SHIFTING REACTIONS—Exp. I-4

Name_____ Lab Section _____

Lab Partner_____

Problem Statement: How can we shift reactions forward and backward?

I. Data Collection and Analysis: $Fe(NO_3)_3$ + KSCN

A. Put about 50 mL of KSCN (potassium thiocyanate solution labeled 0.0005 M) in a 100 mL beaker. Note the appearance of the solution. Add about 5 drops of $Fe(NO_3)_3$ (iron (III) nitrate solution labeled 0.2 M). Note the appearance of the $Fe(NO_3)_3$ solution, the KSCN solution, and the combined solution. What evidence is there for a chemical reaction between $Fe(NO_3)_3$ and KSCN?

The observed reaction is: $Fe^{3+}(aq) + SCN^{-}(aq) \rightarrow FeSCN^{2+}(aq)$. Identify the color of each reactant and product ion.

B. Fill each of three large test tubes about 1/3 full with the combined solution made in part I.A. Keeping one test tube as a standard for comparison, put a few crystals of KSCN into the second test tube and one drop of $Fe(NO_3)_3$ solution into the third test tube. Record your observations below.

C. Given your observations, what can you say about the reaction:

$$Fe^{3+}(aq) + SCN\text{-}(aq) \rightarrow FeSCN^{2+}(aq)$$

Is the reaction 100% complete with one limiting reagent, or is it only fractionally complete (equilibrium) with neither reagent as limiting? Explain your reasoning in detail.

D. Keep your standard, test tube #1, but discard the contents of the other two test tubes into your waste beaker. Rinse these and then refill each about 1/3 full with the combined solution from part I.A. Place one test tube in a hot water bath (50–70 °C) and the other in an ice bath. Leave each test tube in its bath about 10 minutes to ensure that the contents have reached the bath temperature. Remove the tubes and compare their color intensity to that of your standard. Record your observations.

Offer an explanation, at the ion level, for why the color intensity varies as it does with temperature.

E. Allow your test solutions to get back to room temperature. To the contents of test tube #2 add a small amount of solid NaF. The amount should be about the volume of a pencil eraser or less. Mix gently and note your observations below.

Put a few mL of the solution in test tube #2 into each of two other test tubes. Add a few mL of KSCN solution to one and 3–6 drops of $Fe(NO_3)_3$ solution to the other. Record your observations.

F. Fluoride ion, F^-, reacts with Fe^{3+} to form FeF_6^{3-} ion. Knowing this, offer explanations for all the data you collected in part I.E.

G. Mental Model—You have investigated the effect of three conditions on the reaction $Fe^{3+}(aq) + SCN^-(aq) \rightarrow FeSCN^{2+}(aq)$. These were: adding more of either reactant (part B), chaning temperature (part D), and adding an outside chemical (part E). Pick one of these conditions and draw a molecular-level picture illustrating the effect.

II. Data Collection and Analysis: $CuSO_4 + NH_3$

A. Put about 2 mL of $CuSO_4$ (copper (II) sulfate solution labeled 0.1 M) in a test tube. Note the appearance of the solution.

B. Using a medicine dropper add NH_3 (ammonia solution labeled 1 M) to the $CuSO_4$ dropwise, mixing the solution between drops. Make observations and continue adding the NH_3 by the dropperful until the total volume is approximately 6 mL. Record your observations below.

The reactions you observed were:

$$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$$

$$Cu^{2+}(aq) + 4NH_3(aq) \rightarrow Cu(NH_3)_4^{2+}(aq)$$

Identify the colors of each reactant and product of the above reactions.

C. Add HCl (hydrochloric acid labeled 1.5 M) dropwise to the solution in part B. Make observations and continue adding the HCl until 3 mL have been added.

$NH_3(aq)$ solution is basic: It contains OH^- ion. Also, H^+ from HCl will react with NH_3 to form NH_4^+. Knowing this, offer an explanation for your observations.

D. Add the NH_3 dropwise to the solution in part C. Make observations and continue adding the NH_3 until the total volume is approximately 15 mL. Record your observation below.

Offer an explanation for these data.

III. Conclusions

Given all that you have seen in these experiments, what are your answers to the Problem Statement questions at the beginning of this lab? Justify your answers by citing data.