Chemistry 12

Lab: Investigating Chemical Equilibrium

Name:

Block:

<u>Introduction:</u>

The chemical reactions you have studied to this point have proceeded to completion. However, many reactions proceed only to a state of equilibrium, where both reactants and products exist together. This results from some of the product molecules having sufficient energy to reform the reactants in a reverse reaction.

A state of equilibrium is established when the rates of the forward and reverse reactions are equal. Although both reactions continue to occur, there is no net change in the observable properties (called macroscopic properties) such as concentration, pressure (for gases), or color intensity of a coloured solution. In a reversible reaction, constant macroscopic properties (including temperature) indicate that equilibrium is present.

Any change to the conditions at equilibrium, such as concentration, pressure or temperature, is said to produce a stress on the equilibrium. Le Chatelier's principle allows us to predict the effects of such a stress. The stress produces a shift in the system that attempts to counteract the imposed stress and a new equilibrium is established. The macroscopic properties of the system change, until they become constant once more as the new equilibrium is reached.

<u>Part I: Equilibrium Involving Bromcresol Green</u>

<u>Reactions:</u>

$$\underset{\text{Yellow}}{\text{HBcg (Acid)}} \leftrightharpoons \underset{\text{Blue}}{\text{Bcg}^- \text{ (Base)}} + H^+$$

$$H^+ + OH^- \leftrightharpoons H_2O$$

<u>Procedure:</u>

1. Obtain 2 clean medium Erlenmeyer flasks.
2. Add approximately 50mL of water and 10 drops of bromcresol green solution to each flask and label the flasks as #1 and #2. Record the colour of each solution in the data table.
3. The first flask will serve as a control. To the second flask, add 0.01M HCl drop by drop while swirling the flask until a green colour change is observed. Compare to the control. Record the new colour and the number of drops required for this change in the data table.
4. Continue the drop by drop addition of 0.01M HCl until a second colour shift is observed. (What colour should be observed?) Record the new colour and the number of drops required for this change in the data table.
5. Now add 0.01M NaOH drop by drop in the second flask until the green colour is observed again. Record the new colour and the number of drops required for this change in the data table.
6. Continue the drop by drop addition of 0.01M NaOH until a second colour shift is observed. (What colour should be observed?) Record the new colour and the number of drops required for this change in the data table.
7. Pour all contents of both flasks down the sink. Rinse out all glassware.
8. Wash hands with soap and give partner a wink.

Part II: Equilibrium Involving Thiocyanatoiron (III) Ion

Reaction:

$Fe^{3+}_{(aq)}$ +	$SCN^{-}_{(aq)}$	⇋	$FeSCN^{2+}_{(aq)}$
Light yellow	Colourless		Red

Procedure:

1. Add 1.0 mL of 0.2M $FeCl_3$ to a 1.0mL portion of 0.2M KSCN to a medium beaker using a graduated cylinder.
2. Add water to dilute the intensity of the colour until the solution is light orange. Record the colour observation in the data table.
3. Pipette 5.0 mL of the solution into 5 separate test tubes labeled A to E.
4. Test tube A will serve as a control.
5. To test tube B, add 10 drops of 0.2M KSCN.
6. To test tube C, add 10 drops of 0.2M $FeCl_3$.
7. To test tube D, add 10 drops of 0.2M KCl.
8. To test tube E, add 10 drops of 1.0M NaOH.
9. For each test tube, record the colour change observed in the data table.
10. Pour all contents of test tubes down the sink. Rinse out all glassware.
11. Wash hands with soap and give partner a wink.

Part III: Equilibrium Involving Cobalt (II) Complexes

Reaction:

$Co(H_2O)_6^{2+}{}_{(aq)} + 4Cl^-$	⇋	$CoCl_4^{2-}{}_{(aq)} + 6\ H_2O_{(l)}$
Pink		Blue

Procedure:

1. Place approximately 0.3g of $CoCl_2$ into each of two small beakers. (The exact mass is not important). Label as beaker #1 and #2.
2. To the first beaker, add 10mL of 6.0M HCl (Be careful with acid!). Remember to pour the acid into a small beaker first and then pipette into the graduated cylinder.
3. To the second beaker, add 10mL of water. Record the colours of the solutions in each beaker in the data table.
4. Using a squeeze bottle, gradually add water to the solution in the first beaker until a definite colour change occurs. Record your observations in the data table.
5. Place the first beaker on a hot plate. When a definite colour change is observed, shut off the hot plate and remove the beaker using tongs. Record the colour observation in the data table.
6. Place the warm beaker into a cold water bath. Record any colour observations in the data table.
7. Pour all contents of both beakers down the sink. Rinse out all glassware.
8. Wash hands with soap and give partner a wink.