

EXPERIMENT 15: SOME CHEMISTRY OF THE THIRD-ROW ELEMENTS

Equipment: test tubes, rack, glass rods.

Materials: pH indicator paper, hydroxides of Na, Mg, Al, P, S, and Cl

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	H																	He
2	Li	Be											B	C	N	O	F	Ne
3	Na	Mg											Al	Si	P	S	Cl	Ar
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

In this experiment we shall examine the hydroxides of the period 3 elements: Na, Mg, Al, P, S, and Cl. We shall also try to understand the reasons for their basic or acidic properties.

Let us show the model structural formula for each of these hydroxides as $X-O-H$ where X stands for any of the Period 3 elements. (We omit other OH groups and oxygen atoms in order to keep this model formula simple.)

We are going to test the water solutions of these hydroxides for pH by using a pH indicator paper. Water molecules are strong dipoles and so we can picture their positive or negative ends pulling element X or H out of our model formula by breaking bond 1 or 2.

If bond 1 breaks, OH^- ion is liberated from the compound and we obtain a base. On the other hand, if bond 2 breaks, H^+ ion is liberated and we obtain an acid.

What we are trying to find out for each hydroxide in this experiment is **a) does bond 1 or bond 2 break**, and **b) to what extent does it break**. For example, if we get a strong base (high pH), then many OH^- ions were liberated and bond 1 must be weak; but if we get a strong acid (low pH), then many H^+ ions were liberated and bond 2 must be weak. Of course there are other possibilities between these two extremes.

A. Determine the approximate hydrogen ion concentration of each of the aqueous solutions or slurries of the hydroxides using appropriate indicators. List the pH in the table below. (The $Al(OH)_3$ must be freshly prepared).

- Which of the hydroxides solutions were acidic? _____
- Which of the hydroxides solutions were alkaline? _____
- From the approximate pH, estimate the strength of the acid or base, using the following terms: "very strong", "strong", "moderate", "weak", "very weak". Record your estimate in column 5 of Table B below.
- How does the strength of the acid or base correlate with the position of element X in Period 3? _____

B. TABLE OF RESULTS

1	2	3	4	5	6
HYDROXIDE	Indicator Color	pH	Which Bond Breaks, 1 or 2 ?	Estimated Strength of Acid or Base	Is it an acid or base solution?
Na - O - H					
H - O - Mg - O - H					
$\begin{array}{c} \text{H} - \text{O} - \text{Al} - \text{O} - \text{H} \\ \\ \text{O} \\ \\ \text{H} \end{array}$					
$\begin{array}{c} \text{O} \\ \\ \text{H} - \text{O} - \text{P} - \text{O} - \text{H} \\ \\ \text{O} \\ \\ \text{H} \end{array}$					
$\begin{array}{c} \text{O} \\ \\ \text{H} - \text{O} - \text{S} - \text{O} - \text{H} \\ \\ \text{O} \end{array}$					
$\begin{array}{c} \text{O} \\ \\ \text{O} = \text{Cl} = \text{O} \\ \\ \text{O} \\ \\ \text{H} \end{array}$					

SUMMARY QUESTIONS

1. Compare the electronegativity difference between two atoms to the strength of the bond between them? _____

2. Could you have predicted the acidic or basic properties of each of the Period 3 hydroxides by using electronegativity differences alone? Try it, and see if your predictions agree with the experimental results! Explain any differences.