Chemistry 141 Name

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Exam 4 December 9, 2010

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| --- | --- | --- |
|  | Points Earned | Points Possible |
| Page 1 multiple choice |  | 30 |
| Page 5 |  | 17 |
| Page 6 |  | 12 |
| Page 7 |  | 20 |
| Page 8 |  | 12 |
| Page 9 |  | 12 |
| Page 10 |  | 8 |
| Total |  | 111 |
| Percent Score |  | 100 |

Note: All work must be shown to receive credit. On calculation problems show answer with the correct number of significant figures using scientific notation if necessary.

Chemistry Formulas and Constants



Formulas

Kinetic energy = ½ mv2

w = -PΔV

Ptotal = P1+P2+P3+…

u = (3RT/MW)½

ΔG = ΔH - TΔS

PV = nRT

Rate ∝ (MW)-½

P1=*i*X1\*Ptotal

C = q/ΔT

w=dxF

E = IR

ΔGo = -nFEo

ΔG = - RTlnK

E = mc2

Ba(Na)2 = fruit

HΨ=EΨ

Amp = C/sec

Π= *i*MRT

E = hν = hc/λ

M1V1 = M2V2

Ptotal = P1 + P2 + P3 + …

M = mol/L

m = mol/kg solvent

Xi = moli/ moltotal

ΔTb = i(kb)(m)

ΔTf = i(kf)(m)

Psoln = (Psolv)(Xsolv)

pH = -log [H3O+]

pOH = -log[OH-]

[H3O+][OH-]= 1.0x10-14M2

pH+pOH = 14



Constants

1 angstrom = 10-8 cm

F = 9.65 x 104 C

h = 6.626 x 10-34 J sec

c= 2.9979 x 108 m/sec

e = 1.602 x 10-19 C

NA = 6.022 x 1023/mol

k = 1.381 x 10-23 J/K

K = oC + 273.16

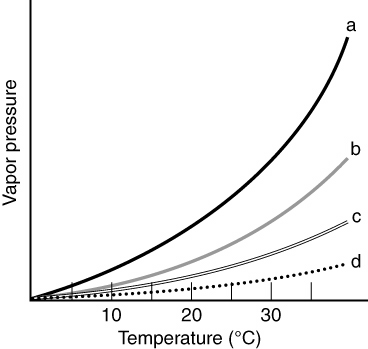
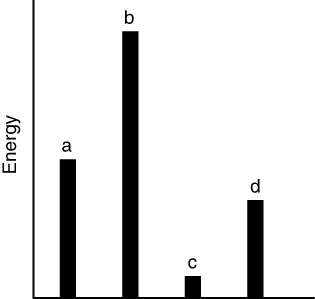
Kw = 1.0 x 10-14M2

mass electron = 9.109 x 10-31 kg

R = 0.0821 L atm/mol K= 8.314 J/K mol= 1.987 cal.mol K= 62.4 L torr/mol K

Standard Temperature and Pressure = 0oC and 1 atm

Multiple Choice (30 points)

1. Which of the following will require the greatest energy input to separate the ions?
   1. MgI2
   2. MgCl2
   3. MgF2
   4. MgBr2
2. For a compound to exhibit dipole–dipole interactions, it must
   1. have a temporary dipole moment.
   2. have a hydrogen bound to an oxygen, nitrogen, or fluorine.
   3. have a permanent dipole moment.
   4. be an ion.
3. Which of the following compounds is capable of hydrogen bonding?
   1. CH3OCH3
   2. CH3CH2OH
   3. CH3COCH3
   4. H2CO
4. Polarizability refers to
   1. the ease with which the electron cloud of an atom or molecule can be perturbed.
   2. the magnitude of the dipole moment of a molecule.
   3. the ease with which a dipole moment can polarize an atom or a molecule.
   4. the perturbation in a molecule’s electron cloud due to hydrogen bonding.
5. Indicate which of the following compounds will have the lowest boiling point.
   1. CCl4
   2. CF4
   3. CI4
   4. CH4
6. When two liquids mix completely in all proportions, they are
   1. soluble.
   2. insoluble.
   3. miscible.
   4. solvated.
7. The vapor pressure curves for four different substances are shown in the following figure as a function of temperature. Which substance will have the lowest vapor pressure at 20°C?
   1. a
   2. c
   3. b
   4. d
8. If a sample of water at 10°C is placed in a container at 20°C and the vapor pressure of the sample is measured immediately, the vapor pressure will be
   1. lower than expected.
   2. exactly what would be expected.
   3. higher than expected.
   4. dropping rapidly.
9. Which of the following substances will have the greatest viscosity?
   1. ethane (C2H6)
   2. methanol (CH3OH)
   3. ethanol (C2H5OH)
   4. ethylene (C2H4)
10. Viscosity is a measure of a substance’s
    1. ability to resist changes in its surface area.
    2. surface tension.
    3. resistance to flow.
    4. compressibility.
11. Which solution will have the lowest osmotic pressure when measured against pure water?
    1. 0.10 M sodium chloride
    2. 0.10 M sodium sulfide
    3. 0.10 M sodium sulfate
    4. 0.10 M sodium phosphate
12. The following figure shows the relative magnitudes of the intermolecular forces for four different substances at room temperature. Which substance is likely to be a solid at room temperature?
    1. a
    2. b
    3. c
    4. d
13. What is equal in an equilibrium?
    1. the concentrations of reactant and products
    2. the rate constants for the forward and reverse reactions
    3. the time that a particular atom or molecule spends as a reactant and product
    4. the rate of the forward and reverse reaction
14. Write the equilibrium expression for the following reaction:

fool

* 1. *K* = [fool(money)10][fool][money]
  2. *K* =
  3. *K* =
  4. *K* =

1. A chemical equilibrium may be established by
   1. starting a reaction with reactants only.
   2. starting a reaction with products only.
   3. starting a reaction with equal quantities of reactants and products.
   4. all the above.
2. The equilibrium constant for the acid ionization of mercaptoethanol is 1.91  10–10:

HSCH2CH2OH(*aq*)  H+(*aq*) + SCH2CH2OH–(*aq*)

A solution of mercaptoethanol in water

* 1. is almost entirely ionized.
  2. is about one-half ionized.
  3. is almost entirely un-ionized.
  4. is a strong acid.

Problems (70 points)

1. (4 points) The normal boiling points of liquids A and B are 75.0oC and 151oC, respectively. Which of these liquids would you expect to have the higher viscosity and vapor pressure at 25oC? Explain your answer.

Because B boils at a higher temperature it must have stronger intermolecular forces than A. That means that it will have a higher viscosity and lower vapor pressure at 25oC.

1. (9 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.
   1. higher boiling point: CH3CH2-O-CH2CH3 or CH2CH2CH2CH2CH3

CH3CH2-O-CH2CH3 will have the higher boiling point. This is because it is polar and if the molar masses are approximately the same, the polar compound will have stronger intermolecular forces.

* 1. higher vapor pressure at 25oC: Cl2 or I2

Cl2 will have the higher vapor pressure because it has weaker intermolecular forces. (less polarizable)

* 1. higher viscosity CH2CH2NH2 or CH2CH2CH3

CH2CH2NH2 is capable of hydrogen bonding, therefore it will have stronger intermolecular forces and will have the higher viscosity.

1. (4 points) The dipole moment of CH2F2 (1.93 debyes) is larger than that of CH2Cl2 (1.60 debyes), yet the boiling point of CH2Cl2 (40oC) is much higher than that of CH2F2(-52oC). Why?

Although CH2F2 is more polar, the CH2Cl2 has much greater dispersion forces. In this particular case the dispersion forces are more important than the dipole-dipole forces in determining which substance will have the stronger intermolecular forces and higher boiling point.

1. (4 points) The thermostat in a refrigerator filled with cans of soft drinks malfunctions and the temperature of the refrigerator drops below 0oC. The contents of the cans of diet soft drinks freeze, rupturing many of the cans and causing an awful mess. However, none of the cans containing regular, non-diet soft drinks rupture. Why?

Diet soda contains much less sweetener than sugared soda. That means the molality of the solution will be lower and there will be less of a freezing point depression. And they will freeze at a higher temperature!

1. (8 points) Eugenol is one of the compounds responsible for the flavor of cloves. A 111-mg sample of eugenol was dissolved in 1.00 g of chloroform (CH3F, Kb = 3.63 K/m), increasing the boiling point of chloroform by 2.45oC. Calculate eugenol’s molar mass. Eugenol is 73.17% C, 7.32% H, and 19.51% O by mass. What is the molecular formula of eugenol?

The molar mass of this is 82 therefore there are 2 units and the molecular formula is C10H12O2

1. (20 points) Ethylene glycol, C2H6O2, was once the primary component of antifreeze. A 2.041 M solution of ethylene glycol in water has a density of 1.154 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 molality of ethylene glycol
   4. The osmotic pressure of the solution at 20oC
   5. The vapor pressure (in torr) of the solution at 20oC.
2. (6 points) How will the changes listed affect the position of the following equilibrium?

Ho = + 35 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 |
|  | Remove NO(g) | 🡪 🡨 NC | Concentration of NO3 | 🡩 🡫 NC ? |
|  | Raise temperature | 🡪 🡨 NC | Rate of reverse reaction | 🡩 🡫 NC ? |
|  | Reduce volume | 🡪 🡨 NC | Concentration of NO | 🡩 🡫 NC ? |

1. (6 points) Write the equilibrium expressions for the following reactions
   1. 2 ClO*(g)* + 3 O2*(g)* 🡨🡪 2 N2*(g)* + 6 H2O*(g)*
   2. Fe*(s)* + CO2*(g)* 🡨🡪 FeO*(s)* + CO*(g)*
2. (12 points) A 100 mL reaction vessel initially contains 2.70 x 10-2 moles of NO and 1.50 x 10-2 mol of H2. At equilibrium(600K), the concentration of NO in the vessel is 0.161 M. The reaction that occurs is

2 H2*(g)* + 2 NO*(g)*  N2*(g)* + 2 H2O *(g)*

* 1. What are the equilibrium concentrations of all species?

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2 H2(g) | + | 2 NO*(g)* |  | N2(g) | + | 2 H2O(g) |
| I | 0.150 M |  | 0.270 M |  | 0 M |  | 0 M |
|  | -2x |  | -2x |  | +x |  | +2x |
| E | 0.150 -2x  = 0.041 M |  | x=0.0545 M  0.270 -2x  =0.161 M |  | x  =0.055 M |  | 2x  =0.109 M |

* 1. What is the value of Kc at 600K?
  2. What is the value of Kp in atm at 600K?

Or

* 1. What is the value of Kc for the reaction below at 600 K?

2 N2*(g)* + 4 H2O *(g)*  4 H2*(g)* + 4 NO*(g)*

1. (8 points) The value of Kc is 0.739 for the reaction between water vapor and dichlorine monoxide

H2O(g) + Cl2O(g)  2 HOCl(g)

at 27oC. Determine the equilibrium concentrations of all three compounds if the starting concentrations of both reactants are 0.623 M and no HOCl is present.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | H2O (g) | + | Cl2O (g) |  | 2 HOCl (g) |
|  | 0.0623M |  | 0.0623M |  | 0 |
|  | - x |  | - x |  | + 2x |
|  | 0.623 - x |  | 0.623 - x |  | 2x |

[H2O] = [Cl2O] = 0.623 M – 0.187 M = 0.0.436 M

[HOCl] = 2 (0.187 M) = 0.374 M