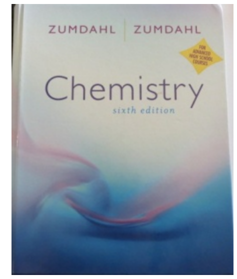
ACR 2019-20 Summer Assignment

June 2019

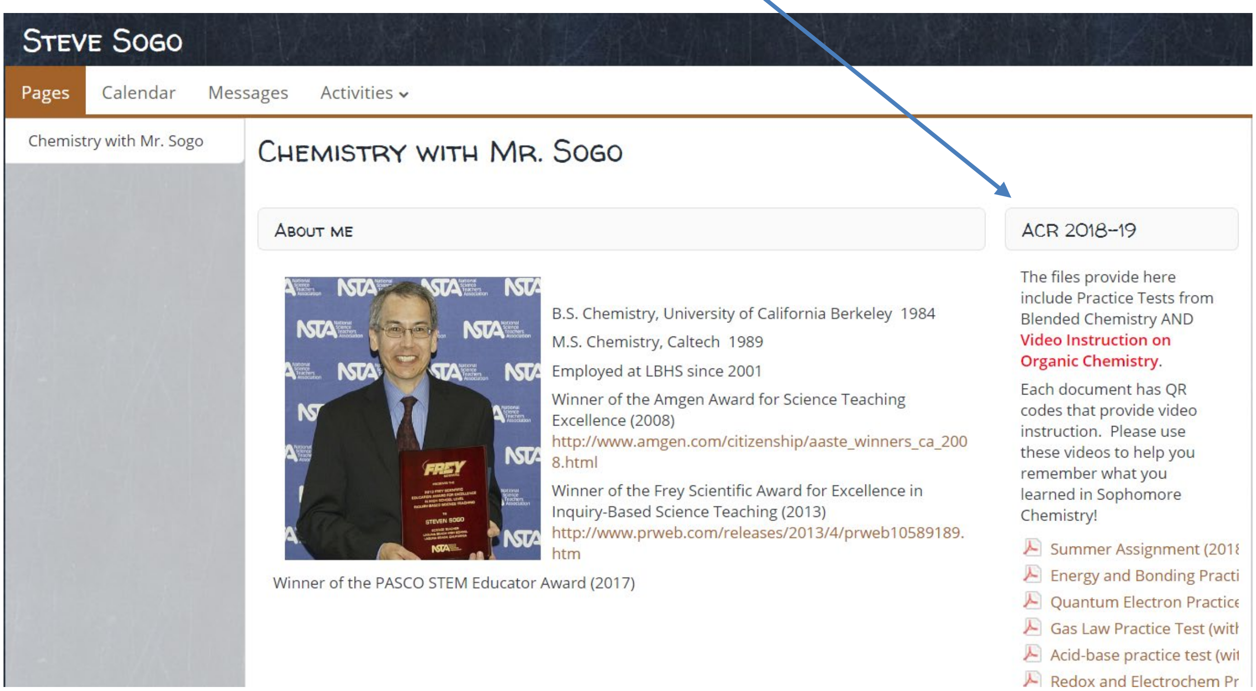


Overview: You should take home the textbook *Chemistry*, by Zumdahl and Zumdahl (6th Edition) to help you sharpen your chemistry skills over the summer. **Please help each other in this learning endeavor. Work together in person (or communicate electronically) to pool your wisdom.**

At the beginning of the summer, I expect you to be rusty, but by August 25, I expect you to have polished your skills. Please do NOT wait until the end of August to start your preparation!

On the first day of class, you will have a test worth **25 points** covering the topics outlined below. It is very important that you do your best to prepare for the test. ACR is a course built on teamwork, and it is imperative that EVERY individual be a contributor to the team. In previous years, results on the *Welcome Back Test* ranged from abject failure (12 out of 25) to supreme mastery (25 out of 25).

Video instruction covering a wide variety of Honors Chem topics is available on the LBHS Chemistry YouTube Channel. These videos should remind you of important concepts that you may have forgotten. Video Instruction for Practice Tests may be the best way to refresh your understanding. Practice Tests are available for download on my Haiku Page (search Steve Sogo Haiku)



Textbook Work

The topics and problems I would like you to study in your textbook are listed below: *Note: answers for most of these problems are provided in the back of the book.*

Chapter 3: Stoichiometry
Skim the chapter and do the following problems:
(pp. 123-129) # 33, 45, 51, 75, 83, 87, 109, 111, 121

Chapter 4: Types of Chemical Reactions and Solution Stoichiometry
Skim the chapter and do the following problems:
(pp. 180-186) #1, 5, 11, 15, 21, 23a,b, 25, 27, 29, 39, 45, 55, 61, 93

Chapter 5: Gases
Skim the chapter and do the following problems:
(pp. 230-239) #5, 8, 19, 22, 29, 31, 51, 59, 73, 103

Chapter 6: Thermochemistry
Skim the chapter and do the following problems:
(pp. 280-285) #31, 33, 47, 53, 61, 63, 81

Chapter 8: Bonding: General Concepts
Skim the chapter and do the following problems:
(pp. 402-408) #11, 29, 33, 61 (draw each molecule with CORRECT GEOMETRY), 67, 70.

Chapter 14: Acids and Bases
Skim the chapter and do the following problems:
(pp. 703-709) #16, 29, 31, 45, 47, 51, 59, 75

Chapter 22: Organic Chemistry
Read this chapter thoroughly. Most of this will be new & challenging for you. **A large part of the ACR experience involves organic chemistry**, so you will want to be competent in interpreting molecular pictures, sketching structures, and naming compounds. **Handouts with Video Instruction for Organic Chemistry are available on Haiku.**
(pp. 1091-1100) #23, 27, 31, 35, #38 (instead of naming the compounds, translate the structures shown into formulas (*e.g.* 38b = C_8H_{14})), #41, 51, 56, 111

Please note that the goal is to **gain skills**. If you had trouble with a particular problem on the list above, you should work on additional problems of a similar nature in the textbook to hone your skills. Keep practicing until you feel confident. **COLLABORATION WITH OTHER ACR STUDENTS IS ENCOURAGED!!!!!**

Virtual Molecular Model Kit

A good tool for exploring Organic Chemistry is the Virtual Molecular Model Kit from Illinois State University:
https://chemagic.com/molecules/amini.html

I suggest you start your exploration of the VMK by clicking on "Load Model" by "Name" on the start page. The default molecule is aspirin, which is a good place to start. Then you can type in names of other molecules you may have heard of. If you can't think of any molecule names, try these:

- Cholesterol
- Cipro (a commonly prescribed antibiotic)
- Tyrosine (an amino acid)
- ATP

There are also Youtube tutorials that can help you understand how to use the capabilities of the VMK.

It is likely that I will be inviting you to help set up and organize laboratory equipment in August prior to the beginning of the school year. If you are able to participate, you can get acquainted with the research lab and the advanced materials you will be working with in ACR.

On the following pages are some "old friends" that should help you do the summer work.

SOLUBILITY CHART

							Hydroxide	Nitrate	Acetate	Sulfate		Carbonate	Phosphate	Chromate
		F^-	Cl^-	Br^-	I^-	S^{2-}	OH^-	NO_3^-	$C_2H_3O_2^-$	SO_4^{2-}	O^{2-}	CO_3^{2-}	PO_4^{3-}	CrO_4^{2-}
	Ag^+	S	I	I	I	I	–	S	I	I	I	I	I	I
	Pb^{2+}	I	I	I	I	I	I	S	S	I	I	I	I	I
	Hg_2^{2+}	d	I	I	I	I	d	S	S	I	I	I	I	I
	Hg^{2+}	d	S	s	I	I	d	S	S	I	I	I	I	d
	Mg^{2+}	I	S	S	S	d	I	S	S	S	I	I	I	S
	Cu^{2+}	S	S	S	S	I	I	S	S	S	I	I	I	I
	Zn^{2+}	S	S	S	S	I	I	S	S	S	I	I	I	I
	Fe^{2+}	s	S	S	S	d	I	S	S	S	I	I	I	I
	Ca^{2+}	I	S	S	S	d	s	S	S	s	d	I	I	I
	Ba^{2+}	s	S	S	S	d	S	S	S	I	S	I	I	I
	Sr^{2+}	I	S	S	S	I	s	S	S	I		s	I	I
	Co^{2+}	S	S	S	S	I	I	S	S	S	I	I	I	I
	Ni^{2+}	S	S	S	S	I	I	S	S	S	I	I	I	I
	Fe^{3+}	s	S	S	S	d	I	S	S	S	I	I	I	I
	Al^{3+}	s	S	S	S	d	I	S	S	S	I	–	I	–
	Cr^{3+}	I	S	S	S	d	I	S	S	S	I	I	I	I
	Na^+	S	S	S	S	S	S	S	S	S	S	S	S	S
	K^+	S	S	S	S	S	S	S	S	S	S	S	S	S
Ammonium	NH_4^+	S	S	S	S	S	–	S	S	S	–	S	S	S
	Cd^{2+}	S	S	S	S	I	I	S	S	S	I	I	I	–

S = soluble in cold water (greater than 1 g/100 mℓ)
s = slightly soluble in cold water (between 0.1 and 1 g/100 mℓ)
I = insoluble in cold water (less than 0.1 g/100 mℓ)
d = decomposes in water

Increasing electronegativity →

↓ Decreasing electronegativity

						H 2.1										
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.9	Ni 1.9	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5
Cs 0.7	Ba 0.9	La–Lu 1.0–1.2	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.9	Bi 1.9	Po 2.0	At 2.2
Fr 0.7	Ra 0.9	Ac 1.1	Th 1.3	Pa 1.4	U 1.4	Np–No 1.4–1.3										

e- neg difference	Type of Bond
0 - 0.4	Non-Polar } covalent
0.5 or greater	Polar } covalent
Metal + Non-metal	Ionic

TABLE 15.3
Oxidizing and reducing agents

INCREASING STRENGTH OF REDUCING AGENTS

Oxidation Half-Reaction	*Reducing Agents*	*Electrode Potential, E^0 (volts)*
$2\,F^-(aq) \longrightarrow F_2(g) + 2e^-$	F^-	−2.65
$2\,H_2O(l) \longrightarrow H_2O_2(aq)\ 2\,H^+(aq) + 2e^-$	H_2O	−1.77
$PbSO_4(s) + 2\,H_2O(l) \longrightarrow PbO_2(s) + SO_4^{2-}(aq) + 4\,H^+(aq) + 2e^-$	$PbSO_4$	−1.68
$Au(s) \longrightarrow Au^{3+}(aq) + 3e^-$	Au	−1.50
$Mn^{2+}(aq) + 4\,H_2O(l) \longrightarrow MnO_4^-(aq) + 8\,H^+(aq) + 5e^-$	Mn^{2+}	−1.50
$2\,Cl^-(aq) \longrightarrow Cl_2(g) + 2e^-$	Cl^-	−1.36
$2\,Cr^{3+}(aq) + 7\,H_2O(l) \longrightarrow Cr_2O_7^{2-}(aq) + 14\,H^+ + 6e^-$	Cr^{3+}	−1.33
$Mn^{2+}(aq) + 2\,H_2O(l) \longrightarrow MnO_2(s) + 4\,H^+(aq) + 2e^-$	Mn^{2+}	−1.23
$2\,H_2O(l) \longrightarrow O_2(g) + 4\,H^+(aq) + 4e^-$	H_2O	−1.23
$2\,Br^-(aq) \longrightarrow Br_2(l) + 2e^-$	Br^-	−1.06
$NO(g) + 2\,H_2O(l) \longrightarrow NO_3^-(aq) + 4\,H^+(aq) + 3e^-$	NO	−0.96
$Ag(s) \longrightarrow Ag^+(aq) + e^-$	Ag	−0.80
$Fe^{2+}(aq) \longrightarrow Fe^{3+}(aq) + e^-$	Fe^{2+}	−0.77
$Mn(OH)_3(s) + NH_3(aq) \longrightarrow MnO_2(s) + H_2O(l) + NH_4^+(aq) + e^-$	$Mn(OH)_3$	−0.74
$H_2O_2(aq) \longrightarrow O_2(g) + 2\,H^+(aq) + 2e^-$	H_2O_2	−0.68
$2\,I^-(aq) \longrightarrow I_2(s) + 2e^-$	I^-	−0.54
$Ni(OH)_2(s) + 2\,OH^-(aq) \longrightarrow NiO_2(s) + 2\,H_2O(l) + 2e^-$	$Ni(OH)_2$	−0.49
$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$	Cu	−0.34
$H_2S(aq) \longrightarrow S(s) + 2\,H^+(aq) + 2e^-$	H_2S	−0.14
$Hg(l) + 2\,OH^-(aq) \longrightarrow HgO(s) + H_2O(l) + 2e^-$	Hg	−0.10
$H_2(g) \longrightarrow 2\,H^+(aq) + 2e^-$	H_2	0.00
$Pb(s) \longrightarrow Pb^{2+}(aq) + 2e^-$	Pb	+0.13
$Sn(s) \longrightarrow Sn^{2+}(aq) + 2e^-$	Sn	+0.14
$Ni(s) \longrightarrow Ni^{2+}(aq) + 2e^-$	Ni	+0.25
$Pb(s) + SO_4^{2-}(aq) \longrightarrow PbSO_4(s) + 2e^-$	Pb	+0.36
$Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$	Fe	+0.44
$Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$	Zn	+0.76
$Cd(s) + 2\,OH^-(aq) \longrightarrow Cd(OH)_2(s) + 2e^-$	Cd	+0.81
$H_2(g) + 2\,OH^-(aq) \longrightarrow 2\,H_2O(l) + 2e^-$	H_2	+0.83
$Cr(s) \longrightarrow Cr^{2+}(aq) + 2e^-$	Cr	+0.91
$Zn(s) + 2\,OH^-(aq) \longrightarrow Zn(OH)_2(s) + 2e^-$	Zn	+1.25
$Al(s) \longrightarrow Al^{3+}(aq) + 3e^-$	Al	+1.66
$Mg(s) \longrightarrow Mg^{2+}(aq) + 2e^-$	Mg	+2.37
$Na(s) \longrightarrow Na^+(aq) + e^-$	Na	+2.71
$Li(s) \longrightarrow Li^+(aq) + e^-$	Li	+3.01

Electrode Potential, E^0 (volts)	*Oxidizing Agents*	*Reduction Half-Reaction*
+2.65	F_2	$F_2(g) + 2e^- \longrightarrow 2\,F^-(aq)$
+1.77	H_2O_2	$H_2O_2(aq) + 2\,H^+(aq) + 2e^- \longrightarrow 2\,H_2O(l)$
+1.68	PbO_2	$PbO_2(s) + SO_4^{2-}(aq) + 4\,H^+ + 2e^- \longrightarrow PbSO_4(s) + 2\,H_2O(l)$
+1.50	Au^{3+}	$Au^{3+}(aq) + 3e^- \longrightarrow Au(s)$
+1.50	MnO_4^-	$MnO_4^-(aq) + 8\,H^+(aq) + 5e^- \longrightarrow Mn^{2+}(aq) + 4\,H_2O(l)$
+1.36	Cl_2	$Cl_2(g) + 2e^- \longrightarrow 2\,Cl^-(aq)$
+1.33	$Cr_2O_7^{2-}$	$Cr_2O_7^{2-}(aq) + 14\,H^+(aq) + 6e^- \longrightarrow 2\,Cr^{3+}(aq) + 7\,H_2O(l)$
+1.23	MnO_2	$MnO_2(s) + 4\,H^+(aq) + 2e^- \longrightarrow Mn^{2+}(aq) + 2\,H_2O(l)$
+1.23	O_2	$O_2(g) + 4\,H^+(aq) + 4e^- \longrightarrow 2\,H_2O(l)$
+1.06	Br_2	$Br_2(l) + 2e^- \longrightarrow 2\,Br^-(aq)$
+0.96	NO_3^-	$NO_3^-(aq) + 4\,H^+(aq) + 3e^- \longrightarrow NO(g) + 2\,H_2O(l)$
+0.80	Ag^+	$Ag^+(aq) + e^- \longrightarrow Ag(s)$
+0.77	Fe^{3+}	$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$
+0.74	MnO_2	$MnO_2(s) + H_2O(l) + NH_4^+(aq) + e^- \longrightarrow Mn(OH)_3(s) + NH_3(aq)$
+0.68	O_2	$O_2(g) + 2\,H^+(aq) + 2e^- \longrightarrow H_2O_2(aq)$
+0.54	I_2	$I_2(s) + 2e^- \longrightarrow 2\,I^-(aq)$
+0.49	NiO_2	$NiO_2(s) + 2\,H_2O(l) + 2e^- \longrightarrow Ni(OH)_2(s) + 2\,OH^-(aq)$
+0.34	Cu^{2+}	$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$
+0.14	S	$S(s) + 2\,H^+(aq) + 2e^- \longrightarrow H_2S(aq)$
+0.10	HgO	$HgO(s) + H_2O(l) + 2e^- \longrightarrow Hg(l) + 2\,OH^-(aq)$
0.00	H^+	$2\,H^+(aq) + 2e^- \longrightarrow H_2(g)$
−0.13	Pb^{2+}	$Pb^{2+}(aq) + 2e^- \longrightarrow Pb(s)$
−0.14	Sn^{2+}	$Sn^{2+}(aq) + 2e^- \longrightarrow Sn(s)$
−0.25	Ni^{2+}	$Ni2^{+}(aq) + 2e^- \longrightarrow Ni(s)$
−0.36	$PbSO_4$	$PbSO_4(s) + 2e^- \longrightarrow Pb(s) + SO_4^{2-}$
−0.44	Fe^{2+}	$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s)$
−0.76	Zn^{2+}	$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$
−0.81	$Cd(OH)_2$	$Cd(OH)_2(s) + 2e^- \longrightarrow Cd(s) + 2\,OH^-(aq)$
−0.83	H_2O	$2\,H_2O(l) + 2e^- \longrightarrow H_2(g) + 2\,OH^-(aq)$
−0.91	Cr^{2+}	$Cr^{2+}(aq) + 2e^- \longrightarrow Cr(s)$
−1.25	$Zn(OH)_2$	$Zn(OH)_2(s) + 2e^- \longrightarrow Zn(s) + 2\,OH^-(aq)$
−1.66	Al^{3+}	$Al^{3+}(aq) + 3e^- \longrightarrow Al(s)$
−2.37	Mg^{2+}	$Mg^{2+}(aq) + 2e^- \longrightarrow Mg(s)$
−2.71	Na^+	$Na^+(aq) + e^- \longrightarrow Na(s)$
−3.01	Li^+	$Li^+(aq) + e^- \longrightarrow Li(s)$

INCREASING STRENGTH OF OXIDIZING AGENTS

cm^3 or liters (volume)	⟷ *Density*	Grams (mass)	⟷ *Molar Mass*	Moles	*Mole Ratio* ⟷ *Coefficients*	Moles of another substance

1 calorie = 4.18 joules
1 pound = 454 grams
1 liter = 1000 cm^3

PERIODIC CHART OF THE ELEMENTS

I 0 or +1	II 0 or +2											III 0 or +3	IV ?	V 0 or -3	VI 0 or -2	VII 0 or -1	VIII
1 H 1.0079																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.011	7 N 14.007	8 O 16.00	9 F 19.00	10 Ne 20.179
11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.974	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	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 95.94	43 Tc (97)	44 Ru 101.1	45 Rh 102.91	46 Pd 106.4	47 Ag 107.868	48 Cd 112.41	49 In 114.82	50 Sn 118.7	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.33	57 *La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 'Ac (227)															

*Lanthanum Series

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	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 173.04	71 Lu 174.97

'Actinium Series

90 Th 232.0	91 Pa 231.0	92 U 238.03	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Activity Series

lithium
potassium
calcium
sodium
magnesium
aluminum
zinc
chromium
iron
nickel
tin
lead
HYDROGEN*
copper
mercury
silver
platinum
gold

Selected density values:	
Sodium	0.95 g/cm^3
Calcium	1.54 g/cm^3
Magnesium	1.74 g/cm^3
Aluminum	2.70 g/cm^3
Zinc	7.14 g/cm^3
Tin	7.31 g/cm^3
Iron	7.86 g/cm^3
Nickel	8.90 g/cm^3
Copper	8.94 g/cm^3
Silver	10.5 g/cm^3
Lead	11.3 g/cm^3
Mercury	13.6 g/cm^3
Gold	19.2 g/cm^3

$R = .082$ L-atm/mol-K

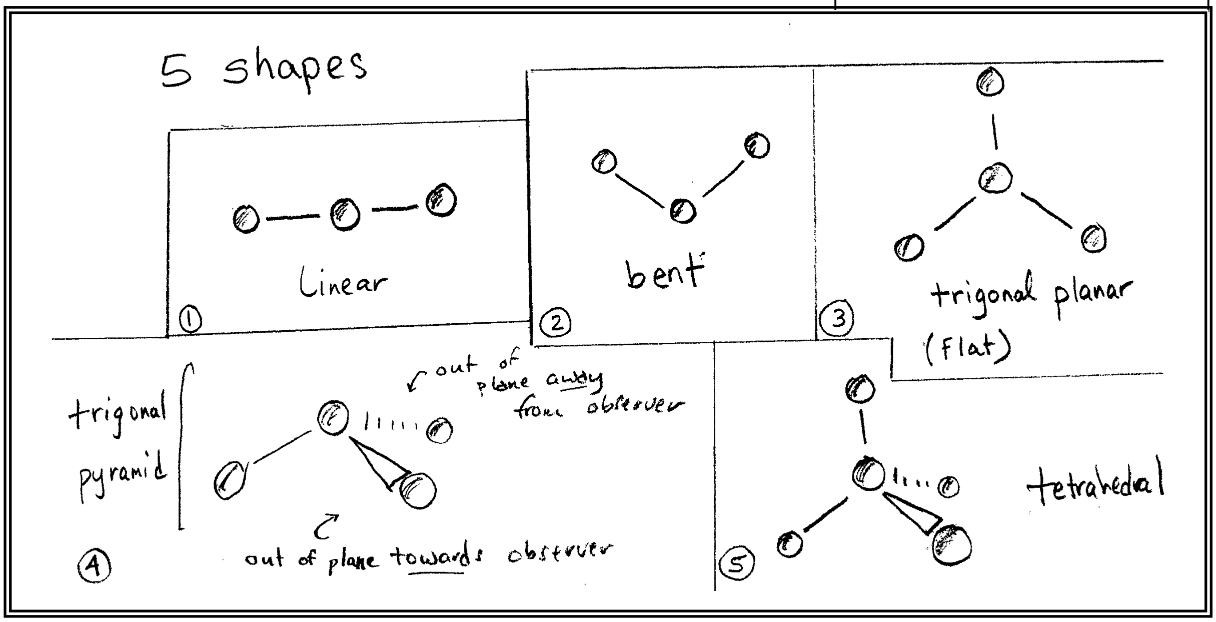
$c = 3.0 \times 10^8$ m/s

Pressure Conversions

1 atm =
760 torr (mm Hg)
14.7 PSI
101 kPa

The rule of HONC
H = 1 bond
O = 2 bonds
N = 3 bonds
C = 4 bonds

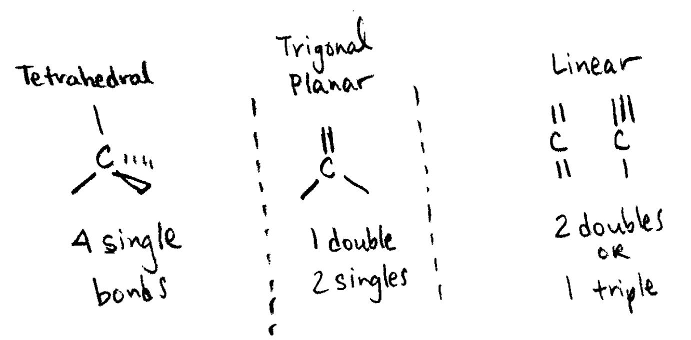
Molecular Shapes Handout



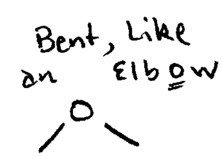
Predicting Shapes

Carbon has **3** possible shapes, **nitrogen** has **two** possible shapes, **oxygen** has only **one** possible shape. *Note: don't try to bend a* *<u>double-bonded</u>* *oxygen. . .*

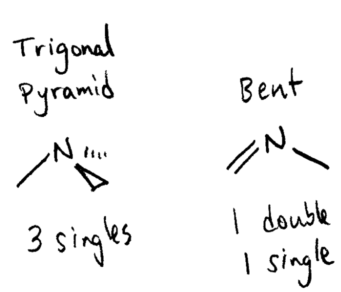
CARBON



OXYGEN



NITROGEN



Color Code for Models
Black = Carbon
Red = Oxygen
Blue = Nitrogen
White = Hydrogen
Green = Chlorine
Yellow = Sulfur
Orange = Bromine
Purple = Iodine

Some additional problems:

1. Consider the following half-reactions

$$MnO_4^- + 8\,H^+ + 5\,e^- \rightarrow Mn^{2+} + 4\,H_2O \qquad E° = +1.50\ V$$
$$2\,I^- \rightarrow I_2 + 2\,e^- \qquad E° = -0.54\ V$$

When the equation for the oxidation of iodide ion by permanganate ion is balanced with the lowest whole–number coefficients possible, the coefficient for Mn^{2+} is:

(A) 1
(B) 2
(C) 4
(D) 5
(E) 6

2. Sketch a molecular picture showing the reaction that would occur when acetic acid (CH_3COOH) reacts with hydroxide ion. Draw all structures with proper geometry and show formal negative charges where appropriate.

3. Sketch a picture showing the expected chemistry that would occur when a solution of nickel chloride is electrolyzed using a copper cathode and a graphite anode. *Note: your picture should show the experimental set-up as well as any chemical reactions that would occur.*

4. $I_{2(g)} + 3\ Cl_{2(g)} \rightarrow 2\ ICl_{3(g)}$ $\Delta H = -382$ kJ

According to the equation shown above, how much energy will be released if 0.27 moles of $Cl_2(g)$ are reacted with 0.15 moles of $I_2(g)$? *Hint: think about which is the LIMITING reactant. . .*

(A) 34.4 kJ
(B) 57.3 kJ
(C) 103 kJ
(D) 115 kJ
(E) No energy will be released!

5. A buffer is created using 2 moles of NH_4^+ and 1 mole of NH_3. What is the approximate pH of this buffer? (For NH_4^+, $K_a = 5.6 \times 10^{-10}$.) *Hint: two brackets on the top, one bracket on the bottom.*

(A) pH = 2
(B) pH = 7
(C) pH = 8
(D) pH = 9
(E) pH = 10

6. Describe how the buffer mentioned in problem #5 would be able to "absorb" strong base or strong acid without showing a big change in its pH value. *Molecular pictures appreciated.*