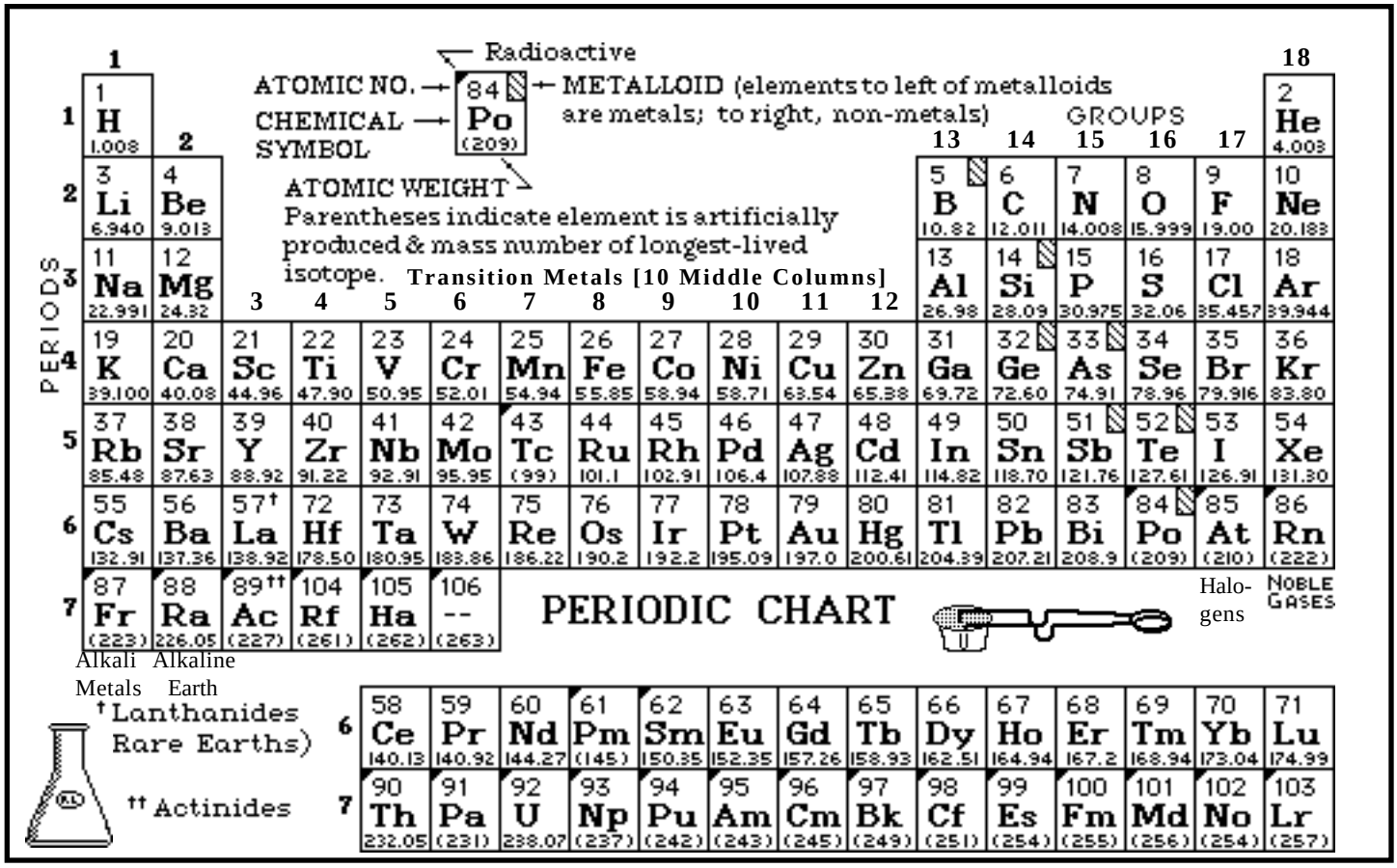
The Chemistry Cruncher Vol. 1©



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.008																	2 He 4.003
2	3 Li 6.940	4 Be 9.013											5 B 10.82	6 C 12.011	7 N 14.008	8 O 15.999	9 F 19.00	10 Ne 20.183
3	11 Na 22.991	12 Mg 24.32											13 Al 26.98	14 Si 28.09	15 P 30.975	16 S 32.06	17 Cl 35.457	18 Ar 39.944
4	19 K 39.100	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.95	24 Cr 52.01	25 Mn 54.94	26 Fe 55.85	27 Co 58.94	28 Ni 58.71	29 Cu 63.54	30 Zn 65.38	31 Ga 69.72	32 Ge 72.60	33 As 74.91	34 Se 78.96	35 Br 79.916	36 Kr 83.80
5	37 Rb 85.48	38 Sr 87.63	39 Y 88.92	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc (99)	44 Ru 101.1	45 Rh 102.91	46 Pd 106.4	47 Ag 107.88	48 Cd 112.41	49 In 114.82	50 Sn 118.70	51 Sb 121.76	52 Te 127.61	53 I 126.91	54 Xe 131.30
6	55 Cs 132.91	56 Ba 137.36	57† La 138.92	72 Hf 178.50	73 Ta 180.95	74 W 183.86	75 Re 186.22	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 197.0	80 Hg 200.61	81 Tl 204.39	82 Pb 207.21	83 Bi 208.9	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra 226.05	89†† Ac (227)	104 Rf (261)	105 Ha (262)	106 -- (263)												

	58	59	60	61	62	63	64	65	66	67	68	69	70	71
6	Ce 140.13	Pr 140.92	Nd 144.27	Pm (145)	Sm 150.35	Eu 152.35	Gd 157.26	Tb 158.93	Dy 162.51	Ho 164.94	Er 167.2	Tm 168.94	Yb 173.04	Lu 174.99
7	90 Th 232.05	91 Pa (231)	92 U 238.07	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (245)	97 Bk (249)	98 Cf (251)	99 Es (254)	100 Fm (255)	101 Md (256)	102 No (254)	103 Lr (257)

STOICHIOMETRY FLOW CHART

Start With:	Convert to:	Multiply by:	Convert to:
Mass (g,kg,etc.) Volume (L,mL,etc.) or # of items (atoms,molec.) of a Given reactant or product	→ Moles of Given	→ Mole Ratio from the Balanced Chemical Equation	→ Mass (g,kg,etc.) Volume (L,mL,etc.) or # of items (atoms,molec.) of Unknown reactant or product

Diatomic Elements
Bromine
Chlorine
Fluorine
Hydrogen
Iodine
Nitrogen
Oxygen
HOFBrINCl

1 = atomic mass in grams for an element
M = formula mass in grams for a compound
O = 6.02×10^{23} atoms of an element
L = 6.02×10^{23} formula units of a compound
E = 22.4 liters of a gas at STP

For mole problems call Avogadro's No.: 6.02×10^{23}

Colligative Properties

$T_{bp} = K_{bp} m$

$T_{fp} = K_{fp} m$ H_2O

$K_{bp} = .52°C/m$

$K_{fp} = 1.86°C/m$

$pH = - \log [H^+]$ & $pOH = - \log [OH^-]$

Diagonal Rule

1s
2s 2p
3s 3p 3d
4s 4p 4d 4f
5s 5p 5d 5f
6s 6p 6d
7s 7p

relative/%error

$E_r = \frac{|O-A|}{A}$

Gases at STP	# of Liters
moles	22.4

# of Particles (atoms/molec. etc.)	
6.02×10^{23}	Moles

# of Grams	
Formula Mass	Moles

Std. Temperature
0°C
273.16 K

Std. Pressure:
1 atm
760 mmHg
101.3 kPa
14.7 lb/in^2
760 Torr
1.01×10^5 N/m^2

Gas Laws

Boyles Law: $V_1P_1=V_2P_2$

Charles Law: $V_1T_2=V_2T_1$

Combined Gas Law: $V_1P_1T_2=V_2P_2T_1$

Ideal Gas Law: $PV=nRT$

$R=.0821 \frac{\text{L-atm}}{\text{mole-K}}$

Moles of Solute	
Molality	kg of solvent

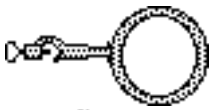
Moles	
Molarity	Liters

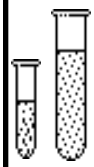
Normality	
Molarity	+ Oxidation Number

Solubility Table

s = soluble
i = insoluble
- = does not exist
s/i = partly soluble
d = decomposes

	Acetate	Bromide	Carbonate	Chlorate	Chloride	Hydroxide	Iodide	Nitrate	Oxide	Phosphate	Sulfate	Sulfide	
	$C_2H_3O_2^-$	Br^-	CO_3^{-2}	ClO_3^-	Cl^-	OH^-	I^-	NO_3^-	O^-	PO_4^{-3}	SO_4^{-2}	S^{-2}	
Aluminum	s	s	-	s	s	i	s	s	i	i	-	d	Al^{+3}
Ammonium	s	s	s	s	s	s	s	s	-	s	s	s	NH_4^+
Barium	s	s	i	s	s	s	s	s	s	i	i	s	Ba^{+2}
Cadmium	s	s	i	s	s	i	s	s	i	i	s	i	Cd^{+2}
Calcium	s	s	i	s	s	i	s	s	i	i	i	i	Ca^{+2}
Copper I (ous)	-	s/i	i	-	i	i	i	-	i	-	d	i	Cu^+
Copper II (ic)	s	s	d	s	s	i	-	s	i	i	s	i	Cu^{+2}
Hydrogen	s	s	s	s	s	HOH	s	s	s	s	s	s	H^+
Iron II (ous)	s	s	i	-	s	i	s	s	i	i	s	i	Fe^{+2}
Iron III (ic)	i	s	-	-	s	i	-	s	i	i	s/i	i	Fe^{+3}
Lead II (ous)	s	s/i	i	s	s/i	i	i	s	i	i	i	i	Pb^{+2}
Lead IV (ic)	d	-	-	-	d	-	-	-	i	-	-	-	Pb^{+4}
Magnesium	s	s	i	s	s	i	s	s	i	i	s	d	Mg^{+2}
Manganese	s	s	i	-	s	i	s	s	i	-	s	i	Mn^{+2}
Mercury I (ous)	s/i	i	i	s/i	i	-	s/i	s/d	i	i/d	i	i	Hg_2^{+2}
Mercury II (ic)	s	s/i	i	s	s	i	i	s	i	s/i	d	i	Hg^{+2}
Nickel	s	s	i	s	s	i	s	s	i	i	s	i	Ni^{+2}
Potassium	s	s	s	s	s	s	s	s	d	s	s	i	K^+
Silver	s	i	i	s	i	-	i	s	i	i	s	i	Ag^+
Sodium	s/i	s	s	s	s	s	s	s	d	s	s	s	Na^+
Tin II (ous)	-	-	-	-	s	i	s	-	i	-	s	i	Sn^{+2}
Tin IV (ic)	-	s/d	-	-	s/d	-		s	i	i	s/d	i	Sn^{+4}
Zinc	s	s	i	s	s	i		s	i	i	s	i	Zn^{+2}





Reaction Types

Direct Combination or Synthesis
A + B -----> AB
Decomposition or Analysis
AB -------> A + B
Single Replacement
A + BC ------> B + AC
Double Replacement
AB + CD -------> AD + CB
Combustion of Hydrocarbon
$C_xH_y + O_2$ ----> CO_2 + H_2O


Pipette

Common Acids

Sulfuric	H_2SO_4
Nitric	HNO_3
Hydrochloric	HCl
Acetic	$HC_2H_3O_2$
Carbonic	H_2CO_3
Phosphoric	H_3PO_4
Perchloric	$HClO_4$
Oxalic	$H_2C_2O_4$

Prefixes

1. mono	6. hexa
2. di	7. hepta
3. tri	8. octa
4. tetra	9. nona
5. penta	10. deca

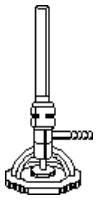
Do what you oughta add acid to watta

Polyatomic Ions

Ammonium	NH_4^{+1}
Acetate	$C_2H_3O_2^{-1}$
Arsenate	AsO_4^{-3}
Arsenite	AsO_3^{-1}
Bicarbonate	HCO_3^{-1}
Bisulfate	HSO_4^{-1}
Carbonate	CO_3^{-2}
Chlorate	ClO_3^{-1}
Chlorite	ClO_2^{-1}
Chromate	CrO_4^{-2}
Cyanide	CN^{-1}
Dichromate	$Cr_2O_7^{-2}$
Hydroxide	OH^{-1}
Iodate	IO_3^{-1}
Nitrate	NO_3^{-1}
Nitrite	NO_2^{-1}
Oxalate	$C_2O_4^{-2}$
Permanganate	MnO_4^{-1}
Perchlorate	ClO_4^{-1}
Phosphate	PO_4^{-3}
Sulfate	SO_4^{-2}
Thiocynate	SCN^{-1}
Thiosulfate	$S_2O_3^-$

Common Molecular Masses (g/mole)

NaCl	58.45	$HC_2H_3O_2$	60.05	NaOH	40.00
Al_2O_3	101.96	HCl	36.46	Fe_2O_3	159.70
HNO_3	63.01	HgO	216.61	H_2SO_4	98.08
$Ca(OH)_2$	74.10	$CuSO_4$	159.61	$AgNO_3$	169.89
H_3PO_4	98.00	$KMnO_4$	158.04	$KClO_3$	122.55

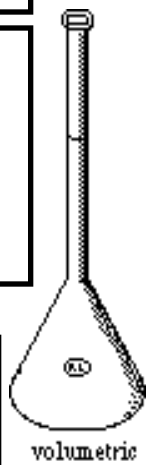


Conversions

1.0 in. = 2.54 cm
1.0 lb = 454 g
1.0 qt = 0.9463 L
1.0 km = 0.6214 mi
1 cal = 4.184 J

Common Anions & Cations

Fe	+2,+3	Pb	+2,+4	Zn	+2	Na	+1	F	-1
Cu	+1,+2	K	+1	Ag	+1	Ba	+2	Cl	-1
Al	+3	Mg	+2	Sn	+2,+4	Ca	+2	Br	-1
Cd	+2	Li	+1	Hg	+1,+2	Sr	+2	I	-1
Au	+1	Ni	+2	Co	+2,+3	H	+1	O	-2


volumetric flask

Temp. conversions:

$$°C = \frac{°F-32}{1.8}$$

F = (1.8) (°C) + 32
K = °C + 273.16

Density = $\frac{\text{mass}}{\text{volume}}$

A = r^2 }○
C = d

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

$V_{cyl.} = r^2h$

V = l x w x h } ▭

Neutralization:
Acid + Base ---> Salt + Water
HCl + NaOH ---> NaCl + H_2O

H___	acids start with H
___OH	bases end with OH
___	salts do neither
HOH	water does both

System International Prefixes [SI]

Prefix	abbr.	means	multiplier*
tera	T	Trillion	10^{12}
giga	G	billion	10^{9}
mega	M	million	10^{6}
kilo	k	thousand	10^{3}
hecto	h	hunderd	10^{2}
deka	da	ten	10^{1}
-----	--	base unit	10^{0}
deci	d	1 tenth	10^{-1}
centi	c	1 hundredth	10^{-2}
milli	m	1 thousandth	10^{-3}
micro	µ	1 millionth	10^{-6}
nano	n	1 billionth	10^{-9}
pico	p	1 trillionth	10^{-12}

* replace prefix with multiplier, eg. 5.92 µg = 5.92 x 10^{-6}g

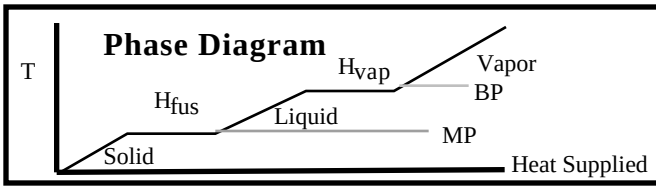
Physical Constants

Avogadro's number	N_A	= 6.0221 x 10^{23} /mole
Bohr radius	a_o	= 5.292 x 10^{-11} m
Boltzmann constant	k	= 1.381 x 10^{-23} J/K
Faraday constant	F	= 9.649 x 10^{4} C/mol e$^-$
gas constant	R	= 8.206 x 10^{-2} L·atm/mol·K
		= 62.4 L·torr/mol·K
		= 8.314 J/mol·K
		= 8.314 L·kPa/mol·K
Planck's constant	h	= 6.626 x 10^{-34} J·s
absolute zero		= 0 K or – 273.15 °C
amu	u	= 1.6605 x 10^{-24} g
		= 1.6605 x 10^{-27} kg
gravitational const.	g	= 9.807 m/sec^2
molar volume at STP	V_m	= 22.414 L/mol
speed of light	c	= 2.998 x 10^{8} m/s
		= 2.998 x 10^{10} cm/s
electron charge	– e	= –1.602 x 10^{-19} C
electron rest mass	m_e	= 9.1096 x 10^{-28} g
		= 0.00054580 amu
proton rest mass	m_p	= 1.67265 x 10^{-24} g
		= 1.007277 amu
neutron rest mass	m_n	= 1.67495 x 10^{-24} g
		= 1.008665 amu

SI Base Units

Quantity	Unit	abbr.	Apparatus
length	meter	m	ruler
mass	kilogram	kg	balance
time	second	s	stopwatch
amount of substance	mole	mol	----------
temperature	kelvin	K	thermometer
electric current	ampere	A	ammeter
luminous intensity	candela	cd	light meter

Phase Diagram



Metric English Equivalents [length]

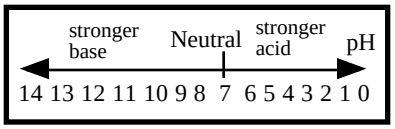
1.000 mi = 5282 ft
1.000 in = 2.540 cm
1.000 ft = 30.48 cm
1.000 yd = 0.9144 m
1.000 mi = 1.609 km
1 Å = 10^{-10} m = 0.1 nm
1.000 cm = 0.3937 in
1.000 m = 39.37 in
1.000 m = 1.094 yd
1.000 km = 0.6214 mi

Metric English Equivalents [mass]

1 lb = 16 oz
1.000 oz = 28.23 g
1.000 lb = 453.6 g
1.000 lb = 0.4536 kg
1 metric ton = 1000 kg
1.000 g = 0.03527 oz
1.000 kg = 35.27 oz
1.000 kg = 2.205 lb

Metric English Equivalents [volume]

1 ft^3 = 1728 in^3
1 yd^3 = 27 ft^3 = 46656 in^3
1.000 in^3 = 16.39 cm^3
1.000 ft^3 = 28.32 dm^3
1 m^3 = 1 000 000 cm^3
1.000 cm^3 = 0.06102 in^3
1.000 dm^3 = 61.02 in^3
1.000 m^3 = 35.31 ft^3



Electroneg. Differfence	Type of Bond
0.0-0.4	Covalent [NP]
0.4-1.0	Covalent [MP]
1.0-2.0	Covalent [VP]
2.0	Ionic

H	Li	Be	B	C	N	O	F	Na	Mg	Al	Si	P	S	Cl
2.1	1.0	1.5	2.0	2.5	3.0	3.5	4.0	0.9	1.2	1.5	1.8	2.1	2.5	3.0
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As
0.8	1.0	1.3	1.5	1.6	1.6	1.5	1.8	1.8	1.8	1.9	1.6	1.6	1.8	2.0
Se	Br	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In
2.4	2.8	0.8	1.0	1.2	1.4	1.6	1.8	1.9	2.2	2.2	1.9	1.9	1.7	1.7
Sn	Sb	Te	I	Cs	Ba	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
1.8	1.9	2.1	2.5	0.7	0.9	1.3	1.5	1.7	1.9	2.2	2.2	2.4	2.4	1.9
Tl	Pb	Bi	Po	At	Fr	Ra								
1.8	1.8	1.9	2.0	2.2	0.7	0.9								

Table of Electronegativities

The Element List

Actinium	Ac	Mercury	Hg
Aluminum	Al	Molybdenum	Mo
Americium	Am	Neilsbohrium	Ns
Antimony	Sb	Neodyium	Nd
Argon	Ar	Neon	Ne
Arsenic	As	Neptunium	Np
Astatine	At	Nickel	Ni
Barium	Ba	Niobium	Nb
Berkelium	Bk	Nitrogen	N
Beryllium	Be	Nobelium	No
Bismuth	Bi	Osmium	Os
Boron	B	Oxygen	O
Bromine	Br	Palladium	Pd
Cadmium	Cd	Phosphorus	P
Calcium	Ca	Platinum	Pt
Californium	Cf	Plutonium	Pu
Carbon	C	Polonium	Po
Cerium	Ce	Potassium	K
Cesium	Cs	Praeseodymium	Pr
Chlorine	Cl	Promethium	Pm
Chromium	Cr	Protactinium	Pa
Cobalt	Co	Radium	Ra
Copper	Cu	Radon	Rn
Curium	Cm	Rhenium	Re
Dysprosium	Dy	Rhodium	Rh
Einsteinium	Es	Rubidium	Rb
Erbium	Er	Ruthenium	Ru
Europium	Eu	Rutherfordium	Rf
Fermium	Fm	Samarium	Sm
Fluorine	F	Scandium	Sc
Francium	Fr	Selenium	Se
Gadolinium	Gd	Silicon	Si
Gallium	Ga	Silver	Ag
Germanium	Ge	Sodium	Na
Gold	Au	Strontium	Sr
Hafnium	Hf	Sulfur	S
Hahnium	Ha	Tantalum	Ta
Hassium	Hs	Technetium	Tc
Helium	He	Tellurium	Te
Holmium	Ho	Terbium	Tb
Hydrogen	H	Thallium	Tl
Indium	In	Thorium	Th
Iodine	I	Thullium	Tm
Iridium	Ir	Tin	Sn
Iron	Fe	Titanium	Ti
Krypton	Kr	Tungsten	W
Lanthanum	La	Unnilhexium	Unh
Lawrencium	Lr	Ununnilium	Uun
Lead	Pb	Uranium	U
Lithium	Li	Vanadium	V
Lutetium	Lu	Xenon	Xe
Magnesium	Mg	Ytterbium	Yb
Manganese	Mn	Yttrium	Y
Meitnerium	Mt	Zinc	Zn
Mendelevium	Md	Zirconium	Zr

Heat Equations

$Q = mH_V$ $Q = mc\ T$ $Q = mH_f$

$H = H_f(\text{products}) - H_f(\text{reactants})$

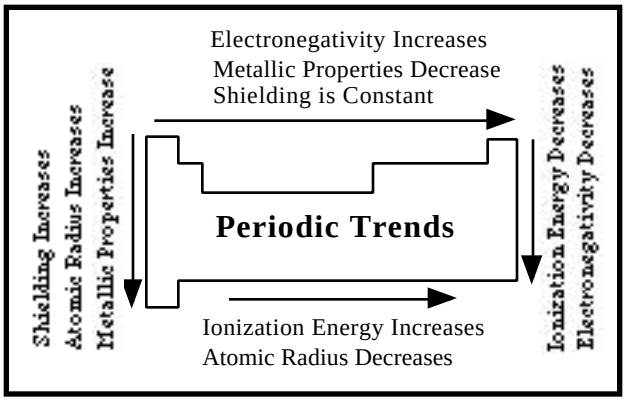
Activity Series (Metals)

Li
K
Ba
Ca
Na
Mg
Al
Mn
Zn
Cr
Fe
Cd
Co
Ni
Sn
Pb
H
Sb
Bi
As
Cu
Hg
Ag
Pt
Au

Buret

Wear Goggles

Wear Apron



Rules for Significant Figures

Significant figures are the digits in any measurement that are known with certainty plus one digit that is uncertain.

Rule 1: In numbers that do not contain zeros, all the digits are significant.

3.1428	[5]	3.14	[3]
469	[3]		

Rule 2: All zeros between significant digits are significant

7.053	[4]	7053	[4]
302	[3]		

Rule 3: Zeros to the left of the first nonzero digit serve only to fix the position of the decimal point and are not significant

0.0056	[2]	0.0789	[3]
0.000001	[1]		

Rule 4: In a number with digits to the right of a decimal point, zeros to the right of the last nonzero digit are significant

43	[2]	43.0	[3]
43.00	[4]	0.00200	[3]
0.40050	[5]		

Rule 5: In a number that has no decimal point, and that ends in zeros (such as 3600), the zeros at the end may or may not be significant (it is ambiguous). To avoid ambiguity express the number in scientific notation showing in the coefficient the number of significant digits.

Selected Constants for H_2O

molar mass.....18.0153 g/mol
normal freezing point.....0.00 °C
normal boiling point.....100.00°C
average specific heat, C_p.....2.06 J/g·°C, solid
4.18 J/g·°C, liquid
2.02 J/g·°C, gas
heat of fusion, H_f.....334 J/g
heat of vaporization, H_v...2260 J/g
molal fp depression, K_f.....1.853 kg·°C/mol
molal bp elevation, K_b.....0.515 kg·°C/mol

Rounding Rules

XY--------> X

When Y > 5, increase X by 1
When Y < 5, don't change X
When Y = 5,
if X is odd, increase X by 1
if X is even, don't change X

Oxidation	Reduction
Loss of e^-	Gain of e^-
gain of O	loss of O