Exam 4

# Part 1: Multiple Choice (2 points each)

## Directions: Please circle the *best* answer for each of the following questions.

1. An element has a crystal structure in which the width of the cubic unit cell equals the diameter of an atom. What type of unit cell does it have?
   1. Simple cubic
   2. Body-centered cubic
   3. Cubic closest packing
   4. Hexagonal closest packing
   5. Square planar
2. How is the miscibility of two liquids related to their polarity?
3. Nonpolar liquids are miscible with other nonpolar liquids.
4. Polar liquids are not miscible with nonpolar liquids.
5. Polar liquids are not miscible with other polar liquids
6. a and b
7. all of the above
8. What happens to the vapor pressure of a substance when its surface area is increased at constant temperature?
9. The vapor pressure increases.
10. The vapor pressure decreases.
11. The vapor pressure remains the same.
12. Not enough information
13. none of the above
14. Which one of the following solutions has the highest vapor pressure?
    1. 20.0 g of glucose (C6H12O6) in 100.0 mL of water
    2. 20.0 g of sucrose (C12H22O11) in 100.0 mL of water
    3. 10.0 g of potassium acetate (KC2H3O2) in 100.0 mL of water
    4. all of the above
    5. none of the above
15. Red blood cells are placed into pure water. Which of the following statements is true?
    1. The osmotic pressure inside the cells equals the osmotic pressure outside.
    2. Water molecules flow out of the red blood cells, causing them to collapse.
    3. The osmotic pressure of the cell contents increases, causing the cells to burst.
    4. Water flows into the red blood cells, causing them to swell and burst.
    5. a and b
16. A crude type of disappearing ink is based on the following endothermic equilibrium:

[Co(H2O)6]Cl2 (aq) [CoCl2(H2O)4] (aq) + 2 H2O (g)

Colorless Blue

If the reactant solution is used to write on a piece of paper and the paper is allowed to partially dry, what can be done to bring out the colored handwriting?

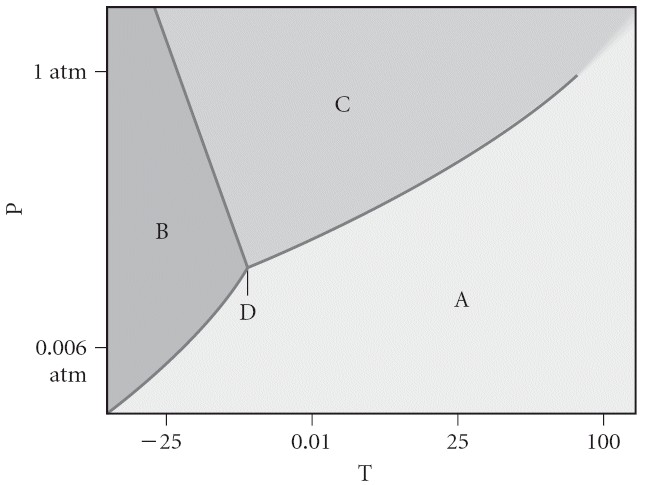
* 1. add water
  2. put the paper in the oven
  3. put the paper in the freezer
  4. decrease the volume
  5. none of the above

1. In a reaction mixture containing only products, what is the value of Q?
   1. -1
   2. 1
   3. 0
   4. ∞
   5. It cannot be determined without concentrations.
2. What is ∆n for the following equation in relating Kc to Kp? N2 (g) + 3 Cl2 (g) 2 NCl3 (g)
   1. 4
   2. -4
   3. -2
   4. 2
   5. 1
3. Give the major forces in seawater.
   1. Dipole-dipole
   2. Dispersion
   3. Hydrogen bonding
   4. Ion-ion
   5. Ion-dipole
4. Give the reason that antifreeze is added to a car radiator.
   1. The freezing point is lowered and the boiling point is elevated.
   2. The freezing point is elevated and the boiling point is lowered.
   3. The freezing point and boiling point are elevated.
   4. The freezing point and boiling point are lowered.
   5. none of the above

# Part 2: Short Answer

## Directions: Answer each of the following questions. Be sure to use complete sentences where appropriate. For full credit be sure to show all of your work.

1. Consider the phase diagram shown below. Evaluate if the following statements are **true** or **false**. If they are false, correct them (7 points).



|  |  |  |
| --- | --- | --- |
|  | A = solid, B = gas, C = liquid | False, A = gas, B = solid, C = liquid |
|  | The triple point occurs at a temperature of -10 °C. | True |
|  | The solid phase of this substance is lower in density than the liquid phase. | False, the density of the solid phase is higher than the liquid phase. |
|  | The line separating the solid and liquid phases represents the ∆Hvap. | False, melting/freezing point. |

1. A 10.0 g sample of p-dichlorobenzene, a component of mothballs, is dissolved in 80.0 g of benzene, C6H6. The freezing point of the solution is 1.20 °C. The freezing point of pure benzene is 5.48°C. What is the approximate molar mass of p-dichlorobenzene? Kf for benzene is 5.12 °C/m (6 points).
2. 3.179 M solution of glucose (C6H12O6) has a density of 1.381 g/mL at 25oC (20 points). Calculate
   1. the mass percent of glucose
   2. the mole fraction of glucose
   3. The molality of glucose

* 1. The vapor pressure of water at 25oC is 23.8 torr. What is the vapor pressure of the glucose solution under these same conditions?
  2. What is the boiling point of the glucose solution (Kb water is 0.512 °C/m)?
  3. What is the osmotic pressure of the glucose solution at 20oC?

1. Consider the following reactions containing hydrogen and deuterium atoms. A deuterium is a hydrogen-2 atom. The equilibrium constant is given for one of the reactions below. Determine the value of the missing equilibrium constant (5 points).

2 HD (g) H2 (g) + D2 (g) Kc = 0.28

6 H2 (g) + 6 D2 (g) 12 HD (g) Kc’ = ?

1. In *The Rhime of the Ancient Mariner* the poet Samuel Taylor Coleridge wrote, “…Water, water, everywhere/And all the boards did shrink…” Explain this effect in terms of osmosis (4 points).

Water in the cells of the wood leaked out, since the osmotic pressure inside the cells was less than that of the seawater in which the wood was sitting.

1. A drooping plant can be made upright by watering the ground around it. Explain (3 points).

Water exhibits strong capillary action, which allows it to be easily absorbed by the plant’s roots and transported upward to the leaves.

1. Rhodium crystallized in a face-centered cubic unit cell. The radius of a rhodium atom is 135 pm. Determine the density of rhodium in g/cm3 (6 points).

1. The boiling point of phosphine, PH3, (-88 °C) is lower than that of ammonia (-33 °C) even though phosphine has twice the molar mass of ammonia. Why (3 points)?

Ammonia has the potential for hydrogen bonding due to the presence of one of the three very electronegative elements (F, O, and, in this case, N) whereas phosphine does not. The higher boiling point of ammonia is due to the strong dipole-dipole interaction of the hydrogen bond.

1. The vapor pressure of a substance is measured over a range of temperatures. A plot of the natural log of the vapor pressure versus the inverse of the temperature (in Kelvin) produces a straight line with a slope of -3.34 x 103 K. Find the enthalpy of vaporization of the substance in kJ/mol (5 points).
2. Suppose that 0.83 g of water condenses on a 85.0 g block of iron that is initially at 24 °C. If the heat released during condensation goes only to warming the iron block, what is the final temperature in degrees Celsius of the iron block? (Assume a constant enthalpy of vaporization for water of 44.0 kJ/mol and the specific heat of iron is 0.449 J/g °C.) (8 points)
3. Consider the following reaction: NH4HS (s) NH3 (g) + H2S (g)

At a certain temperature, Kc = 8.5 x 10-3M2. A reaction mixture at this temperature containing solid NH4HS and [NH3] = 0.166 M and [H2S] = 0.166 M. will more of the solid form or will some of the existing solid decompose as equilibrium is reached (3 points)?

Qc > Kc, so the reaction will move towards the reactants. Therefore more solid will form.

1. Consider the following reaction: Fe3+ (aq) + SCN- (aq) ) FeSCN2+ (aq)

A solution is made containing an initial [Fe3+] of 1.2 x 10-3 M and an initial [SCN-] of 8.2 x 10-4 M. At equilibrium [FeSCN2+] is 1.7 x 10-4 M. Calculate the value of the equilibrium constant Kc (10 points).

|  |  |  |  |
| --- | --- | --- | --- |
|  | Fe3+ (aq) + | SCN- (aq) | FeSCN2+ (aq) |
| I | 1.2 x 10-3 M | 8.2 x 10-4 M | 0 M |
| C | -x | -x | +x |
| E | 1.2 x 10-3 M –x =  1.2 x 10-3 M – 1.7 x 10-4 M =  1.03 x 10-3 M | 8.2 x 10-4 M – x =  8.2 x 10-4 M - 1.7 x 10-4 M =  6.5 x 10-4 M | x = 1.7 x 10-4 M |