BH}^+]}$$

$$[\text{H}^+]^3 + K_\text{a}[\text{H}^+]^2 - \left\{K_\text{a}[\text{HA}]_\text{F} + K_\text{w}\right\}[\text{H}^+] - K_\text{a}K_\text{w} = 0$$

$$[H^+] = \sqrt{\frac{K_{a,2}c_{HA^-} + K_w}{1 + \frac{c_{HA^-}}{K_{a,1}}}}$$

$$[H^+] = \sqrt{K_{a,1}K_{a,2}}$$