Chem 1121
Spring 2012
Exam 3A

Name: KEY

Show all work to receive credit. You must use the factor-label (conversion-factor) method for all conversions. Be sure to show all units and write your answers using the correct number of significant figures or decimal places.

>0.4 ≤0.4

Q1. [6 pts.] Predict whether the following bonds will be POLAR or NON-POLAR. Explain how you determined your answers.

a) C—H Non-polar $\Delta E_{neg} = |2.5 - 2.1| = 0.4$

b) F—F Non-polar $\Delta E_{neg} = |4.0 - 4.0| = 0.0$

c) C—O Polar $\Delta E_{neg} = |2.5 - 3.5| = 1.0$

Q2. [20 pts.] Predict whether CF_4 will be POLAR or NON-POLAR. Your answer should include a valid Lewis structure, a sketch of the molecular geometry, bond dipole-moments, and the overall dipole-moment.

Lewis:

VSEPR:

⟶ = bond dipole moment

Overall dipole-moment = 0
(all bond-dipoles cancel out!
they all "pull" in opposite directions)

⇒ NON-POLAR.

Q3. [5 pts.] Explain what the phrase: *like dissolves like* means. Give examples.

polar molecules dissolve well in polar solvents ex: SO_2 in H_2O

non-polar " ——————— " non-polar " ex: CH_4 in C_8H_{18}

Q4. [22 pts.] Balance the following chemical equations using the lowest whole number coefficients:

a) $\_\_H_2SO_4 + 2\_KOH \rightarrow \_\_K_2SO_4 + 2\_H_2O$

b) $2\_NaClO_3 \rightarrow 2\_NaCl + 3\_O_2$

c) $11\_O_2 + 2\_C_4H_8O \rightarrow 8\_CO_2 + 8\_H_2O$

Q5. [15 pts.] Calculate the molar mass of the following substances:

a) CS_2

$1 \times C = 1 \times 12.01$

$2 \times S = 2 \times 32.07$

76.15

$\Rightarrow 1\ mol\ CS_2 = 76.15\ g\ CS_2$

b) $C_6H_4N_2O_4$

$6 \times C = 6 \times 12.01$

$4 \times H = 4 \times 1.01$

$2 \times N = 2 \times 14.01$

$4 \times O = 4 \times 16.00$

168.12

$\Rightarrow 1\ mol\ C_6H_4N_2O_4 = 168.12\ g\ C_6H_4N_2O_4$

c) $Ca_3(PO_4)_2$

$3 \times Ca = 3 \times 40.08$

$2 \times P = 2 \times 30.97$

$8 \times O = 8 \times 16.00$

310.18

$\Rightarrow 1\ mol\ Ca_3(PO_4)_2 = 310.18\ g\ Ca_3(PO_4)_2$

Q6. [12 pts.] Using your answers to the previous question:

(Note: you must use the conversion-factor / factor-label method to receive full credit for this question!)

a) What mass would 0.39 mol of CS_2 weigh?

$$0.39\ mol\ CS_2 \left| \frac{76.15\ g\ CS_2}{1\ mol\ CS_2} \right. = 30.\ g\ CS_2 \quad (2sf.)$$

b) How many moles of $C_6H_4N_2O_4$ are there in a 139 g sample of this compound?

$$139\ g\ C_6H_4N_2O_4 \left| \frac{1\ mol\ C_6H_4N_2O_4}{168.12\ g\ C_6H_4N_2O_4} \right. = 0.827\ mol\ C_6H_4N_2O_4 \quad (3s.f.)$$

c) What mass would 0.092 mol of $Ca_3(PO_4)_2$ weigh?

$$0.092\ mol\ Ca_3(PO_4)_2 \left| \frac{310.18\ g\ Ca_3(PO_4)_2}{1\ mol\ Ca_3(PO_4)_2} \right. = 29\ g\ Ca_3(PO_4)_2 \quad (2sf)$$

Q7. [20 pts.] Given the following balanced chemical equation:
(Note: you must use the conversion-factor / factor-label method to receive full credit for this question!)

$$2NaCl + F_2 \rightarrow 2NaF + Cl_2$$

a) How many moles of Cl_2 can be formed from 0.42 mol NaCl?

$$0.42 \text{ mol NaCl} \left| \frac{1 \text{ mol } Cl_2}{2 \text{ mol NaCl}} \right. = 0.21 \text{ mol } Cl_2 \quad (2sf)$$

b) What mass in grams of Cl_2 can be formed from 0.42 mol NaCl?

Cl_2
$2 \times Cl = 2 \times 35.45$
70.90

$$0.42 \text{ mol NaCl} \left| \frac{1 \text{ mol } Cl_2}{2 \text{ mol NaCl}} \right| \frac{70.90 \text{ g } Cl_2}{1 \text{ mol } Cl_2} = 15 \text{ g } Cl_2 \quad (2sf)$$

c) What mass in grams of Cl_2 can be formed from 13.4 g NaCl?

NaCl
$1 \times Na = 22.99$
$1 \times Cl = 35.45$
58.44

$$13.4 \text{ g NaCl} \left| \frac{1 \text{ mol NaCl}}{58.44 \text{ g NaCl}} \right| \frac{1 \text{ mol } Cl_2}{2 \text{ mol NaCl}} \left| \frac{70.90 \text{ g } Cl_2}{1 \text{ mol } Cl_2} \right. = 8.13 \text{ g } Cl_2$$

d) If 3.51 g of Cl_2 is made from 13.4 g of NaCl, then what is the percent yield?
(Note: you should be using your answer to part c to answer this question.)

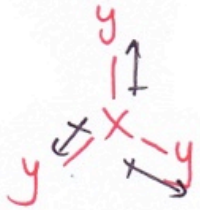
$$\% \text{ yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100 = \frac{3.51 \text{ g}}{8.13 \text{ g}} \times 100 = \boxed{43.2\%}$$

BONUS Question:

Given that the X—Y bond is polar, then *explain* how you can tell whether XY_3 is trigonal planar or trigonal pyramidal if you were told that XY_3 is polar!

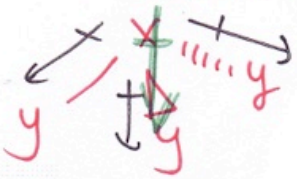
$X \longrightarrow Y$ (or other way... doesn't affect answer)

if XY_3 is trigonal planar:



all bond dipoles would cancel
⇒ NON-POLAR

if XY_3 is trigonal pyramidal:



overall dipole ≠ 0 ⇒ POLAR

⇒ XY_3 must be trigonal pyramidal!

"IT WAS INEVITABLE. THEY WERE CHEMISTRY PARTNERS."