Chem 210 – Exam 1a *Name:* _____
Spring 2012

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 = 6.022×10^{23} $^{\text{units}}/_{\text{mol}}$
$32.00^{\circ}F = 0.000^{\circ}C = 273.15K$
Density of Water = $1.000\ ^{g}/_{mL}$
$R = 0.08206\ ^{L \cdot atm}/_{mol \cdot K} = 8.314\ ^{J}/_{mol \cdot K}$
1atm = 760torr = 760mmHg = 101.325kPa
$PV=nRT$
$\Delta T_{fp/bp} = k_{fp/bp} \bullet m \bullet i$
For water: $k_{fp} = -1.86\ ^{^{\circ}C}/_{m}$
$k_{bp} = 0.512\ ^{^{\circ}C}/_{m}$
$P_1 = X_1 P_1^{\circ}$
$\Pi = MRTi$
$C_1V_1 = C_2V_2$

Integrated Rate Laws:

$\ln[A]_t = -kt + \ln[A]_o$
$1/[A]_t = kt + 1/[A]_o$
$[A]_t = -kt + [A]_o$

$k = Ae^{-Ea/RT}$

$$\ln(k) = \left(\frac{-E_a}{R}\right)\left(\frac{1}{T}\right) + \ln(A)$$

$$\ln\left(\frac{k_1}{k_2}\right) = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$pH = pK_a + \log\left(\frac{[\text{conjugate base}]}{[\text{conjugate acid}]}\right)$$

$E_{cell} = E^{o}_{cell} - {}^{RT}/_{nF}\ ln Q$
$E^{o}_{cell} = {}^{RT}/_{nF}\ ln K^{o}$
$K^{o} = e^{\wedge}({}^{nF}/_{RT}\ E^{o}_{cell})$
$F = 96485\ ^{J}/_{V \cdot mol\ of\ electrons}$
$\Delta G^{o} = \Delta H^{o}_{system} - T\Delta S^{o}_{system}$
$\Delta G^{o} = -nFE^{o}_{cell} = -RT ln K^{o}$
$\Delta G = \Delta G^{o} + RT ln Q$
$F = 96485\ ^{C}/_{mol\ electrons}$
1A = 1 C / sec

Quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

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

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Multiple Choice (3pts each): Circle the letter of the most correct response.

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

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

3. Which of the following statements is most correct about colligative properties of an ideal solution?
   a. The presence of a solute lowers the boiling point of a solution.
   b. The presence of a solute raises the vapor pressure of a solution.
   c. Colligative properties depend upon the number of solute particles, not on the identity of the solute particles.
   d. The presence of a solute raises the freezing point of a solution.
   e. These statements are all correct.

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

5. Under which of the following conditions is a gas ***least*** "ideal"?
   a. Room temperature, 25ºC
   b. High temperature, high pressure
   c. Low temperature, high pressure
   d. Low temperature, low pressure
   e. High temperature, low pressure

6. Which of the following is ***not*** a correct gas law relationship?
   a. $PV = nRT$
   b. $n_1T_1 = n_2T_2$
   c. $V_1n_1 = V_2n_2$
   d. $P_1V_1 = P_2V_2$
   e. $P_1 / T_1 = P_2 / T_2$

7. 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

8. What is the volume of 2.834mols of ideal gas at 11.14ºC and 4.64atm pressure? (8pts)

PV=nRT
(4.64atm) V = (2.834mols)(0.08206 $^{L.atm}/_{mol.K}$)(284.29K)

Answer 8:

14.2 L

9. You have a 82.91L sample of gas at 21.61°C. What is the volume of this gas if the temperature is increased to 62.93°C? (8pts)

$V_1 / T_1 = V_2 / T_2$
(82.91L) / (294.76K) = V_2 / (336.08K)

Answer 9:

94.53 L

10. You have prepared a solution by dissolving 15.443g of magnesium bromide in enough water to make 250.0mL of solution. What is the *molarity* of this solution? (8pts)

(15.443g / 184.113$^{g}/_{mol}$) / 0.2500L =

Answer 10:

0.3355 M

11. You have prepared a solution by dissolving 17.228g of ammonium chlorate in 100.0g of water. What is the *molality* of this solution? (8pts)

(17.228g / 101.489$^{g}/_{mol}$) / (0.1000kg) =

Answer 11:

1.698 m

12. You have prepared a solution by diluting 25.00mL of a 1.885M aqueous solution of iron(II) sulfate to a total volume of 125.0mL. What is the *molarity of iron(II)* of this solution? (8pts)

$C_1V_1 = C_2V_2$
(1.885M)(25.00mL) = C_2(125.0mL)

Answer 12:

0.37 M

13. What is the boiling point of a solution made by dissolving 13.861g of nickel(II) nitrate in 150.0g of water? (12pts)

(13.861g / 182.698$^{g}/_{mol}$) / (0.1500kg) = 0.505789 m

$\Delta T_{bp} = k_{bpe} \bullet m \bullet i = (0.52\ ^{\circ C}/_{m})(0.505789\ m)(3) = 0.789°C$

Answer 13:

100.79 °C

Score

14. Each of the following solids is dissolved in separate beakers containing 500.0mL of water. Rank the solutions from lowest freezing point to highest freezing and explain your answer. (12pts)
    a. 0.5mols sodium phosphate
    b. 0.5mols calcium nitrate
    c. 0.6mols magnesium chloride
    d. 0.6mols ammonium carbonate

a = 2.0mol particles; b = 1.5mol particles; c = 1.8mol particles; d=1.8mol particles
Lowest T_{fp} = a < {c = d} < b

15. A laboratory technician prepares a solution by weighing out 39.225g of potassium bromide and dissolving it in enough water to make 150.00mL of solution. The technician labels the solution "1.3m KBr(aq)". Why is this not correct? What should the laboratory technician do to correct the error? Calculate a correct concentration for this solution. (8pts)

Wrong unit → should be M
Too few sig figs
$(39.225g / 119.002\,^{g}/_{mol}) / 0.15000L = 2.1974\ M$

16. How much energy is required to heat 500.0g of water from -37.25ºC to 21.39ºC? {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 $^{kJ}/_{mol}$ } (15pts)

Answer 16:

Heating ice + melting + heating liquid water
$(2.09\,^{J}/_{g\bullet K})(500.0g)(37.25K) = 38.9kJ$
$(6.02\,^{kJ}/_{mol})(500.0g / 18.015\,^{g}/_{mol}) = 167kJ$
$(4.184\,^{J}/_{g\bullet K})(500.0g)(21.39K) = 44.75kJ$
Total = 251kJ transfer

17. Some salts have enough covalent bond character that they do not completely dissociate when dissolved in water. You have performed an experiment in which you have made a solution by dissolving 29.531g of tin(IV) bromide in 250.00mL of water. The observed freezing point of this solution is –1.50ºC. Which of the following equations is most consistent with your observed freezing point? Explain your answer with explicit calculations. (15pts)

$SnBr_4(s) \rightarrow Sn^{4+}(aq) + 4\ Br^-(aq)$
$SnBr_4(s) \rightarrow [SnBr]^{3+}(aq) + 3\ Br^-(aq)$
$SnBr_4(s) \rightarrow [SnBr_2]^{2+}(aq) + 2\ Br^-(aq)$
$SnBr_4(s) \rightarrow [SnBr_3]^{+}(aq) + Br^-(aq)$
$SnBr_4(s) \rightarrow SnBr_4(aq)$

$\Delta T_{fp} = k_{fpd} \bullet m \bullet i$
$1.50°C = (1.86\,^{°C}/_{m})\ (\ (29.531g / 438.326\,^{g}/_{mol}) / 0.25000kg\ ) \bullet i$
i = 3 → when tin(IV) bromide dissolves, it forms 3 solute particles, so the 3rd equation is most consistent.

Score

18. You have reacted 8.042g of aluminum metal with150.0mL of 4.623M HCl(aq) to produce hydrogen gas and aluminum chloride. How many liters of hydrogen gas can be produced at 41.61°C and 1.137atm? (15pts)

$2\ Al(s) + 6\ HCl(aq) \rightarrow 3\ H_2(g) + 2\ AlCl_3(aq)$

Answer 18:

10.16L

$(8.042g\ Al(s) / 26.982\ ^{g}/_{mol\ Al})(3mols\ H_2(g) / 2mols\ Al(s))\{(0.08206\ ^{L \cdot atm}/_{mol \cdot K})(314.76K) / 1.137atm \} = 10.16L$

$(0.1500L)(4.623\ ^{mol\ HCl}/_{L})(3mols\ H_2(g) / 6mols\ HCl(aq))\{(0.08206\ ^{L \cdot atm}/_{mol \cdot K})(314.76K) / 1.137atm \} = 23.63L$

19. A newly discovered protein has been isolated from seeds of a tropical plant and needs to be characterized. A total of 0.137g of this protein was dissolved in enough water to produce 2.00mL of solution. At 31.68°C the osmotic pressure produced by the solution was 0.134atm. What is the molar mass of the protein? (15pts)

$\Pi = MRTi$

$0.134atm = (0.137g / MW / 0.00200L)(0.08206\ ^{L \cdot atm}/_{mol \cdot K})(304.83K)(1)$

$MW = 156000\ ^{g}/_{mol}$

Answer 19:

$156000\ ^{g}/_{mol} = 156kDa$

Score