Neutralization:
Acid + Base --> Salt + Water
HCl + NaOH --> NaCl + H₂O

H____ acids start with H
____OH bases start with OH
salts do neither
HOH water does both

Common Molecular Masses (g/mole)

<table>
<thead>
<tr>
<th>Compound</th>
<th>Mass (g/mole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaCl</td>
<td>58.45</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>101.96</td>
</tr>
<tr>
<td>HNO₃</td>
<td>63.01</td>
</tr>
<tr>
<td>H₂SO₄</td>
<td>146.09</td>
</tr>
<tr>
<td>H₃PO₄</td>
<td>98.01</td>
</tr>
</tbody>
</table>

Conversions

1.0 in. = 2.54 cm
1.0 lb = 454 g
1.0 qt = 0.946 L
1.0 km = 0.6214 mi
1 cal = 4.184 J

Temp. conversions:
°C = °F - 32
°F = (1.8)(°C) + 32
K = °C + 273.16

Density = mass / volume

Ammonium  NH₄⁺
Acetate    CH₃COO⁻
Arsenate   AsO₄⁻³
Arsenite   AsO₃⁻¹
Bicarbonate HCO₃⁻¹
Bisulfate  HSO₄⁻¹
Carbonate  CO₃⁻²
Chlorate   ClO₄⁻¹
Chlorite   ClO₂⁻¹
Chromate   CrO₄⁻²
Cyanide    CN⁻¹
Dichromate Cr₂O₇⁻²
Hydroxide  OH⁻¹
Iodate     IO₃⁻¹
Nitrite    NO₂⁻¹
Oxalate    C₂O₄⁻²
Permanganate MnO₄⁻¹
Perchlorate ClO₄⁻¹
Phosphate  PO₄⁻³
Sulfite     SO₄⁻²
Thiocyanate SCN⁻¹
Thiosulfate S₂O₃⁻²

Polyatomic Ions

Thiosulfate "S₂O₃⁻²"
### System International Prefixes [SI]

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

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

### SI Base Units

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Unit</th>
<th>abbr.</th>
<th>Apparatus</th>
</tr>
</thead>
<tbody>
<tr>
<td>length</td>
<td>meter</td>
<td>m</td>
<td>ruler</td>
</tr>
<tr>
<td>mass</td>
<td>kilogram</td>
<td>kg</td>
<td>balance</td>
</tr>
<tr>
<td>time</td>
<td>second</td>
<td>s</td>
<td>stopwatch</td>
</tr>
<tr>
<td>amount of substance</td>
<td>mole</td>
<td>mol</td>
<td></td>
</tr>
<tr>
<td>temperature</td>
<td>kelvin</td>
<td>K</td>
<td>thermometer</td>
</tr>
<tr>
<td>electric current</td>
<td>ampere</td>
<td>A</td>
<td>ammeter</td>
</tr>
<tr>
<td>luminous intensity</td>
<td>candela</td>
<td>cd</td>
<td>light meter</td>
</tr>
</tbody>
</table>

### Physical Constants

- **Avogadro’s number**: $N_A = 6.0221 \times 10^{23}$/mole
- **Bohr radius**: $a_o = 5.292 \times 10^{-11}$ m
- **Boltzmann constant**: $k = 1.381 \times 10^{-23}$ J/K
- **Faraday constant**: $F = 9.649 \times 10^4$ C/mol e–
- **gas constant**: $R = 8.206 \times 10^2$ L·atm/mol·K
- **Planck’s constant**: $h = 6.626 \times 10^{-24}$ J·s
- **absolute zero**: $0$ K or $-273.15\, ^\circ C$
- **amu**: $u = 1.6605 \times 10^{-24}$ g
- **gravitational const.** $g = 9.807 \times 10^2$ m/sec$^2$
- **Planck’s constant**: $\hbar = 6.626 \times 10^{-34}$ J·s
- **gas constant**: $R = 8.206 \times 10^2$ L·atm/mol·K
- **speed of light**: $c = 2.998 \times 10^8$ m/s
- **electron charge**: $-e = -1.602 \times 10^{-19}$ C
- **electron rest mass**: $m_e = 9.1096 \times 10^{-28}$ g
- **proton rest mass**: $m_p = 1.67265 \times 10^{-24}$ g
- **neutron rest mass**: $m_n = 1.67495 \times 10^{-24}$ g

### Table of Electronegativities

<table>
<thead>
<tr>
<th>Elecm. Type of Bond</th>
<th>Difference</th>
<th>pH</th>
<th>Stronger base</th>
<th>Neutral</th>
<th>Stronger acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covalent [NP]</td>
<td>0.0-0.4</td>
<td></td>
<td>14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</td>
<td>Covalent [MP]</td>
<td>Covalent [VP]</td>
</tr>
<tr>
<td>Covalent [MP]</td>
<td>0.4-1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covalent [VP]</td>
<td>1.0-2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ionic</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Metric English Equivalents

#### [length]
- $1.000 \text{ mi} = 5282 \text{ ft}$
- $1.000 \text{ in} = 2.540 \text{ cm}$
- $1.000 \text{ ft} = 0.3048 \text{ cm}$
- $1.000 \text{ yd} = 0.9144 \text{ m}$
- $1.000 \text{ mi} = 1.609 \text{ km}$
- $1 \text{ Å} = 10^{-10} \text{ m} = 0.1 \text{ nm}$
- $1.000 \text{ cm} = 0.3937 \text{ in}$
- $1.000 \text{ m} = 39.37 \text{ in}$
- $1.000 \text{ m} = 1.094 \text{ yd}$
- $1.000 \text{ km} = 0.6214 \text{ mi}$

#### [mass]
- $1 \text{ lb} = 16 \text{ oz}$
- $1.000 \text{ oz} = 28.23 \text{ g}$
- $1.000 \text{ lb} = 453.6 \text{ g}$
- $1.000 \text{ lb} = 0.4536 \text{ kg}$
- $1 \text{ metric ton} = 1000 \text{ kg}$
- $1.000 \text{ g} = 0.03527 \text{ oz}$
- $1.000 \text{ kg} = 35.27 \text{ oz}$
- $1.000 \text{ kg} = 2.205 \text{ lb}$
- $1.000 \text{ lb} = 0.4536 \text{ kg}$
- $1 \text{ metric ton} = 1000 \text{ kg}$

#### [volume]
- $1 \text{ ft}^3 = 1728 \text{ in}^3$
- $1.000 \text{ yd}^3 = 27 \text{ ft}^3 = 46656 \text{ in}^3$
- $1.000 \text{ in}^3 = 16.39 \text{ cm}^3$
- $1.000 \text{ ft}^3 = 28.32 \text{ dm}^3$
- $1.000 \text{ m}^3 = 1000000 \text{ cm}^3$
- $1.000 \text{ cm}^3 = 0.06102 \text{ in}^3$
- $1.000 \text{ dm}^3 = 61.02 \text{ in}^3$
- $1.000 \text{ m}^3 = 35.31 \text{ ft}^3$

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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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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 \[3\]

Rule 2: All zeros between significant digits are significant.

7.053 \[4\] 7053 \[4\]

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.

Activity Series (Metals)

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

Buret

Selected Constants for H₂O

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
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

Heat Equations

\[ Q = mH_v \]
\[ Q = mcT \]
\[ Q = mH_f \]

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

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

Loss of e⁻  Gain of e⁻

Reduction

gain of O  loss of O