Name: ____

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 = $6.022\text{x}10^{23}\ ^{\text{units}}/_{\text{mol}}$
$32.00^{o}F = 0.000^{o}C = 273.15K$
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, $k_{fp} = -1.86^{\circ C}/_{m}$; $k_{bp} = 0.512^{\circ C}/_{m}$
$P_1 = X_1P_1^{o}$
$\Pi = (\Delta M)RTi$
$C_1V_1 = C_2V_2$

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. (6pts. per question)

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

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

3. Which of the following is ***not*** a correct gas law relationship?
   a. $PV = nRT$
   b. $V_1/V_2 = P_1/P_2$
   c. $V_1P_1 = V_2P_2$
   d. $V_1T_1 = V_2T_2$
   e. $P_1/T_1 = P_2/T_2$

   This was an error, there should have only been one correct answer.

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 dioxide (CO_2) has a lower boiling point than sulfur dioxide (SO_2) because:
   a. The bonds in SO_2 are polar but the bonds in CO_2 are not
   b. CO_2 has stronger London dispersion forces than SO_2
   c. SO_2 is a polar molecule but CO_2 is not
   d. SO_2 forms stronger hydrogen bonds than CO_2
   e. CO_2 sublimes

6. If each of the following solids is added to 500.0mL of water, which will change the vapor pressure the most?
   a. 1.2mols sugar
   b. 0.4mols calcium phosphate
   c. 0.6mols sodium chloride
   d. 0.5mols calcium nitrate
   e. 0.7mols ammonium phosphate

Score

7. You have prepared a solution by dissolving 18.153g of potassium phosphate in enough water to make 500.0mL of solution. What is the *molarity* of this solution? (14pts)

$$(18.153\text{g K}_3\text{PO}_4)\left(\frac{1\text{mol K}_3\text{PO}_4}{212.264\text{g K}_3\text{PO}_4}\right)\left(\frac{1}{0.5000\text{L sol'n}}\right) = 0.1710\text{M}$$

8. You have prepared a solution by dissolving 8.192g of ammonium bromide in 100.0g of water. What is the *molality* of this solution? (14pts)

$$(8.192\text{g NH}_4\text{Br})\left(\frac{1\text{mol NH}_4\text{Br}}{97.943\text{g NH}_4\text{Br}}\right)\left(\frac{1}{0.1000\text{kg sol'n}}\right) = 0.8364\text{m}$$

9. You have prepared a solution by diluting 75.00mL of a 1.892M aqueous solution of sugar ($C_6H_{12}O_6$) to a total volume of 250.0mL. What is the *molarity* of this solution? (14pts)

$$C_1V_1 = C_2V_2$$
$$(1.892\text{M})(75.00\text{mL}) = (x\text{ M})(250.0\text{mL})$$
$$x = 0.5676\text{M}$$

10. What is the boiling point of a solution made by dissolving 18.188g of lithium nitrate in 200.0g of water? (18pts)

Boiling point is a colligative property that depends upon the molality of particles in solution.

$$\Delta T_{bp} = (18.188\text{g LiNO}_3)\left(\frac{1\text{mol LiNO}_3}{68.945\text{g LiNO}_3}\right)\left(\frac{1}{0.2000\text{kg sol'n}}\right)\left(\frac{2\text{mols particles}}{1\text{mol LiNO}_3}\right)\left(0.512\,\tfrac{°\text{C}}{\text{m particles}}\right) = 1.35°\text{C}$$

This is how much the boiling point temperature ***changes*** when the solute is added. The boiling point of the solution is 1.35ºC ***higher*** than the boiling point of the pure solvent (water). The boiling point of the solution is 101.35ºC

11. A 2.00L vessel contains 4.719g of helium gas at 21.38ºC. What is the pressure of the gas? (14pts)

$$PV = nRT$$
$$P(2.00\text{L}) = \left(\frac{4.719\text{g He}}{4.0026\,\frac{\text{g He}}{\text{mol He}}}\right)\left(0.08206\,\tfrac{\text{L}\bullet\text{atm}}{\text{mol}\bullet\text{K}}\right)(294.53\text{K})$$
$$P = 14.2\text{atm}$$

Score

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 0.335mols of lead(IV) chloride is dissolved in 500.0g 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. (20pts)

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

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

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

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

Using the freezing point depression equation:

$$\Delta T_{fp} = k_{fpd} \bullet m \bullet i$$

$$6.24^\circ C = \left(1.86 \tfrac{^\circ C}{m\ particles}\right)\left(\frac{0.335\ mols\ PbCl_4}{0.5000kg\ solvent}\right)\left(\frac{x\ mols\ particles}{1mol\ PbCl_4}\right)$$

Solving for x, there are 5 solute particles for every $PbCl_4$ unit that dissolves in water, therefore the first equation is most consistent with the observed freezing point.

13. How much energy is required to heat 95.82kg of ice from –12.36ºC to 68.85ºC? {C_s(ice) = 2.09 $^J/_{g.K}$; C_s(water) = 4.184 $^J/_{g.K}$; C_s(steam) = 2.01 $^J/_{g.K}$; ΔH_{fusion}(water) = 6.02 $^{kJ}/_{mol}$; $\Delta H_{vaporization}$(water) = 40.7 $^{kJ}/_{mol}$ } (20pts)

Heating this sample over the indicated temperature range will involve 3 processes:

1. Heat 95.82kg of solid water from –12.36ºC to 0ºC {a heat capacity problem}
2. Melt 95.82kg of solid water to form liquid water {a ΔH_{fusion} problem}
3. Heat 95.82kg of liquid water from 0ºC to 68.85ºC {another heat capacity problem}

$$(95820g)(12.36^\circ C)(2.09\ ^J/_{g\bullet^\circ C}) = 2.4753x10^3kJ$$

$$(95820g)\left(\frac{1mol\ water}{18.015g\ water}\right)\left(6.02 \tfrac{kJ}{mol}\right) = 32.0198x10^3kJ$$

$$(95820g)(68.85^\circ C)(4.184\ ^J/_{g\bullet^\circ C}) = 27.6027x10^3kJ$$

Adding up and round to the appropriate number of sig figs, the energy required to complete this process is $6.21x10^4$ kJ

Score