Chemistry 141 Name

Martin Larter Exam 4B December 3. 2015

Multiple Choice (30 points)

Page 6 (18 points)

Page 7 (12 points)

Page 8 (20 points)

Page 9 (18 point)

Page 10 (10 point)

Total (108 points)

Chemistry Formulas and Constants

Kinetic energy = ½ mv2

w = -PΔV

ΔTb = i(kb)(m)

ΔGo = -nFEo

ΔG = - RTlnK

w=dxF

E = mc2

Ptotal = P1+P2+P3+…

Kp = Kc(RT)Δn

HΨ=EΨ

M1V1 = M2V2

u = (3RT/MW)½

ΔG = ΔH - TΔS

Ptotal = P1 + P2 + P3 + …

PV = nRT

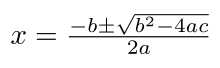
Rate ∝ (MW)-½

P1=X1\*Ptotal

Π= iMRT

C = q/ΔT

Ptotal = P1 + P2 + P3 + …





Constants

F = 9.65 x 104 C

h = 6.626 x 10-34 J sec

c= 2.9979 x 108 m/sec

mass electron = 9.109 x 10-31 kg RE = 2.18 x 10-18 J

e = 1.602 x 10-19 C

R = 0.0821 L atm/mol K = 62.4 L torr/mol K = 8.31 kJ/mol K

Extra credit: (3 points) Arterial blood contains about 0.25 g of oxygen/liter x atm air at 37 °C. What is the Henry’s law constant [mol/(L atm O2)] for O2 dissolution in blood? The mole fraction of O2 in air is 0.209

Grossmont College

Periodic Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IA |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  | VIIA | NOBLE GASES |
| 1  **H**  1.008 | IIA |  |  |  |  |  |  |  |  |  | |  | IIIA | IVA | VA | VIA | 1  **H**  1.008 | 2  **He**  4.002 |
| 3  **Li**  6.941 | 4  **Be**  9.012 |  |  |  |  |  |  |  |  |  | |  | 5  **B**  10.81 | 6  **C**  12.01 | 7  **N**  14.01 | 8  **O**  16.00 | 9  **F**  19.00 | 10  **Ne**  20.18 |
| 11  **Na**  23.00 | 12  **Mg**  24.30 | IIIB | IVB | VB | VIB | VIIB | VIII VIII VIII | | | | IB | IIB | 13  **Al**  27.00 | 14  **Si**  28.09 | 15  **P**  30.97 | 16  **S**  32.06 | 17  **Cl**  35.45 | 18  **Ar**  39.95 |
| 19  **K**  39.10 | 20  **Ca**  40.08 | 21  **Sc**  44.96 | 22  **Ti**  47.90 | 23  **V**  50.94 | 24  **Cr**  52.00 | 25  **Mn**  54.94 | 26  **Fe**  55.85 | 27  **Co**  58.93 | 28  **Ni**  58.70 | | 29  **Cu**  63.55 | 30  **Zn**  65.38 | 31  **Ga**  69.72 | 32  **Ge**  72.59 | 33  **As**  74.92 | 34  **Se**  78.96 | 35  **Br**  79.90 | 36  **Kr**  83.80 |
| 37  **Rb**  85.47 | 38  **Sr**  87.62 | 39  **Y**  88.91 | 40  **Zr**  91.22 | 41  **Nb**  92.91 | 42  **Mo**  95.94 | 43  **Tc**  (99) | 44  **Ru**  101.1 | 45  **Rh**  102.9 | 46  **Pd**  106.4 | 47  **Ag**  107.9 | | 48  **Cd**  112.4 | 49  **In**  114.8 | 50  **Sn**  118.7 | 51  **Sb**  121.8 | 52  **Te**  127.6 | 53  **I**  126.9 | 54  **Xe**  131.3 |
| 55  **Cs**  132.9 | 56  **Ba**  137.3 | 57  **La**  138.9 | 72  **Hf**  178.5 | 73  **Ta**  180.9 | 74  **W**  183.9 | 75  **Re**  186.2 | 76  **Os**  190.2 | 77  **Ir**  192.2 | 78  **Pt**  195.1 | 79  **Au**  197.0 | | 80  **Hg**  200.6 | 81  **Tl**  204.4 | 82  **Pb**  207.2 | 83  **Bi**  209.0 | 84  **Po**  (209) | 85  **At**  (210) | 86  **Rn**  (222) |
| 87  **Fr**  (223) | 88  **Ra**  226.0 | 89  **Ac**  227.0 | 104  **Rf**  (261) | 105  **Db**  (262) | 106  **Sg**  (263) | 107  **Bh**  (262) | 108  **Hs**  (265) | 109  **Mt**  (266) | 110  **??**  (269) |  | |  |  |  |  |  |  |  |

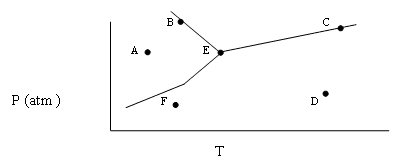
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 58  **Ce**  140.1 | 59  **Pr**  140.9 | 60  **Nd**  144.2 | 61  **Pm**  (147) | 62  **Sm**  150.4 | 63  **Eu**  152.0 | 64  **Gd**  157.3 | 65  **Tb**  158.9 | 66  **Dy**  162.5 | 67  **Ho**  164.9 | 68  **Er**  167.3 | 69  **Tm**  168.9 | 70  **Yb**  173.0 | 71  **Lu**  175.0 |
| 90  **Th**  232.0 | 91  **Pa**  231.0 | 92  **U**  238.0 | 93  **Np**  (237) | 94  **Pu**  (244) | 95  **Am**  (243) | 96  **Cm**  (247) | 97  **Bk**  (247) | 98  **Cf**  (251) | 99  **Es**  (252) | 100  **Fm**  (257) | 101  **Md**  (258) | 102  **No**  (259) | 103  **Lr**  (260) |

Lanthanide series

Actinide series

Multiple Choice (30 points)

1. Based on the phase diagram shown below, which of the following **statements are correct**?
2. Sublimation occurs at a point in the transformation that falls along a straight line from point A to point F.
3. C and E represent points where the gas and liquid phases are in equilibrium.
4. *H*vap can be measured at point B.
5. Molecules at point D have a greater average kinetic energy than those at point F.
6. The temperature at point E is called the critical temperature of the compound.



A) II, IV, V B) I, II, IV

C) I, II, III D) II, V

E) I, III, IV

1. A reaction reaches dynamic equilibrium at a given temperature when
   1. Opposing reactions cease and the system is static.
   2. The amount of products exceeds the amount of reactants.
   3. kfwd equals k rev
   4. The relative amounts of reactants and products are constant and ratefwd = raterev.
   5. None of the above
2. A solute added to a solvent raises the boiling point of the solution because
3. The solute particles lower the solvent's vapor pressure, thus requiring a higher temperature to cause boiling.
4. The temperature to cause boiling must be great enough to boil not only the solvent but also the solute.
5. The solute particles raise the solvent's vapor pressure, thus requiring a higher temperature to cause boiling.
6. The solute increases the volume of the solution, and an increase in volume requires an increase in the temperature to reach the boiling point (derived from *PV* = *nRT*).
7. Two of the above are correct.
8. In the Haber process, N2 gas and H2 gas are combined to produce ammonia gas, NH3. **At equilibrium**, what is true about the **rate of production** of reactants compared with **the rate of production** of products? KC = 2.9

|  |  |  |
| --- | --- | --- |
| 1. slightly lower; | 1. much lower; | 1. the same; |
| 1. slightly higher; | 1. much higher; |  |

1. Which of the following is the most likely arrangement for the following compounds in order of **increasing boiling point?**

CH4, N2, O2, CO2, Cl2, C2H2

|  |  |
| --- | --- |
| 1. CH4 < CO2 < C2H2 < N2 < O2 < Cl2 | 1. CH4 < N2 < O2 < CO2 < Cl2 < C2H2 |
| 1. CH4 < C2H2 < CO2 < O2 < N2 < Cl2 | 1. O2 < N2 < Cl2 < CH4 < CO2 < C2H2 |
| 1. CH4 < C2H2 < N2 < O2 < CO2 < Cl2 |  |

1. \_\_\_\_\_\_\_\_\_\_ are particularly polarizable.

|  |  |  |
| --- | --- | --- |
| 1. Small polar molecules | 1. Small nonpolar molecules | 1. Large nonpolar molecules |
| 1. Large polar molecules | 1. Large molecules, regardless of their polarity | |

1. For which case would Δ*Hsoln* be expected to be **negative**?
   1. if solute-solvent interactions are much greater than solvent-solvent and solute-solute interactions
   2. if solute-solute interactions are much greater than solvent-solvent and solute-solvent interactions
   3. if solvent-solvent interactions are much greater than solute-solvent and solute-solute interactions
   4. if solute-solvent interactions are the same as solvent-solvent and solute-solute interactions
   5. none of the above
2. Indicate which aqueous solution has the **fastest evaporation rate**.

|  |  |  |
| --- | --- | --- |
| 1. 0.2 *M* MgCl2 | 1. 0.2 *M* Na2CO3 | 1. 0.1 *M* MgCl2 |
| 1. 0.2 *M* NaCl | 1. 0.1 *M* KCl |  |

1. Rank the following compounds according to **increasing solubility** in water.

I. CH3–CH2–CH2–CH3 II. CH3–OH III. CH3–CH2–O–CH2–CH3 IV. CH3–CH2–OH

|  |  |
| --- | --- |
| 1. I < II < III < IV | 1. I < II < IV < III |
| 1. III < IV < II < I | 1. I < III < IV < II |
| 1. None is correct. |  |

1. Which of the following statements is **TRUE**?
   1. If Q < K, it means the forward reaction will proceed to form more products.
   2. If Q = K, it means the reaction is not at equilibrium.
   3. If Q > K, it means the forward reaction will proceed to form more products.
   4. All of the above are true.
   5. None of the above are true
2. Which substance has the least **negative lattice energy**?

|  |  |  |
| --- | --- | --- |
| * 1. MgF2 | * 1. MgBr2 | * 1. MgI2 |
| * 1. MgCl2 | * 1. all of the above |  |

1. Which of the following statements is **TRUE**?
   1. In general, the solubility of a solid in water decreases with increasing temperature.
   2. In general, the solubility of a gas in water decreases with increasing temperature.
   3. The solubility of a gas in water usually increases with decreasing pressure.
   4. The solubility of an ionic solid in water decreases with increasing temperature.
   5. None of the above statements are true.
2. Which of the following statements is **true** for a supersaturated solution?
   1. The solute in the solution is at equilibrium with undissolved solute.
   2. A supersaturated solution is more than 50% solute by mass.
   3. The solution is stable and the solute will not precipitate.
   4. The solution contains more than the equilibrium amount of solute.
   5. It is both b and d
3. Which of the following statements concerning equilibrium **is *not* true**?
   1. The equilibrium constant is independent of temperature.
   2. A system that is disturbed from an equilibrium condition responds in such a way as to restore equilibrium.
   3. Equilibrium in molecular systems is dynamic, with two opposing processes balancing one another.
   4. The value of the equilibrium constant for a given reaction mixture is the same regardless of the direction from which equilibrium is attained.
   5. A system moves spontaneously toward a state of equilibrium.
4. Which statement is ***not* correct**? Determination of molar mass of an unknown sample by an osmotic pressure measurement requires that \_\_\_\_\_\_\_\_
5. The solute dissolved in the solution is pure.
6. The molar concentration of the solute in the solution is known in advance.
7. The solute is a nonelectrolyte.
8. The molecules of the solute do not pass through the semipermeable membrane.
9. The mass of the solute dissolved in the solution is known in advance.

Problems (78 points)

1. (12 points) Lysine, one of the amino acid building blocks found in proteins, contains 49.29% C, 9.65% H, 19.16% N, and 21.89% O by elemental analysis. A solution prepared by dissolving 30.0 mg of lysine in 1.200 g of the organic solvent biphenyl, gives a freezing point depression of 1.37oC. (Lysine does not dissociate.) (Kf for biphenyl is 8.00oC/m) )

Determine empirical formula

Determine Molar mass

Determine Molecular formula

1. (6 points) From this information below, determine Kp for the reaction below.

N2(g)+ O2(g)+ Br2(g) ↔2 NOBr (g)

Consider the following reactions and their equilibrium constants. (Show all work)

1. NOBr (g) ↔ NO (g)+ 1/2 Br2(g) Kp= 0.137

1. 2 NO(g) ↔ N2(g) + O2 (g) Kp= 3.57 x 1020
2. (12 points) In each group of substances, pick the one that has the given property. Justify your answer using descriptions of the types of intermolecular forces that are important as well as **other factors** determining liquid properties.
   1. Highest viscosity: F2 or I2
   2. lowest vapor pressure at 25oC:  or 
   3. lowest boiling point  or 
3. (20 points) An automobile antifreeze mixture is made by mixing equal volumes of ethylene glycol C2H6O2 (primary component of antifreeze). A 12.5 m solution of ethylene glycol in water has a density of 1.114 g/mL at 20oC. (vapor pressure of pure water at 20oC = 17.5 torr) Calculate
   1. The mass percent ethylene glycol
   2. The mole fraction of ethylene glycol
   3. The molarity of ethylene glycol
   4. The osmotic pressure of the solution at 20oC
   5. The vapor pressure (in torr) of the solution at 20oC.
4. (8 points) Methanol (CH3OH) is manufactured by the reaction of carbon monoxide with hydrogen in the presence of a ZnO/Cr2O3 catalyst:

 ΔHo = −91 kJ

For each of the following changes indicate whether the reaction shifts to the right (🡪), shifts to the left (🡨), or no shift (NC). Then answer the question regarding the shift with increases (🡩) decreases (🡫) no change (NC) or unable to determine (?).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Change to system | Shift (Circle one) | Question | Change |
|  | Add ZnO/Cr2O3 | 🡪 🡨 NC | mol of CO | 🡩 🡫 NC ? |
|  | Reduce volume | 🡪 🡨 NC | Concentration of CH3OH | 🡩 🡫 NC ? |
|  | Lower temperature | 🡪 🡨 NC | Rate forward reaction | 🡩 🡫 NC ? |
|  | remove CO(g) | 🡪 🡨 NC | Concentration of H2 | 🡩 🡫 NC ? |

1. (10 points) Consider the decomposition of ammonia:

N2(g) +3 H2(g) ↔ 2 NH3(g)

A sealed flask initially contains 0.276 atm of ammonia, 0.150 atm of nitrogen and 0.075 atm of hydrogen. When equilibrium is established, the partial pressure of ammonia is 0.248 atm.

* 1. Calculate Kp for the formation of ammonia.
  2. What is Kc at 20°C

1. (10 points) Hydrogen cyanide, a highly toxic gas, can be formed by combination of cyanogen and hydrogen gases:

C2N2(g) + H2(g) ↔ 2 HCN(g) Kp = 0.25 at 100ºC

* 1. The initially partial pressures are C2N2= H2= 0.34 atm and HCN= 0.27 atm. Determine Q and find the directions in which the reaction will proceed
  2. What are the partial pressures of all gases at equilibrium?