Oxidation-Reduction: Reactions of the Halogens

Introduction

In this lab, you will make a comparison of the relative oxidizing strengths of three members of the halogen family: Chlorine, Bromine and Iodine. You will determine which halogen, Cl_2, Br_2 or I_2 is capable of removing electrons from the halide ions, Cl^{-1}, Br^{-1} and I^{-1}. This information will help you arrange the halogen – halide ion half-reactions in order of decreasing ease of reduction.:

$$X_2 + 2e^{-1} \rightarrow 2\,X^{-1}$$

Purpose

To determine the relative oxidizing strengths of three members of the halogen family: Cl_2, Br_2 and I_2.

Materials

$Cl_{2(aq)}$, $Br_{2(aq)}$, $I_{2(aq)}$, trichlorofluoroethane, TTE ($C_2Cl_3F_3$), 0.1M $KCl_{(aq)}$, 0.1M $KBr_{(aq)}$, 0.1M $KI_{(aq)}$

Safety

Aqueous chlorine, bromine and iodine are corrosive. Aqueous chlorine may also give off toxic chlorine gas. Aqueous bromine and iodine cause stains on skin and clothing.

Procedure

1. Fill in the data tables below:

TABLE I

Halogen	Colour in water	Colour in TTE
Chlorine		
Bromine		
Iodine		

TABLE II

Halogen/halide	$KCl_{(aq)}$	$KBr_{(aq)}$	$KI_{(aq)}$	H_2O
$Cl_{2(aq)}$ + TTE	-------			
$Br_{2(aq)}$ + TTE		--------		
$I_{2(aq)}$ + TTE			-------	

2. In separate clean, small test tube place 2 cm^3 of $Cl_{2(aq)}$, $Br_{2(aq)}$ and $I_{2(aq)}$. Record the colour of each solution

3. Add 2 cm^3 of TTE to each test tube, shake gently and allow the two layers to separate. Record the colours of these three halogens when they are dissolved in TTE layer (the bottom layer). Retain these tubes to be used for colour comparisons if needed later in the experiment.

4. Obtain 2cm^3 each of $KCl_{(aq)}$, $KBr_{(aq)}$, $KI_{(aq)}$ in three test tube. As a control, place 2 cm^3 of distilled water in a fourth test tube.

5. Add 3 - 4 drops of $Cl_{2(aq)}$ to each of the four test tube. Shake gently. Record the colour of the solutions. Now add 1 cm^3 of TTE to each of the four test tube and shake well. Examine the colours of the TTE layer.

6. Repeat procedures 4 and 5, substituting first $Br_{2(aq)}$ and then $I_{2(aq)}$ for the $Cl_{2(aq)}$.

Processing The Data

1. Describe the colours of the three halogens when dissolved in water and in TTE. The latter colours are characteristic of the halogens and are used to test for their presence.

2. Which of the halogens tested was reduced by two of the halide ions?

3. Which halogen was reduced by only one halide ion?

4. Which halogen was not reduced by either of the halide ions?

5. Which of the three halogens is the strongest oxidizing agent? Justify this in the light of your results obtained for this lab.

6. Compare the halogen – halide ion pairs by arranging their half-reaction in a column in order of decreasing ease of reduction.

7. Write the balanced equations for the cases where oxidation-reduction reactions occurred between halide ions and the halogens.

Conclusion

Refer to the objectives of this lab.