Study Guide Exam II Fall 2009

Show logic and calculations for all problems. Remember to include units and be careful with sig. fig.

1. *Regarding the Boltzmann molecular simulator program used in lecture, would increasing the number of red spheres in the box increase or decrease the pressure? Explain your answer using the Kinetic Molecular Theory.*

The pressure would increase. Pressure is related to the number and force of collisions that atoms/molecules make with the walls of the container. If the number of spheres increase, the number of collisions would increase.

2. What pressure is exerted by 0.533 moles of Ar*(g)* at 24.7° C in a 2.500 L container?

PV = nRT n = 0.533 moles T = 24.7 + 273.15 = 297.85 V = 2.500 L R = 0.08205 (L•atm/mol•K)

$P = nRT/V = \frac{(0.533\ moles)(0.08205\ \frac{L-atm}{mol-K})(297.85)}{2.500\ L}$ = 5.210 atm = 5.21 atm

3. *A syringe if filled with 48.0 mL of air at a pressure of 748 mm Hg. What would the pressure in the syringe be when the volume is decreased to 9.2 mL?*

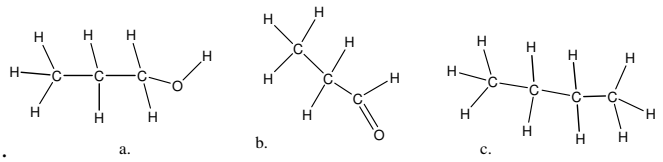
$P_1V_1 = P_2V_2$ V_1 = 48.0 mL P_1 = 748 mm Hg V_2 = 9.2 mL

$P_2 = P_1V_1/V_2$ = (748 mm Hg)(48.0 mL)/(9.2 mL) = 3902.6 mm Hg = 3900 mm Hg or 3.9×10^3 mm Hg

3.5. *Name the 3 types of intermolecular attractive forces we considered in lecture. Describe each and indicate any requirements for the formation of each type of interaction.*

London Dispersion forces – A result of attraction between molecules experiencing temporary, unsymmetrical distribution of electrons resulting in temporary dipoles. Attraction by London dispersion forces requires that atoms/molecules be in close contact with each other. All atoms/molecules have these attractive forces.
Hydrogen bonding – A bond formed between a H atom covalently bonded to a N, O, or F and the non-bonding electron pair of a N, O, or F. The H must be correctly aligned with the non-bonding electron pair of the N, O or F.
Dipole-dipole forces – A result of attraction between molecules with permanent dipoles (polar molecules). Dipoles have a permanent asymmetric charge distribution.

4. *Which of the following compounds would have the highest, intermediate, and lowest boiling point? Explain your answer, using structures where appropriate*



a. b. c.

A – (propanol) highest bp – strongest IMF (intermolecular forces), hydrogen bonds .
B – (propanal) intermediate bp – intermediate IMF, dipole-dipole forces.
C –(butane) lowest bp – weakest IMF, London dispersion forces
For compounds of similar molecular weight, the stronger the IMF, the higher the boiling point.

5. *What would be the physical state of a compound at room temp that boiled at 55.9 ^{o}C and melted at 10.8 ^{o}C.?*

Room temperature is roughly 22 ^{o}C. This temperature is above the melting point and below the boiling point of the compound, so the compound would be a liquid.

6. *Draw a picture of three molecules of water connected by hydrogen bonds.*

7. *How many moles of propane (C_3H_8) are present in 500.8 g propane? How many propane molecules are present in this 500.8 g? How many C atoms are present in this sample?*

First find the molecular weight of C_3H_8. 3 C 3 x 12.011 = 36.033
8 H 8 x 1.00794 = 8.06352
44.09652 g/mole

500.8 g x $\frac{1\ mole}{44.09652\ g}$ = 11.3569 mol C_3H_8. or 11.36 mol C_3H_8.

(11.3569 mol C_3H_8)(6.022 x 10^{23}) = 6.839 x 10^{24} molecules C_3H_8

(6.839 x 10^{24} molecules C_3H_8)($\frac{3\ C\ atoms}{1\ molecule}$) = 2.052 x 10^{25} C atoms

8. *What volume of a 15% (w/v) solution of LiOH would be produced if you used 8750 g of LiOH?*

% (w/v) = $\frac{g\ solute}{mL\ solution}$ x 100 15 = $\frac{8750}{x}$ x 100 x = $\frac{8750}{15}$ x 100 = 58333 mL = 58,000 mL

9. What is the concentration in molarity units of a solution that has 7.00 g of NaCl dissolved in water to give 520.6 mL of solution?

M = mol/liter, First need to convert 7.00 g of NaCl into moles of NaCl using the molecular weight of NaCl.

Na 22.98977 g
Cl 35.4527 g
58.44247 g in 1 mol of NaCl 7.00 g x ($\frac{1\ mol\ NaCl}{58.44247\ g}$) = 0.1197759 mol 520.6 mL x $\frac{1\ L}{1000\ mL}$ = 0.5206 L

$\frac{0.1198\ mol}{0.5206\ L}$ = 0.2301 mol/L = 0.230 M

10. *If 83.00 mL of a 3.075 M solution of NaOH is diluted to a final volume of 12.88 L, what will its concentration be?*

$M_1V_1 = M_2V_2$. Rearrange to get $\frac{M1V1}{V2} = M_2$. The volume amounts must be expressed in the same units.

Convert 83.00 mL to liters. 83.00 mL x $\frac{1\ L}{1000\ mL}$ = 0.08300 L $M_2 = \frac{3.075\ M\ x\ 0.08300\ L}{12.88\ L}$ = 0.01982 M

11. *Which of the compounds in Prob. #4 above would you predict to have the highest, intermediate, and lowest <u>solubility</u> in water? Explain your answer, using structures where appropriate.*
C is a non-polar molecule. It would not be soluble in polar water.
Both A and B have a non-polar region and a polar region. The non-polar regions have similar surface areas for both molecules. Next, compare the polar regions.
A can form hydrogen bonds with water. Each of its propanol molecules has two H-bonding acceptor sites and 1 donor site.
B can also form hydrogen bonds w/ water. It has two acceptor sites and no donor sites. This is less than propanol in A.
A is most soluble. B has intermediate solubility. C is least soluble.

12. Predict the products of the following reactions & balance the equations.

a) $FeCl_3 + 3\ K \rightarrow 3\ KCl + Fe$

b) $2\ K_3PO_4(aq) + 3CoCl_2(aq) \rightarrow 6\ KCl\ (aq) + Co_3(PO_4)_2\ (s)$

c) $2\ Ca + O_2 \rightarrow 2\ CaO$

d) $HCl(aq) + NaOH(s) \rightarrow NaCl\ (aq) + H_2O\ (l)$

e) $C_5H_{12} + 8\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$

12. *Define reduction*

The gain of electrons, the gain of H, the loss of O

13. *A sample of 235.00 g of Ca reacts completely with water to produce an explosive gas.*
a) Write a balanced or net ionic chemical equation for the reaction and indicate which reactant is oxidized and which is reduced.

$Ca + 2\ H_2O \rightarrow Ca(OH)_2 + H_2$ $\qquad$ $Ca + 2\ H^+ \rightarrow Ca^{2+} + H_2$

b) How many moles of gaseous product are produced?

$235.00\ g\ x\ (\frac{1\ mole}{40.07838\ g}) = 5.8635$ mole Ca $\qquad$ $5.8635\ mole\ Ca\ x\ (\frac{1\ mol\ Hydrogen\ gas}{1\ mole\ Ca}) = 5.8635$ mole Ca

Supplemental Information ***(that you will be provided)***

Periodic Table and Electronegativity Table
Equations for temperature: °F = 1.8 °C + 32 $\qquad$ K = °C + 273.15

English to metric conversions
Length: 1 m = 39.47 in $\qquad$ *Mass:* 1 kg = 2.205 lb $\qquad$ *Volume* 1 L = 1.057 qt
1 in = 2.54 cm $\qquad$ 1 lb = 453.5 g
R = 0.08205 (L•atm⁄mol•K) $\qquad$ 1 atm = 760. mm Hg $\qquad$ 1 atm = 760. Torr