Chemistry 210 Exam 1

Be sure to put your name on each page. This page can be removed from your exam so that you will have a Periodic Table handy throughout the exam, it does not need to be turned in. Show all your work for problems which require any sort of calculation, no credit will be given for answers without work shown. If you have shown a significant amount of work or multiple drawings for a problem, draw a box around what you consider your final answer.

Avogadro's Number = $6.022 \times 10^{23}\ ^{units}/_{mol}$
$32.00^{o}F = 0.000^{o}C = 273.15K$
Density of Water = $1.000^{g}/_{mL}$
$R = 0.08206\ ^{L \bullet atm}/_{mol \bullet K}$
$PV = nRT$
$\Delta T_{fp/bp} = k_{fp/bp} \bullet m \bullet i$
For water, $k_{fp} = -1.86^{\circ C}/_{m}$; $k_{bp} = 0.52^{\circ C}/_{m}$
$P_1 = X_1 P_1^{o}$
$P = cRTi$
$C_1V_1 = C_2V_2$

1 **H** 1.0079																	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305											13 **Al** 26.982	14 **Si** 28.086	15 **P** 30.974	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.88	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.847	27 **Co** 58.933	28 **Ni** 58.69	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.922	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.94	43 **Tc** (98)	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 **La** 138.91	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** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.03	89 **Ac** 227.03	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 (269)	111 (272)	112 (277)		114		116		

58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	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** 168.94	70 **Yb** 173.04	71 **Lu** 174.97
90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (258)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

Score

Multiple Choice: Circle the letter of the most correct response. (8pts. per question)

1. Rank the 3 states of matter from lowest kinetic energy to highest kinetic energy.
   a. Solid, liquid, gas
   b. Gas, solid, liquid
   c. Solid, gas, liquid
   d. Liquid, gas, solid
   e. Gas, liquid, solid

2. When dissolving a solid in a liquid:
   a. The freezing point of the solution will be lower than that of the pure solvent
   b. The enthalpy of solution is always positive
   c. Energy is released (exothermic) by breaking solvent-solvent and solute-solute interactions
   d. The boiling point of the solution will be lower than that of the pure solvent
   e. Formation of solvent-solute interactions is endothermic

3. Which of the following is ***not*** a correct gas law relationship?
   a. $PV = nRT$
   b. $V_1P_1 = V_2P_2$
   c. $V_1/T_1 = V_2/T_2$
   d. $V_1n_1 = V_2n_2$
   e. $P_1/T_1 = P_2/T_2$

4. The volume of a gas:
   a. Increases as the pressure increases
   b. Decreases as the kinetic energy increases
   c. Is always a constant
   d. Increases as the temperature increases
   e. Remains constant as the amount of gas is increased

5. Carbon tetrabromide (CBr_4) has a higher boiling point than carbon tetrafluoride (CF_4) because:
   a. The bonds in CF_4 are polar but the bonds in CBr_4 are not
   b. CBr_4 has a higher molecular weight than CF_4
   c. CF_4 is a polar molecule but CBr_4 is not
   d. CF_4 has stronger intermolecular forces than CBr_4
   e. CF_4 is a gas at room temperature

Score

Concentration calculations: (10pts each)

6. You have prepared a solution by dissolving 12.383g of sodium sulfate in enough water to make 500.0mL of solution. What is the *molarity* of this solution?

$$\text{Molarity} = \frac{\left(\dfrac{12.383\text{g } Na_2SO_4}{142.042 \dfrac{\text{g } Na_2SO_4}{\text{mol } Na_2SO_4}}\right)}{(500.0\text{mL sol'n})\left(\dfrac{1\text{L sol'n}}{1000\text{mL sol'n}}\right)} = 0.1744 \text{ M}$$

7. You have prepared a solution by dissolving 5.821g of ammonium carbonate in 100.0g of water. What is the *molality* of this solution?

$$\text{Molality} = \frac{\left(\dfrac{5.821\text{g } (NH_4)_2CO_3}{96.085 \dfrac{\text{g } (NH_4)_2CO_3}{\text{mol } (NH_4)_2CO_3}}\right)}{(100.0\text{g water})\left(\dfrac{1\text{kg water}}{1000\text{g water}}\right)} = 0.6058 \text{ m}$$

8. You have prepared a solution by dissolving 0.383g of iron(II) nitrate in 500.0mL of water. What is the concentration of this solution in parts per million, ppm?

$$\text{ppm} = \frac{(0.383\text{g } Fe(NO_3)_2)}{\left[(500.0\text{mL water})\left(\dfrac{1\text{g water}}{1\text{mL water}}\right)\right] + (0.383\text{g } Fe(NO_3)_2)} \text{x}10^6 = 765 \text{ ppm}$$

9. You have prepared a solution by diluting 10.00mL of a 2.38M aqueous solution of sugar ($C_6H_{12}O_6$) to a total volume of 250.0mL. What is the *molarity* of this solution?

$$C_1V_1 = C_2V_2$$
$$(2.38 \text{ M})(10.00\text{mL}) = (C_2)(250.0\text{mL})$$
$$C_2 = 0.0952 \text{ M}$$

10. A lab technician prepares a solution for a freezing point depression experiment by dissolving 0.1250mols of solute in water and diluting to 250.0mL in a volumetric flask. The technician labels the solution "molality = 0.5000". What is wrong with this label?

The solution that was prepared could have been labeled "Molarity = 0.5000", but the units "molality" require that you know the mass of solvent used, not the final volume of the solution.

Score

Colligative Properties: (15pts each)

11. What is the boiling point of a solution made by dissolving 12.952g of potassium bromide in 100.0g of water?

$$\text{Molality} = \frac{\left(\dfrac{12.952\text{g KBr}}{119.002\dfrac{\text{g KBr}}{\text{mol KBr}}}\right)}{(100.0\text{g water})\left(\dfrac{1\text{kg water}}{1000\text{g water}}\right)} = 1.088\text{ m}$$

$$\Delta T_{bp} = k_{bp} \bullet m \bullet i$$

$$\Delta T_{bp} = (0.52\,{}^{\circ C}/_{m})\ (1.088\text{ m})\ (2\ {}^{\text{mols of particles}}/_{\text{mol of KBr}}) = 1.1\ {}^{\circ}\text{C}$$

The change in boiling temperature (ΔT_{bp}) is 1.1ºC, so the boiling point of the KBr solution is:

$$T_{bp} = 100.0^{\circ}\text{C} + 1.1^{\circ}\text{C} = 101.1^{\circ}\text{C}$$

12. Some compounds we call "ionic" do not completely dissociate in water. The extent to which they dissociate can be explored using freezing point depression. When 0.839mols of lead(IV) chloride is dissolved in 750.0g of water, the freezing point of the resulting solution is –6.24ºC. Which of the following equations is most consistent with the observed freezing point depression in this solution? Explain your choice.

$$PbCl_4(s) \rightarrow Pb^{4+}(aq) + 4\ Cl^-(aq)$$

$$PbCl_4(s) \rightarrow [PbCl]^{3+}(aq) + 3\ Cl^-(aq)$$

$$PbCl_4(s) \rightarrow [PbCl_2]^{2+}(aq) + 2\ Cl^-(aq)$$

$$PbCl_4(s) \rightarrow [PbCl_3]^{+}(aq) + 1\ Cl^-(aq)$$

$$\text{Molality} = \frac{(0.839\text{mols }PbCl_4)}{(750.0\text{g water})\left(\dfrac{1\text{kg water}}{1000\text{g water}}\right)} = 1.12\text{ m}$$

$$\Delta T_{bp} = k_{bp} \bullet m \bullet i$$

$$-6.24^{\circ}\text{C} = (-1.86\,{}^{\circ C}/_{m})\ (1.12\text{ m})\ (X\ {}^{\text{mols of particles}}/_{\text{mol of PbCl4}})$$

Based upon the observed freezing point change, $PbCl_4$ must dissociate into 3 particles when it dissolves in water, therefore the third equation is most consistent with the observed freezing point depression.

Score

Name: ______________________________

Gas Laws: (15pts each)

13. You have a 7.50L sample of a pure ideal gas at 1.00atm pressure and 25.35ºC. If the gas has a mass of 26.288g, what is the molecular weight of the gas?

Using the ideal gas law, the number of mols of gas can be determined:

$$PV = nRT$$

$$n = {}^{PV}/_{RT} = {}^{(1.00\text{ atm})(7.50\text{ L})}/_{(0.08206\text{ L•atm/mol•K})(273.15+25.35\text{ K})} = 0.306\text{ mols of gas}$$

$$\text{Molecular weight} = {}^{\text{grams}}/_{\text{mol}} = {}^{26.288\text{ g}}/_{0.306\text{ mols}} = 85.9\ {}^{\text{g}}/_{\text{mol}}$$

14. You have a 38.24L rubber balloon filled with an ideal gas at 3.186ºC and 1.00atm pressure with a large weight tied to it. How many mols of gas are in the balloon? If you heat the balloon to 35.821ºC, what will be the volume of the balloon (assume pressure does not change)?

Using the ideal gas law:

$$PV = nRT$$

$$n = {}^{PV}/_{RT} = {}^{(1.00\text{ atm})(38.24\text{ L})}/_{(0.08206\text{ L•atm/mol•K})(273.15+3.186\text{ K})} = 1.69\text{ mols of gas}$$

When the temperature changes, we need to use the comparative form of the ideal gas law:

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

$$\frac{(1.00atm)(38.24L)}{(1.69mols)(276.34K)} = \frac{(1.00atm)(V_2)}{(1.69mols)(273.15+35.821K)}$$

$$V_2 = 42.8L$$

Score