> When we are planning for posterity, we ought to remember that virtue is not hereditary.--Thomas Paine

Unit 10 Sample Test

The test will follow the usual format. There will be 5 multiple choice questions, two required problems, one option, two net-ionic equations to write and one essay. *The following are representative of typical multiple choice questions but do not necessarily indicate topics to be addressed on your actual test.*

_____ 1. Gaseous water reacts with carbon monoxide gas to produce hydrogen gas and carbon dioxide gas, according to the following equation:

$$H_2O(g) + CO(g) \leftrightarrows H_2(g) + CO_2(g) + 41.8\ kJ$$

Unspecified concentrations of the reactants are mixed at 1000^oC and allowed to come to equilibrium. At equilibrium the concentrations of all species are measured and a value for K_c is calculated. What would the value of the equilibrium constant be if the reaction were allowed to come to equilibrium at a temperature somewhat higher than 1000^oC?

a. less than the constant for 1000^oC
b. greater than the constant for 1000^oC
c. the same value as the constant for 1000^oC
d. more data are needed

_____ 2. Calorimetric studies show that this reaction is exothermic:

$$2\ NO_2(g) \leftrightarrows N_2O_4(g) + 59.0\ kJ$$

Based on this information, which one, if any, of the following changes would increase the molar concentration at equilibrium of $N_2O_4(g)$?

a. decrease the pressure
b. increase the temperature
c. decrease the concentration of NO_2
d. add a catalyst
e. none of the above

_____3. If the value of Q_c exceeds the value of K_c at a given temperature

a. rate reverse > rate forward until equilibrium is achieved
b. rate forward > rate reverse until equilibrium is achieved
c. the reaction cannot achieve equilibrium
d. the reaction is at equilibrium

_____4. In a reversible reaction at equilibrium, the forward and reverse reactions do not

a. occur at equal rates b. have any products c. stop d. continue

_____5. The K_{sp} for lead(II) chloride is best expressed as:

a. $[Pb^{2+}][Cl^-]$ b. $[Pb^{2+}][2Cl^-]$ c. $[Pb^{2+}][Cl^-]^2$ d. $[Pb^{2+}][2Cl^-]^2$

The next section consists of representative problems which might be found in the required section.

6. If we start with 0.10 M N_2 and 0.10 M O_2 in a container at 2000°C, how many moles of NO will be present at equilibrium if the container has a 10.0 L volume? K_c at 2000°C is 0.10.

What is ΔG^o *under these conditions*?

The enthalpy change for this reaction, ΔH, is +180 kJ/mol. The entropy change, ΔS, is +25 J/mol·K. How should the temperature be adjusted to make the forward reaction *more spontaneous*?

7. A sample of 20.0 mL of 0.010 M $Ba(NO_3)_2$ is added to 50.0 mL of 0.0030 M Na_2CO_3. Will $BaCO_3$ precipitate? The K_{sp} for $BaCO_3$ 8.1×10^{-9}. (**YOU MUST SHOW WORK**).

The next section consists of representative problems such as might be found in the "options" section. Each student is expected to select one problem from this section to work on.

8. A solution contains 1.0×10^{-4} M Cu^+ and 2.0×10^{-3} M Pb^{2+}. If a source of I^- ions is added gradually to this solution, will PbI_2 ($K_{sp} = 1.4 \times 10^{-8}$) or CuI ($K_{sp} = 5.3 \times 10^{-12}$) precipitate first? **YOU MUST SHOW WORK!!!!**

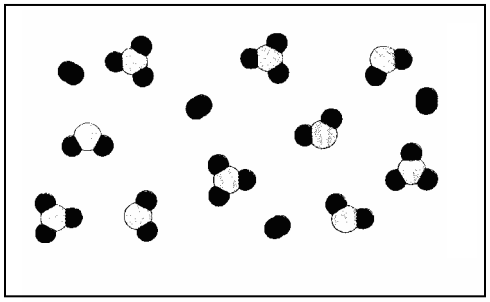
9. Describe how you could separate the following ions from a mixed solution employing successive precipitation based on the solubility rules: Ag^{+}, Ba^{2+}, Cu^{2+}

Would you expect your separations to be "clean"? Explain.

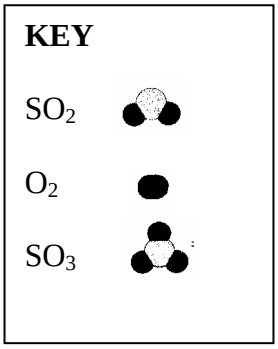
10. One of the steps in the synthesis of sulfuric acid is the combustion of sulfur dioxide:

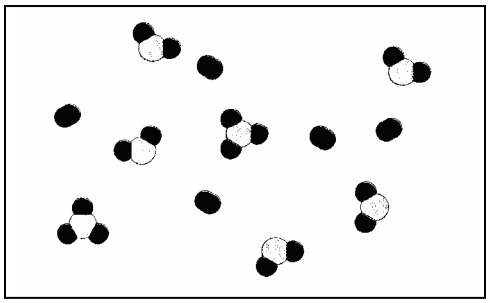
$$2\ SO_2(g) + O_2(g) \leftrightarrows 2\ SO_3(g)$$

The diagrams below represent various equilibrium mixtures for this reaction.

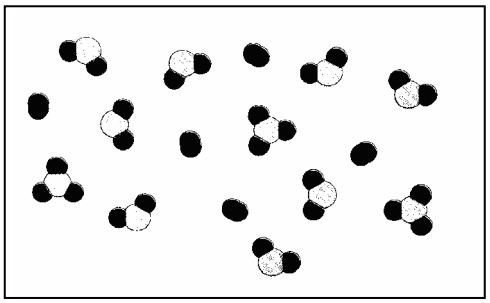


Equilibrium mixture at 1100 K





Equilibrium mixture at 1100 K and different pressure. ***Has pressure increased or decreased? Explain.***



Equilibrium mixture at 1300 K
Is reaction exo- or endothermic? Explain.

The next section consists of representative reactions to complete and write balanced net-ionic equations for. Note that some reactions do not occur in aqueous solution and thus molecular equations are all that would be needed. In some cases no reaction may occur, based on either solubility rules or the activity series. In those cases, no products are required in the reaction. NR *written to the right of the arrow will suffice. Each student is expected to choose two from this section.* ***Phase symbols*** **((s), (aq), etc.)** ***are required****.*

All reactions below occur in aqueous solution.

11. lead(II) nitrate + sodium chloride → _____

_____

_____

type:_____

12. nickel(II) sulfate + potassium chloride → _____

_____

_____

type:_____

13. zinc metal + silver nitrate → _____

_____

_____

type:_____

14. oxalate ion ($C_2O_4^{2-}$) reacts with aqueous hydrogen peroxide in acidic solution; carbon dioxide gas and water are among the products

_____

_____

_____

The final section of the test will consist of one essay question selected from the following topics:

---- application of LeChâtelier's Principle
---- principles and techniques used in lab
including applications of Beer's Law

Answers