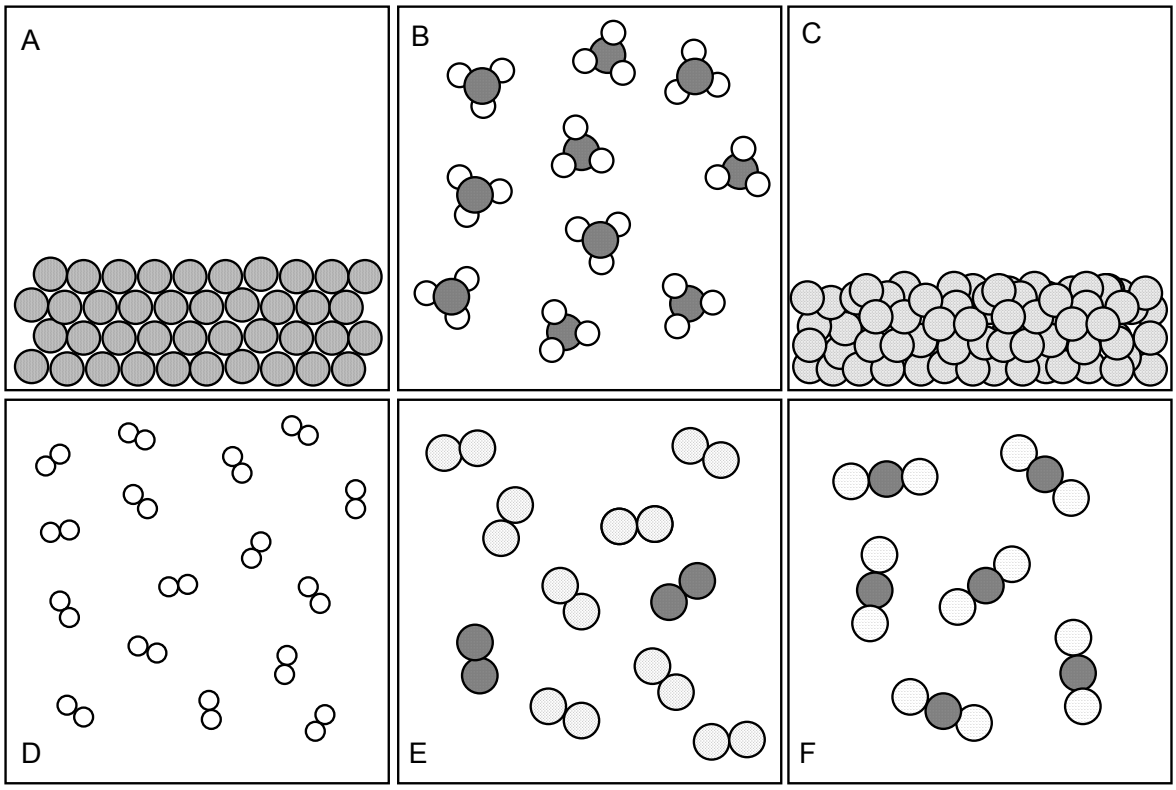
CHM 130: Final Exam Practice Problems

1. Complete the following table:

Isotope	Mass number	# of protons	# of neutrons	# of electrons
strontium-90	**90**	**38**	**52**	**38**
neon-19	**19**	**10**	**9**	**10**
iron-55	**55**	**26**	**29**	**26**

2. Consider Figures A-F below:



Indicate the figure represented as an **element,** a **compound** or a **mixture AND** a **solid,** a **liquid** or a **gas**.

A.	element	compound	mixture	solid	liquid	gas
B.	element	compound	mixture	solid	liquid	gas
C.	element	compound	mixture	solid	liquid	gas
D.	element	compound	mixture	solid	liquid	gas
E.	element	compound	mixture	solid	liquid	gas
F.	element	compound	mixture	solid	liquid	gas

3. Circle all of the following changes that are **chemical**:

vaporizing (fizzing) subliming (precipitating) (burning) (rusting) condensing

4. Indicate the **symbol for the element** that fits each of the following descriptions:

Xe	a.	The noble gas in the fifth period.
F	b.	The halogen with the greatest ionization energy.
Mg	c.	The alkaline earth metal in the third period.
Fr	d.	The alkali metal with the greatest metallic character.
Sc	e.	The transition metal in the fourth period with the lowest atomic number.
Y	f.	The transition metal in the fifth period with the largest atomic radius.

5. A 6.252 g of sodium hydrogen carbonate is mixed with 2.709 g of hydrochloric acid to produce 4.348 g of sodium chloride, 3.273 g of carbon dioxide, and water. What mass of water forms?

$$6.252 + 2.709\ g = 8.961 - 4.348 - 3.273\ g = \mathbf{1.340\ g}$$ (all to 3 decimal places!)

6. A 25.00 g sample of piece of titanium is placed in a graduated cylinder containing 3.56 mL of water. If the density of titanium is 4.51 g/cm^3, what is the new level of the water after the piece of titanium is added.

$$25.00\ g\ Ti \times \frac{mL}{4.51\ g\ Ti} = 5.54\ mL$$

$$5.54\ mL + 3.56\ mL = \mathbf{9.10\ mL}$$ (to 2 decimal places)

7. For each the following compounds, indicate whether it is ionic (I) or molecular (M),and give the corresponding name or formula:

I or M			
M	a.	nitric acid	$HNO_3(aq)$
I	b.	zinc phosphate	$Zn_3(PO_4)_2$
I	c.	silver nitride	Ag_3N
I	d.	ammonium chromate	$(NH_4)_2CrO_4$
M	e.	$HC_2H_3O_2$*(aq)*	acetic acid
I	f.	SrF_2	strontium fluoride
M	g.	H_2S*(aq)*	hydrosulfuric acid
M	h.	N_2O_5	dinitrogen pentaoxide
I	i.	$Sn(CO_3)_2$	tin (IV) carbonate
I	j.	CoN	cobalt (III) nitride

8. For each of the following,

   i. Identify the **type of reaction** using the letters designated below:

   – Combination (**C**) – Double Replacement/Precipitation (**DR**)
   – Decomposition (**D**) – Neutralization (**N**)
   – Single Replacement (**SR**) – Combustion (**B**)

TYPE ii. Balance the equation

SR A. $2\ Na\ (s) + 2\ H_2O\ (l) \rightarrow H_2\ (g) + 2\ NaOH\ (aq)$

DR B. $Fe_2(SO_4)_3\ (aq) + 6\ LiOH\ (aq) \rightarrow 2\ Fe(OH)_3\ (s) + 3\ Li_2SO_4\ (aq)$

B C. $C_5H_6O\ (l) + 6\ O_2\ (g) \xrightarrow{\Delta} 3\ H_2O\ (g) + 5\ CO_2\ (g)$

D D. $2\ H_3BO_3\ (s) \xrightarrow{\Delta} B_2O_3\ (s) + 3\ H_2O\ (l)$

9. For each of the following sets of reactants, write the formulas for the products and balance the equation if the reaction occurs, or write "NR" for no reaction.

a.	$2\ HBr\ (aq) + Mg\ (s) \rightarrow H_2\ (g) + MgBr_2\ (aq)$
b.	$3\ KOH\ (aq) + H_3PO_4\ (aq) \rightarrow 3\ H_2O\ (l) + K_3PO_4\ (aq)$
c.	$NaOH\ (aq) + Al\ (s) \rightarrow$ NR
d.	$C_5H_{12}\ (l) + 8\ O_2\ (g) \xrightarrow{\Delta} 6\ H_2O\ (g) + 5\ CO_2\ (g)$

10. Circle all the examples below that are **equal to 1 mole**:

47.88 g tin | 44.01 g carbon dioxide | 22.4 L Br_2 (l) at STP

6.03×10^{22} H_2O molecules | 22.4 L O_3(g) at STP | 58.44 g sodium chloride

11. Consider the following reaction: $\mathbf{NH_4^+(aq) + HSO_3^-(aq) \Rightarrow H_2SO_3(aq) + NH_3(aq)}$

$-H^+$ $+H^+$

Circle all that apply *for each of the following:*

a. $\mathbf{NH_4^+(aq)}$ is _____.

an Arrhenius acid | a Bronsted-Lowry acid | an Arrhenius base | a Bronsted-Lowry base

b. $\mathbf{HSO_3^-(aq)}$ is _____.

an Arrhenius acid | a Bronsted-Lowry acid | an Arrhenius base | a Bronsted-Lowry base

15. Calculate the number of hydrogen atoms in 25.0 g of urea, $(NH_2)_2CO$.

$$25.0\ g\ (NH_2)_2CO \times \frac{mol\ (NH_2)_2CO}{60.07\ g\ (NH_2)_2CO} \times \frac{6.02x10^{23}\ (NH_2)_2CO}{1\ mol\ (NH_2)_2CO} \times \frac{4\ H\ atoms}{(NH_2)_2CO} = \mathbf{1.00x10^{24}\ H\ atoms}$$

13. Consider the following reaction: $2\ Al\ (s) + 6\ HCl\ (aq) \rightarrow 2\ AlCl_3\ (aq) + 3\ H_2\ (g)$

a. Calculate the volume of hydrogen gas produced when 5.00 g of aluminum reacts at STP.

$$5.00\ g\ Al \times \frac{mol\ Al}{26.98\ g\ Al} \times \frac{3\ mol\ H_2}{2\ mol\ Al} \times \frac{22.4\ L\ H_2}{mol\ H_2} = \mathbf{6.23\ L\ H_2}$$

b. Calculate the volume of hydrogen gas produced when 15.00 g of hydrochloric acid reacts at STP.

$$15.00\ g\ HCl \times \frac{mol\ HCl}{36.46\ g\ HCl} \times \frac{3\ mol\ H_2}{6\ mol\ HCl} \times \frac{22.4\ L\ H_2}{mol\ H_2} = \mathbf{4.61\ L\ H_2}$$

c. Identify the limiting reactant and the reactant in excess when 5.00 g of aluminum reacts with 15.00 g of hydrochloric acid at STP.

Since HCl produced the smaller amount of H_2 gas, HCl is the limiting reactant, and Al is the reactant in excess.

14. Consider the decomposition of sodium azide, NaN_3: $2\ NaN_3\ (s) \xrightarrow{spark} 2\ Na\ (s) + 3\ N_2\ (g)$
What is the percent yield if 50.0 g of sodium azide produced 29.7 g of nitrogen.

$$50.0\ g\ NaN_3 \times \frac{mol\ NaN_3}{65.02\ g\ NaN_3} \times \frac{3\ mol\ N_2}{2\ mol\ NaN_3} \times \frac{28.02\ g\ N_2}{mol\ N_2} = \mathbf{32.3\ g\ N_2}$$

$$\%\ yield = \frac{29.7\ g\ N_2}{32.3\ g\ N_2} \times 100\% = \mathbf{92.0\%}$$

15. Identify the reactant oxidized, the reactant reduced, the oxidizing agent, and the reducing agent in each of the following redox reactions:

$Zn \rightarrow Zn^{+2} + 2\ e^-$ LEO

a. $Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$

$2\ H^+ + 2\ e^- \rightarrow H_2$ GER

Zn is oxidized, acting as the reducing agent; HCl is reduced, acting as oxidizing agent.

$C^{-4} \rightarrow C^{+4} + 4\ e^-$ LEO

b. $CH_4(s) + 2\ O_2\ (g) \rightarrow 2\ H_2O(g) + CO_2\ (g)$

$2\ O_2 + 4\ e^- \rightarrow 4\ O^{-2}$ GER

CH_4 is oxidized, acting as the reducing agent; O_2 is reduced, acting as oxidizing agent.

$3\ H_2 \rightarrow 6\ H^+ + 6\ e^-$ LEO

c. $N_2(g) + 3\ H_2\ (g) \rightarrow 2\ NH_3(g)$

$N_2 + 6\ e^- \rightarrow 2\ N^{-3}$ GER

H_2 is oxidized, acting as the reducing agent; N_2 is reduced, acting as oxidizing agent.

$$2\ Al \rightarrow 2\ Al^{+3} + 6\ e^{-} \quad \text{LEO}$$

d. $$3\ \overset{+2\,|\,-1}{SnCl_2}(aq) + 2\ \overset{0}{Al}(s) \rightarrow 2\ \overset{+3\,|\,-1}{AlCl_3}(aq) + 3\ Sn(s)$$

$$3\ Sn^{+2} + 6\ e^{-} \rightarrow 3\ Sn \quad \text{GER}$$

Al is oxidized, acting as the reducing agent; $SnCl_2$ is reduced, acting as oxidizing agent.

16. A 0.750 mL bubble at 4°C and 6.00 atm occupies what volume at 22.50°C and 725 mmHg?

$$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{(4560\ \text{mmHg})\ (0.750\ \text{mL})\ (296\text{K})}{(277\text{K})(725\ \text{mmHg})} = 5.05\ \text{mL}$$

17. Which of the following that ***increase*** from left to right across the Periodic Table?
Atomic radius, Ionization energy, Metallic character, Electronegativity, # of valence electrons

Ionization energy, Electronegativity, # of valence electrons

18. Circle all of the following that ***increase*** from top to bottom down the Periodic Table?
Atomic radius, Ionization energy, Metallic character, Electronegativity, # of valence electrons

Atomic radius, Metallic character

See next page for problem #19.

20. Consider the following six choices below:

A. ionic bond	D. dispersion (London) forces	G. metallic bonds
B. polar covalent bond	E. dipole-dipole forces	
C. nonpolar covalent bond	F. hydrogen bond	

Give the letter for the type of bond or intermolecular force described for each of the following:

F i. The bonds broken when NH_3*(l)* boils.
B ii. The bonds holding atoms together in water.
D iii. The bonds broken when a sample of Br_2*(s)* boils.
C iv. The bonds holding the atoms together in a Cl_2 molecule.
A v. The bonds broken when a sample of KBr melts.
E vi. The bonds holding broken when a sample of H_2S*(l)* boils.
E vii. The bonds holding two HBr molecules together in a sample of HBr*(l)*.
B viii. The bonds holding atoms together in a sample of HF*(l)*.
G ix. The bonds holding atoms together in a sample of Pb*(s)*.

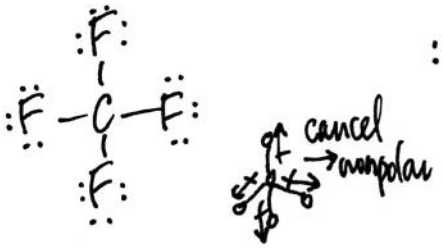
21. Which of the following does NOT increase with stronger intermolecular forces between molecules?
a. boiling point b. molar heat of vaporization c. surface tension d. vapor pressure

22. Circle all of the following that will be soluble in or miscible with water:
CH_3Cl*(l)* $C_{graphite}$*(s)* CO_2*(s)* K_3PO_4 AgBr HCN*(l)* Ag*(s)* I_2*(s)*

23. Circle all of the following that will be soluble in or miscible with olive oil (a nonpolar solvent):
CH_3Cl*(l)* $C_{graphite}$*(s)* CO_2*(s)* K_3PO_4 AgBr HCN*(l)* Ag*(s)* I_2*(s)*

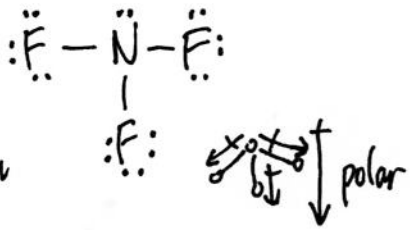
19. For each of the following molecules: CF_4, NF_3, CH_2O, PCl_3, CH_2F_2, CO_2, SO_2, CO_3^{2-}, SO_4^{2-}, NO_2^-
   i. Draw the Lewis electron dot formula.
   ii. Indicate the shape of the molecule and its bond angles.
   iii. Indicate if the molecule is polar or nonpolar.

CF_4: $4 + 4(7) = \frac{32}{2} = 16$ e⁻ pr



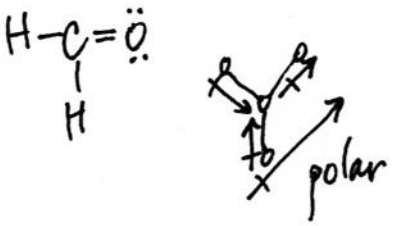
CF_4's shape: tetrahedral
CF_4's bond angle: 109.5°
CF_4 is nonpolar.

NF_3: $5 + 3(7) = \frac{26}{2} = 13$ e⁻ pr



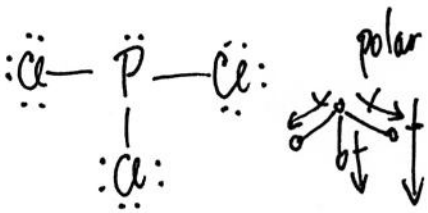
NF_3's shape: trigonal pyramidal
NF_3's bond angle: <109.5°
NF_3 is polar.

CH_2O: $4+2(1)+6 = \frac{26}{2} = 13$ e⁻ pr



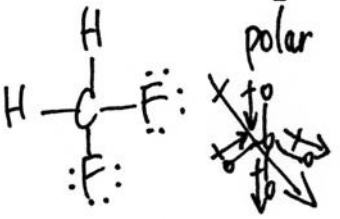
CH_2O's shape: trigonal planar
CH_2O's bond angle: 120°
CH_2O is polar.

PCl_3: $5 + 3(7) = \frac{26}{2} = 13$ e⁻ pr



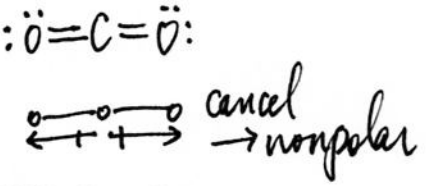
PCl_3's shape: trigonal pyramidal
PCl_3's bond angle: <109.5°
PCl_3 is nonpolar.

CH_2F_2: $4+2(1)+2(7) = \frac{20}{2} = 10$ e⁻ pr



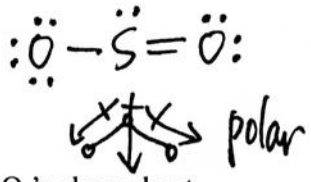
CH_2F_2's shape: tetrahedral
CH_2F_2's bond angle: 109.5°
CH_2F_2 is polar.

CO_2: $4 + 2(6) = \frac{16}{2} = 8$ e⁻ pr



CO_2's shape: linear
CO_2's bond angle: 180°
CO_2 is nonpolar.

SO_2: $6 + 2(6) = \frac{18}{2} = 9$ e⁻ pr

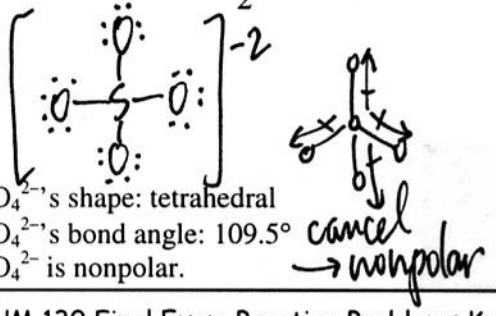


SO_2's shape: bent
SO_2's bond angle: <120°
SO_2 is polar.

CO_3^{2-}: $4+3(6)+2 = \frac{24}{2} = 12$ e⁻ pr

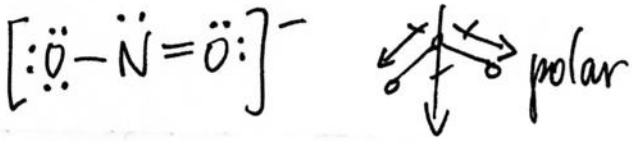
CO_3^{2-}'s shape: trigonal planar
CO_3^{2-}'s bond angle: 120°
CO_3^{2-} is nonpolar.

SO_4^{2-}: $6 + 4(6)+2 = \frac{32}{2} = 16$ e⁻ pr



SO_4^{2-}'s shape: tetrahedral
SO_4^{2-}'s bond angle: 109.5°
SO_4^{2-} is nonpolar.

NO_2^-: $5 + 2(6) + 1 = \frac{18}{2} = 9$ e⁻ pr



NO_2^-'s shape: bent
NO_2^-'s bond angle: <120°
NO_2^- is polar.