Welcome to AP Chemistry!

I hope you are ready for a challenging and great year. In order to learn the material for AP Chemistry, you have to know the basics! The material that follows should be review and I will not spend class time on it in the fall. You will have the opportunity to earn points for doing the summer assignment packet. If you choose not to do the packet, your packet grade will not be affected, but future grades in the class WILL be affected as you will not have learned/reviewed the foundational material. The material covered on this summer assignment will assessed quickly.

I suggest not even thinking about this work until around the 20th of August. That will give you ~two weeks to work on the packet & be ready for school in the fall.

If you have ANY questions, please reach out to me by email: smithke@tcaps.net Like any good chemist, I will be checking my email *periodically* in the summer.
Good Luck and Welcome to the class!
Ms. Smith

Chapter 1: Matter, measurement and problem solving
Classification of Matter

1. The three common states of matter are _______________, ________________, and __________________.
2. Describe the molecules in each state or possibly draw a picture. (Basic drawings only)

Pure Substances have distinct properties and constant compositions. Elements and compounds are two groupings of pure substances. All substances are either elements or compounds. Give a definition of each.

Element –

Compound –

Mixtures are not pure substances. Each substance in the mixture retains its own chemical properties. Mixtures may or may not be uniform throughout. There are two types of mixtures. Describe.

Heterogeneous mixtures –

Homogeneous mixtures (aka solutions)–

Properties of Matter

Physical properties are those that can be observed without altering the substance chemically.

Ex.

Chemical properties are those that cannot be observed without altering the substance chemically.

Ex.

Physical change – change that does not alter the substance chemically

Ex.

Chemical change – change that chemically alters the substance

Ex.

Units of Measurement

Know the SI Units and their abbreviations (IE. meters, kilograms, seconds, Kelvin, moles). Use the common metric prefixes in dimensional analysis. Below are the ones provided to you. Fill in the bolded factors to the right that were not provided for you.

METRIC PREFIXES		
Factor	Prefix	Symbol
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

Factor Meaning	
1 gigameter (Gm) = 1 x 10^9 m	
1 megameter (Mm) = 1 x 10^6 m	
1 kilometer (km)= 1 x 10^3 m = 1,000 m	
1 centimeter (cm) =	
1 millimeter (mm) =	**or 1,000 mm = 1 m**
1 micrometer (μm) =	
1 nanometer (nm) =	
1 picometer (pm) = 1 x 10^{-12} m	

Significant Figures (Digits) – represent the uncertainty in measurements. Measurements should be reported to include the certain digits (the digits/places marked on the scale of the instrument) and the estimated digit (the digit/place you estimate based off the scale).

For example: Shown below is a ruler and a credit card to measure in cm. The card extends past the 8 cm mark, but not quite to the 9. The millimeter increments are marked. The card extends past the 5 mm (.5 cm) mark, but not quite to the 6 mm (.6 cm) mark.

The known or certain digits are the 8 and the .5. You would estimate the hundredths place (between the .5 and .6 cm mark), so a measurement anywhere from 8.56-8.59 cm would be appropriate for this. The key is to include the estimated digit in the hundredths place.

Rules for Sig Figs:

1. All nonzero digits are significant.
   a. Ex. 4.56 (3 sig figs), 8914 (4 sig figs)
2. All zeroes between nonzero digits are significant.
   a. Ex. 908 (3 sig figs), 80.06 (4 sig figs)
3. Zeroes at the beginning of a number are NEVER significant, they only indicate place-holding.
   a. Ex. 0.098 (2 sig figs), 0.01 (1 sig fig)
4. Zeroes at the end of the number are significant IF the number contains a decimal.
   a. Ex. 0.090 (2 sig figs), 900 (1 sig fig), 900. (3 sig figs), 900.0 (4 sig figs)

OR

Use the Atlantic-Pacific rule.

- If a decimal point is **A**bsent, start from the **A**tlantic side of the number (right)
- If a decimal point is **P**resent, start from the **P**acific side of the number (left)
- Start counting digits with the first number that is not a zero. All digits from there to the end are significant.

Practice Underline the significant digits in the following.

1. 907
2. 9.00
3. 900
4. 210
5. 2.30×10^{-12}
6. 0.00076
7. 100.
8. 0.036
9. 455.10
10. 1030

Round each to the proper number of sig figs (#).

1. 45.679 (3) ______________
2. 35.4527 (4) ______________
3. 100.13 (3) ______________
4. 100.12 (2) ______________
5. 0.000349 (1) ______________
6. 2.45 (2) ______________
7. 9.99 (2) ______________
8. 4.003 (2) ______________
9. 39.9 (2) ______________
10. 7.2487392034 (3) __________

Math with sig figs

For **multiplication and division** – the measurement with the fewest number of sig figs determines the number of sig figs in the answer.

Ex. 3.4 cm x 8.00 cm x 2.11 cm → calculator answer=57.392 cm^3 REAL answer = 57 cm^3

3.4 cm has 2 sig figs, 8.00 cm and 2.11 cm each have 3 sig figs, therefore, 2 sig figs in answer.

For **addition and subtraction** – the measurement with the fewest decimal places determines the number of decimal places in the answer.

Ex.
3.40 ← 2 decimal places
12.322 ← 3 decimal places
\+ 83.1 ← 1 decimal place
98.822

Answer: **98.8 (answer rounded to 1 decimal place)**

101
-95.3
5.7
6

If multiplication/division and addition/subtraction are used in the same problem, do in parts and then substitute rounded answer back in to problem.

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

Ex. A gas fills a container whose volume is 1.05×10^3 cm^3. The container plus gas have a mass of 837.6 g. The container when emptied of all gas, has a mass of 836.2 g. What is the density of the gas?

Find the mass of the gas. 837.6 g – 836.2 g = 1.4 g (1 # after decimal)

Find density. $D = \frac{\text{mass}}{\text{volume}} = \frac{1.4\text{g}}{1.05 \times 10^3 \text{cm}^3} = 1.3 \times 10^{-3}$ g/cm^3 = 0.0013 g/cm^3 (1.4 g now has two sig figs, therefore answer from division has two sig figs)

Practice

Carry out the following operations and express the answers with the appropriate number of sig figs.

1. 12.0550 + 9.05 = __________________

2. 257.2 – 19.789 = ____________________

3. 2.0 x 3.11 x 0.098 = __________________

4. 4.31 /100. = _________________________

5. 780/2 = ____________________________

6. (6.21 x 10^3) (0.1050) = ________________

7. 0.0577/0.753 = ______________________

8. 34.0 /(212 x 5.6) = ___________________ (since this is multiplication and division in the same problem, do all in one math problem in your calc, round for sig figs at the end)

Dimensional Analysis – A way to convert units
Ex. Convert 73.4 mL into L   1000 mL = 1 L (from conversions) or

$$\underline{0.0734}\text{ L} = \frac{1\text{ L}}{1000\text{ mL}} \times \frac{73.4\text{ mL}}{} \qquad \text{OR} \qquad \frac{73.4\text{ mL}}{} \times \frac{1\text{L}}{1000\text{ mL}} = 0.0734\text{ L}$$

Old unit cancels out (mL), leaving only "new" unit

Practice – As always, you must show your work, using dimensional analysis where appropriate.
A conversion sheet can be found at the end of this packet.

1. Convert 5.00 days to seconds

2. Convert 0.0550 mi to m

3. Convert 0.105 in to mm

4. 0.076 L to μL

5. 3.21 mi to km

6. 5.0×10^{-8} m to nm

7. 0.50 lb to g

8. 5.850 gal/hr to L/s

9. 1.955 m^3 to yd^3 (you will need the conversion factors listed on the conversion factor sheet)

10. A steel cylinder has a length of 2.16 in, a radius of 0.22 in, and a mass of 41 g. What is the density of the steel in g/cm^3?

11. The density of air at ordinary atmospheric pressure and 25°C is 1.19 g/L. What is the mass, in kilograms, of the air in a room that measures 12.5 x 15.5 x 8.0 ft? (HINT: this is a combination type problem. Get the units to be consistent (DA) with each other then do the math to find out the mass.)

Ch. 2 Material
Atomic Theory
Understand Dalton's Atomic Theory and be able to list the postulates.

Each of these people was responsible for something important in terms of the theory of atomic structure. BRIEFLY list and describe.
Ex. JJ Thomson – experiments with cathode ray tubes, "discovered" electron, named it.

Millikan –

Becquerel –

Marie and Pierre Curie –

Rutherford –

Be able to correctly use and apply these terms –
Atomic number – number of protons
Mass number – number of protons + neutrons
Atomic mass – avg mass of all an atom's isotopes
Isotopes – atoms of the same element with different number of neutrons
Ion – what results after an atom has lost or gained an electron or electrons

Mass number → $^{12}_{6}C$ ← Atomic symbol
atomic number ↗

How do you find the # of protons? Atomic number
How do you find the # of neutrons? Mass number – atomic number, example above = 6 neutrons
Positive ions (cations) have lost electrons, negative ions (anions) have gained electrons

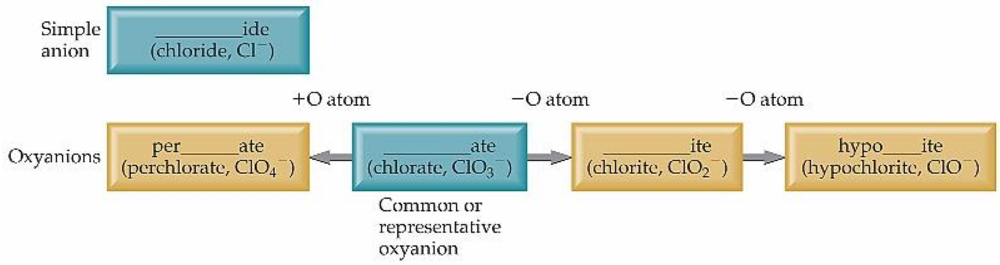
Fill in the table, as in the example.

Complete Symbol	Atomic #	Mass #	# p	#n	#e	Atom or ion?
$^{88}_{38}Sr^{2+}$	38	88	38	50	36	ion
	46	105				atom
$^{123}_{51}Sb$						
			38	51	36	
		75			33	atom
	29	63			27	
			48	63	46	
nickel-57		57				
			6	5	4	

Ch. 3 Material

Diatomic molecules – exist as a pair of atoms in a molecule if they are "by themselves", ie… not bonded to a different type of atom. Their element names end in "ine" or "gen"
Br_2 I_2 N_2 Cl_2 H_2 O_2 F_2

Oxyanions – polyatomic ions that contain oxygen, Named with –ate or –ite ending
-ate is the most common oxyanion in the set
-ite is used for the ion of the same charge, but with one fewer oxygen



As the previous figure illustrates,

Ex. ClO_3^- = chlor**ate** ClO_2^- = chlor**ite**

One fewer oxygen than –ite ion? Prefix hypo- is attached Ex. ClO^- = **hypo**chlor**ite**

One more oxygen than –ate ion? Prefix per- is attached Ex. ClO_4^- = **per**chlor**ate**

Predict bromate, bromite, hypobromite. (same family (group) as chlorine ions, hence same type of structure)

Memorize the common polyatomic ions listed on the AP Common ion sheet (attached).

Naming Ionic Compounds

1. Name cation (same name as element)
2. Determine if cation has more than one charge (usually transition metals)
   a. Indicate charge with roman numerals
3. Name anion
   a. Monatomic (ex. Cl^-) name with root + -ide → chlor**ide**
   b. Polyatomic (ex. SO_4^{2-}) name of ion itself → sulfate

Ex. $CuCl_2$ = copper (II) chloride Ex. $Mg(ClO_3)_2$ = magnesium chlorite

1. $AlCl_3$
2. $Mg(NO_3)_2$
3. FeO
4. $CuCl_2$
5. $(NH_4)_3PO_4$
6. $Fe_2(CO_3)_3$
7. $RbOH$
8. $Sr(NO_3)_2$
9. $Pb(IO_3)_2$
10. $NaHCO_3$
11. $CuSO_4$
12. Li_3N
13. $BaSO_3$
14. $(NH_4)_2Cr_2O_7$
15. $Mg(OH)_2$
16. $AgBr$
17. FeI_3
18. $NaCN$
19. $KSCN$
20. Li_2O

Writing formulas for Ionic Compounds

1. Write cation symbol and charge
2. Write anion symbol and charge
3. Criss cross charges (balance them) (only #s, leave off signs and **do not** leave charges in formula)
4. Reduce subscripts (if nec.)
5. If polyatomic ion is involved, use parentheses (if nec.)

Ex. Magnesium nitride Mg^{2+} N^{3-} $\Rightarrow$ Mg_3N_2
Ex. Aluminum sulfate Al^{3+} SO_4^{2-} $\Rightarrow$ $Al_2(SO_4)_3$ NOT $\rightarrow$ Al_2SO_{43}

1. potassium oxide
2. magnesium carbonate
3. cobalt (III) phosphate
4. aluminum fluoride
5. iron (II) sulfide
6. calcium nitrate
7. lithium chloride
8. ammonium sulfite
9. sodium hypochlorite
10. Iron (III) cyanide
11. barium sulfate
12. ammonium chloride
13. magnesium fluoride
14. sodium oxide
15. sodium peroxide
16. copper (I) iodide
17. potassium carbonate
18. lead (II) acetate
19. iron (III) hydroxide
20. calcium chlorate

Naming Molecular (*usually* two nonmetals)

Use prefixes to indicate # of atoms of each element
Mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca (in ch. 2)
Mono is not used if there is 1 of the first element
Most electronegative element (closest to F on the PT) is written 2nd
2nd atom is named with –ide ending

1. N_2O
2. NO_2
3. SO_3
4. P_2O_5
5. N_2O_4
6. SO_2
7. SiO_2
8. Carbon dioxide
9. Dinitrogen tetroxide
10. Xenon hexafluoride
11. Sulfur hexachloride
12. Dichlorine heptoxide
13. Tetraphosphorus decasulfide
14. Carbon tetrachloride

Writing equations:
Reactant(s) → Product(s), Arrow means "yields"

Balance equations because you must have equal # of atoms of each element on both sides of the equation (obey law of conservation of matter).

Balance reactions with coefficients ONLY. Changing a subscript changes a compound.
Coefficients tell you the # of each cmpd/molecule
Subscripts tell you how many atoms are in the cmpd/molecule
Most ionic substances are solids at room temp, *most* molecular substances are gases

Indicating states of reactants or products: write letter in ( ) after formula to tell whether it is a solid, liquid, gas or in aqueous solution (dissolved in water, soluble in water), generally at room temp (~25°C)
(*s*) = solid (*l*) = liquid (*g*) = gas (*aq*) = aqueous
Balance:

1. ____CH_4 (*g*) + ____O_2 (*g*) → ____CO_2 (*g*) + ____H_2O (*l*)
2. ____CO (*g*) + ____O_2 (*g*) → ____CO_2 (*g*)
3. ____N_2O_5 (*g*) + ____H_2O (*l*) → ____HNO_3 (*aq*)
4. ____CH_4 (*g*) + ____Cl_2 (*g*) → ____CCl_4 (*l*) + ____HCl (*g*)
5. ____Al_4C_3 (*s*) + ____H_2O (*l*) → ____$Al(OH)_3$ (*s*) + ____CH_4(*g*)
6. ____$Fe(OH)_3$ (*s*) + ____H_2SO_4 (*aq*) → ____$Fe_2(SO_4)_3$ (*aq*) + ____H_2O (*l*)
7. ____CH_3NH_2 (*g*) + ____O_2 (*g*) → ____CO_2 (*g*) + ____H_2O (*g*) + ____N_2 (*g*)

Write balanced chemical equations for the following descriptions, **include states**.

8. Solid calcium carbide, CaC_2, reacts with water to form an aqueous solution of calcium hydroxide and acetylene gas, C_2H_2.

9. When solid potassium chlorate is heated, it decomposes to form solid potassium chloride and oxygen gas.

10. Solid zinc metal reacts with sulfuric acid to form hydrogen gas and an aqueous solution of zinc sulfate.

11. Solid ammonium nitrate decomposes to form dinitrogen monoxide gas and gaseous water.

12. Aluminum reacts with chlorine to form aluminum chloride.

Simple Reaction Types:
Composition (Direct Combination/synthesis): two or more reactants combine to form one product
$4Al\ (s) + 3O_2\ (g) \rightarrow 2Al_2O_3\ (s)$
Metal + nonmetal → ionic compound

Decomposition: One reactant splits apart to form more than one product
$2MgO\ (s) \rightarrow 2Mg\ (s) + O_2\ (g)$

Combustion: burning, involves O_2 as a reactant, usually a hydrocarbon (compound containing carbon and hydrogen) sometimes the hydrocarbon contains oxygen, as well. Complete combustion produces carbon dioxide and water.

Organic molecules: basic naming
Hydrocarbons –The root of the hydrocarbon indicates the number of carbons in the molecule.
Roots:

One = "meth-"	Five = "pent-"	Nine = "non-"
Two = "eth-	Six = "hex-"	Ten = "dec-
Three = "prop-"	Seven = "hept-"	
Four = "but-"	Eight = "oct-"	

Alkanes - single-bonded hydrocarbons (all single bonds between the carbons) are named with the suffix "-ane". Alkanes have the general formula C_nH_{2n+2} where n=# of carbons
Ex. Methane has 1 carbon, formula is CH_4 Hexane has 6 carbons, formula is C_6H_{14}

Combustion reaction:
Propane burns in air. $C_3H_8\ (g) + 5O_2\ (g) \rightarrow 3CO_2\ (g) + 4H_2O\ (l)$
Balance the following and indicate whether they are combination, decomposition, or combustion reactions.

1. ____Al (s) + ____ Cl_2 (g) → _____ $AlCl_3$ (s) ____________________________
2. ____C_2H_4 (g) + ____O_2 (g) → ____CO_2 (g) + ____H_2O (g) ____________________________
3. ____ Li(s) + ____N_2 (g) → ____ Li_3N (s) ____________________________
4. ____ $PbCO_3$ (s) → ____ PbO (s) + ____ CO_2 (g) ____________________________
5. ____$C_7H_8O_2$ (l) + ____ O_2 (g) → ____ CO_2 (g) + ____ H_2O (g) ____________________________

Avogadro's Number, the Mole, and Molar Mass
Molar mass is the mass in grams of one mole of that substance. This is the mass from the periodic table.

Use as many sig figs as the masses on the periodic table (attached) indicate AND as many as your calculator says. Masses do have the potential to limit sig figs, though the masses should NEVER actually limit your sig figs.

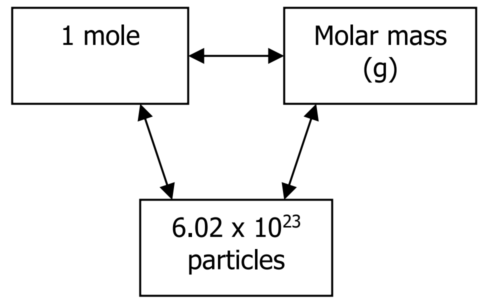
To calculate molar masses, add up the individual masses of the elements in your substance.
Ex. NaOH: 1 Na, 1 O, 1 H ⇒ 22.99g + 16.00g + 1.008 g = 39.998 g NaOH
Ex. $Al_2(SO_4)_3$ 2 Al, 3 S, 12 O ⇒ 2(26.98 g) + 3(32.06g) + 12(16.00g) = 342.14 g $Al_2(SO_4)_3$

Find the molar mass of the following substances.

1. HNO_3
2. $KMnO_4$
3. gallium sulfide
4. $Ca_3(PO_4)_2$

5. phosphorus trichloride

Avogadro's number = 6.022×10^{23}
1 **mole** is the amount of matter that contains 6.022×10^{23} particles (atoms, molecules (mc) or formula units (fu))
Examples: 1 mol C = 6.022×10^{23} C atoms = 12.01 g C
1 mol H_2O = 6.022×10^{23} H_2O mc = 18.016 g H_2O



Example: Calculate the # of mc in 7.49 g H_2O.
Two ways where you begin with the want.

$$2.50 \times 10^{23} \text{ mc } H_2O = \frac{6.02\text{x}10^{23} \text{ mc } H_2O}{18.016 \text{ g } H_2O} \text{ x } \frac{7.49 \text{ g } H_2O}{}$$

OR

$$2.50 \times 10^{23} \text{ mc } H_2O = \frac{6.02\text{x}10^{23} \text{ mc} H_2O}{1 \text{mol} H_2O} \text{ x } \frac{1 \text{mol } H_2O}{18.016 \text{ g} H_2O} \text{ x } \frac{7.49 \text{g} H_2O}{}$$

You can also begin with the Given:

$$\frac{7.49\ g\ H_2O}{} \ x \ \frac{1\ mol\ H_2O}{18.016\ g\ H_2O} \ x \ \frac{6.02\ x\ 10^{23}\ mc\ H_2O}{1\ mol\ H_2O} = 2.50\ x\ 10^{23}\ mc\ H_2O$$

Another example: Find the number of carbon atoms in .350 mol $C_6H_{12}O_6$

$$2.53 \times 10^{24} \text{ atoms C} = \frac{6 \text{ C atoms}}{1 \text{mc } C_6H_{12}O_6} \text{ x } \frac{6.02 \text{x} 10^{23} \text{ mc } C_6H_{12}O_6}{1 \text{mol } C_6H_{12}O_6} \text{ x } \frac{0.350 \text{mol} C_6H_{12}O_6}{}$$

OR

$$\frac{0.350\ mol\ C_6H_{12}O_6}{} \ x \ \frac{6.02\ x\ 10^{23}\ mc\ C_6H_{12}O_6}{1\ mol\ C_6H_{12}O_6} \ x \ \frac{6\ C\ atoms}{1\ mc\ C_6H_{12}O_6} = 2.53\ x\ 10^{24}\ atoms\ C$$

Calculate the following:

1. the mass, in grams, of 0.105 moles sucrose, $C_{12}H_{22}O_{11}$.

2. the moles of $Zn(NO_3)_2$ in 143.50 g.

3. the number of molecules in 1.0×10^{-6} mol CH_3CH_2OH

4. the number of N atoms in 0.410 mol NH_3

5. the mass of 2.50 x 10^{-3} mol of ammonium phosphate

6. the moles of chloride ions in 0.2550 g of aluminum chloride (a chloride ion has essentially the same mass as a chlorine atom)

7. the mass in grams of 7.70 x 10^{20} molecules (mc) of caffeine, $C_8H_{10}N_4O_2$.

8. the number of moles in 112.6 g of NH_4Cl

9. the mass of 5.76 x 10^{-3} moles CdS

10. the number of formula units contained in 1.2 kg table salt (NaCl)

AP Common Ions

MEMORIZE the highlighted ions and names

Aluminum	Al^{3+}
Ammonium	NH_4^+
Barium	Ba^{2+}
Cadmium	Cd^{2+}
Calcium	Ca^{2+}
Chromium (II)	Cr^{2+}
Chromium (III)	Cr^{3+}
Cobalt (II)	Co^{2+}
Cobalt (III)	Co^{3+}
Copper (I)	Cu^{+}
Copper (II)	Cu^{2+}
Hydrogen	H^{+}
Hydronium	H_3O^{+}
Iron (II)	Fe^{2+}
Iron (III)	Fe^{3+}
Lead (II)	Pb^{2+}
Lead (IV)	Pb^{4+}
Lithium	Li^{+}
Magnesium	Mg^{2+}
Manganese (II)	Mn^{2+}
Manganese (IV)	Mn^{4+}
Nickel (II)	Ni^{2+}
Potassium	K^{+}
Silver	Ag^{+}
Sodium	Na^{+}
Strontium	Sr^{2+}
Tin (II)	Sn^{2+}
Tin (IV)	Sn^{4+}
Zinc	Zn^{2+}

Strong Acids – MEMORIZE!!!

Hydroiodic acid	HI
Hydrobromic acid	HBr
Hydrochloric acid	HCl
Nitric acid	HNO_3
Perchloric acid	$HClO_4$
Sulfuric acid	H_2SO_4

Strong Bases – MEMORIZE!!!

Hydroxides of group IA and "heavy" IIA metals

LiOH, NaOH, KOH, RbOH, CsOH, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$

Bromide	Br^-
Hypobromite	BrO^-
Bromite	BrO_2^-
Bromate	BrO_3^-
Perbromate	BrO_4^-
Carbonate	CO_3^{2-}
Hypochlorite	ClO^-
Chlorite	ClO_2^-
Chlorate	ClO_3^-
Perchlorate	ClO_4^-
Chloride	Cl^-
Chromate	CrO_4^{2-}
Cyanide	CN^-
Dichromate	$Cr_2O_7^{2-}$
Acetate	$C_2H_3O_2^-$, CH_3COO^-
Fluoride	F^-
Hydride	H^-
Hydrogen carbonate, Bicarbonate	HCO_3^-
Hydrogen phosphate	HPO_4^{2-}
Hydrogen sulfate, bisulfate	HSO_4^-
Hydrogen sulfide, bisulfide	HS^-
Hydrogen sulfite, bisulfite	HSO_3^-
Hydroxide	OH^-
Hypoiodite	IO^-
Iodite	IO_2^-
Iodate	IO_3^-
Periodate	IO_4^-
Iodide	I^-
Permanganate	MnO_4^-
Nitrate	NO_3^-
Nitride	N^{3-}
Nitrite	NO_2^-
Oxalate	$C_2O_4^{2-}$
Oxide	O^{2-}
Peroxide	O_2^{2-}
Phosphate	PO_4^{3-}
Phosphide	P^{3-}
Phosphite	PO_3^{3-}
Sulfate	SO_4^{2-}
Sulfide	S^{2-}
Sulfite	SO_3^{2-}
Thiosulfate	$S_2O_3^{2-}$
Thiocyanate	SCN^-

Useful conversion factors

Length
SI unit: meter (m)

1 km = 0.62137 mi
1 mi = 5280 ft
1 mi = 1.6093 km
1 m = 1.0936 yd
1 in = 2.54 cm (exactly)
1 cm = 0.39370 in
1 angstrom (Å) = 10^{-10} m

Mass
SI unit: kilogram (kg)

1 kg = 2.2046 lb
1 lb = 453.59 g
1 lb = 16 oz
1 amu = $1.660538782 \times 10^{-24}$ g

Temperature
SI unit: Kelvin (K)

0 K = -273.15 °C
0 K = -459.67 °F
K = °C + 273.15
°C = 5/9 (°F – 32)
°F = (9/5°C) + 32

Energy (derived)
SI unit: Joule (J)

1 J = 1 kg-m^2/s^2
1 J = 0.2390 cal
1 J = 1 C x 1 V
1 cal = 4.184 J
1 eV = 1.602×10^{-19} J

Pressure (derived)
SI unit: Pascal (Pa)

1 Pa = 1 N/m^2
1 Pa = 1 kg/m-s^2
1 atm = 101,325 Pa
1 atm = 760 torr
1 atm = 14.70 lb/in^2
1 bar = 10^5 Pa
1 torr = 1 mm Hg

Volume (derived)
SI unit: cubic meter (m^3)

1 L = 10^{-3} m^3
1 L = 1 dm^3
1 L = 10^3 cm^3
1 L = 1.0567 qt
1 gal = 4 qt
1 gal = 3.7854 L
1 cm^3 = 1 mL
1 in^3 = 16.4 cm^3
1 ft^3 = 1728 in^3

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.008																	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.87	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.63	33 **As** 74.92	34 **Se** 78.97	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.95	43 **Tc**	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57-71 *	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po**	85 **At**	86 **Rn**
87 **Fr**	88 **Ra**	89-103 †	104 **Rf**	105 **Db**	106 **Sg**	107 **Bh**	108 **Hs**	109 **Mt**	110 **Ds**	111 **Rg**	112 **Cn**	113 **Nh**	114 **Fl**	115 **Mc**	116 **Lv**	117 **Ts**	118 **Og**

*Lanthanoids	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm**	62 **Sm** 150.36	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
†Actinoids	89 **Ac**	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np**	94 **Pu**	95 **Am**	96 **Cm**	97 **Bk**	98 **Cf**	99 **Es**	100 **Fm**	101 **Md**	102 **No**	103 **Lr**