

# Experiment 2.

## Periodic Table and Periodic Law

Summary of Experimental Procedure

SAFETY WARNING !  
STRONG ACIDS AND BASES, HALOGENS

Wear safety glasses and gloves when handling with chemicals in a laboratory.

**DISPOSAL:**

Dispose of the waste water / halogen mixtures in the Waste Halogens container in the chemical hood.

**CLEANUP:**

Rinse the test tubes with copious amounts of tap water And twice with distilled water. Discard the rinses in the container.

## PART A. Periodic Trends in Physical Properties (Dry Lab)

The periodic trends for the elements are analyzed through a series of questions on the **Report Sheet**.

**Figure 11.1:** Ionization energy (KJ/mol)

**Figure 11.2:** Atomic radii (pm)

**Figure 11.3:** Electron Affinities (KJ/mol)

**Figure 11.4:** Density (Kg/m<sup>3</sup>)

## PART B. The Appearance of Some Representative Elements

Prepare a hot water bath for PART B-3.

### B-1. Sample of elements

Na, Mg, Al, Si, S

Record your Observations on the Report Sheet.

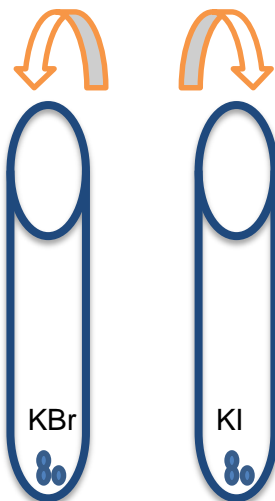
Conduct this PART experiments in the fume hood or near the mouth of movable arm hood.

| Part #                 | PART B.2  | PART B.3   | PART B.4   |
|------------------------|---|--|--|
| Preparation of Halogen | Preparation of Cl <sub>2</sub>  | Preparation of Br <sub>2</sub>   | Preparation of I <sub>2</sub>  |
| 150-mm test tube #     | #1  | #2   | #3   |
| Steps                  | <p><b>Step 1:</b> In a clean test tube, Add 2 mL of 5% NaOCl solution and <u>10 drops</u> of cyclohexane (Agitate the mixture) and 10 drops of 6M HCl</p> <p><b>Step 2:</b> Swirl or agitate it</p> <p><b>Step3:</b> Record your observation.(★1)</p> | <p><b>Step 1:</b> In a clean test tube, Add 2 mL of 3M KBr and <u>10 drops</u> of cyclohexane and 5-10 drops of 8M HNO<sub>3</sub></p> <p><b>Step 2:</b> Swirl or agitate it.</p> <p><b>Step 3:</b> Place the test tube in a hot water</p> <p><b>Step4:</b> Record your observation (★2)</p> | <p><b>Step1:</b> In a clean test tube, Add 2 mL 3M KI and <u>10 drops</u> of cyclohexane and 5-10 drops of 8M HNO<sub>3</sub></p> <p><b>Step2:</b> Swirl or agitate it.</p> <p><b>Step3:</b> Place the test tube in a hot water</p> <p><b>Step4:</b> Record your observation. (★3)</p> |
|                        | <p><i>Do not discard !</i></p> <p><b>Save for PART C.1</b></p>  | <p><i>Do not discard !</i></p> <p><b>Save for PART C.2</b></p>   | <p><i>Do not discard !</i></p> <p><b>Save for PART C.3</b></p>   |

# PART C. The Chemical Properties of the Halogens

## PART C.1

$\text{Cl}_2$ /Cyclohexane  
Solution From **PART B.2**

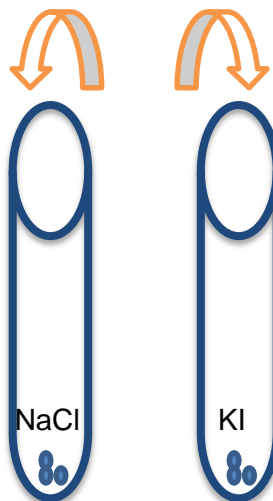


100-mm Test tube #1

#2

## PART C.2

$\text{Br}_2$ /Cyclohexane  
Solution From **PART B.3**

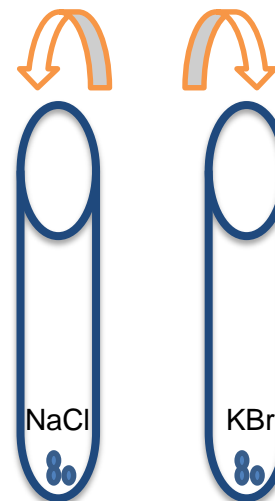


#3

#4

## PART C.3

$\text{I}_2$ /Cyclohexane  
Solution From **PART B.4**



#5

#6

**Step1.** Add a pinch of solid

**Step2:** Add an equal portion of the halogen/cyclohexane solution

**Step3:** Swirl the solution, observe, and record.

Write appropriate net ionic equations. (★4)(★5)(★6)

# PART D. The Chemical Properties of the Halides

## 1. The reactions of the halides with various metal ions

| Reactions                                    | <b>PART D.1-a)</b><br>Slowly add 10 drops of<br><b>2 M <math>\text{Ca}(\text{NO}_3)_2</math></b> .<br>(Vary the color of the<br>background of the test tubes<br>for observation) | <b>PART D.1-b)</b><br>Add slowly 10 drops of<br><b>0.1 M <math>\text{AgNO}_3</math></b> .<br>After 1min, add 10 drops of<br>3 M $\text{NH}_3$ . | <b>PART D.1-c)</b><br>Add 1 drop of 6 M $\text{HNO}_3$<br>and slowly add 10 drops of<br><b>0.1M <math>\text{Fe}(\text{NO}_3)_3</math></b> . |
|--|--|---|---|
| <b>NaF</b><br>+ 10 drops of distilled water  | 100-mm test tube<br># 1  | #2  | #3  |
| <b>NaCl</b><br>+ 10 drops of distilled water | #4   | #5  | #6  |
| <b>KBr</b><br>+ 10 drops of distilled water  | #7   | #8  | #9  |
| <b>KI</b><br>+ 10 drops of distilled water   | #10  | #11   | #12   |

**Step 1:** Add a pinch of solid + 10 drops of distilled water

**Step 2:** Add drops of the metal ion solution to each test tubes

**Step 3:** Observe closely and over a period of time. (★7) (★8) (★9)

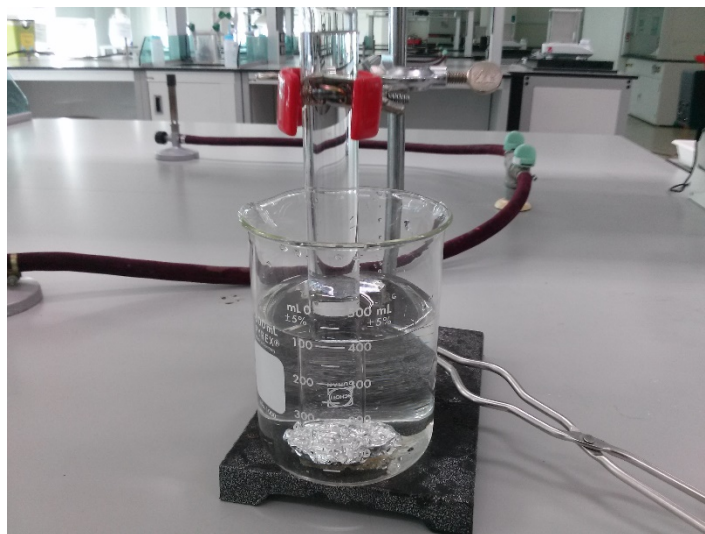
**Step 4:** Record and summarize your observations of chemical activity with the halides with the  $\text{Ca}^{2+}$ ,  $\text{Ag}^+$ , and  $\text{Fe}^{3+}$  ions.

## E. Chemical Reactivity of Some Representative Elements

### E.1. Na

#### TA Demonstration Only

Test the gas by holding the mouth of the inverted test tube over a Bunsen flame.  
(★10) Account for the appearance of the color change in the solution.



## E.2. Mg and Al

| Reactions | PART E.2-a) With Acid  | PART E.2-b) With Base   |
|-----------|--|---|
| Mg        | clean 100-mm test tube<br># 1  | #1  |
| Al        | #2   | #2  |
| Steps     | <p><b>Step 1:</b> Cut 5-mm pieces and place them into separate small test tubes.</p> <p><b>Step 2:</b> Add <u>1 mL of 6 M HCl</u> to each tube.</p> <p>Which metal reacts more rapidly? (★12) What is the gas that is evolved? (★13)</p> <p>Record your observation.</p> | <p><b>Step 1:</b> Add (count) drops of 6 M NaOH to <u>the test tube with Al ion solution</u> until precipitate appears.</p> <p><b>Step 2:</b> Add the same number of drops <u>to the test tube containing the Mg ion solution</u>.</p> <p>Record your observations. (★14)</p> <p><b>Step 3.</b> Add drops of <b>6 M NaOH</b> until both solutions are again colorless. Observe closely as each drop is added. Record and explain.</p> |



### E.3. Solubilities of Alkaline-earth cations

| Solubility         | 0.1 M $\text{MgCl}_2$  | 0.1 M $\text{CaCl}_2$  | 0.1 M $\text{Sr}(\text{NO}_3)_2$   |
|--------------------|--|--|--|
| <b>PART E.3-a)</b> | <b>test tube # 1</b><br>(+ 5 drops of 0.10M NaOH<br>+ 1 ~ 2 drops of 1.0 M NaOH)                           | <b>#2</b><br>(+ 5 drops of 0.10M NaOH<br>+ 1 ~ 2 drops of 1.0 M NaOH)                                      | <b>#3</b><br>(+ 5 drops of 0.10M NaOH<br>+ 1 ~ 2 drops of 1.0 M NaOH)                                      |
| <b>PART E.3-b)</b> | <b>#4</b><br>(+5 drops of 0.10 M $\text{Na}_2\text{SO}_4$<br>+ a pinch of solid $\text{Na}_2\text{SO}_4$ ) | <b>#5</b><br>(+5 drops of 0.10 M $\text{Na}_2\text{SO}_4$<br>+ a pinch of solid $\text{Na}_2\text{SO}_4$ ) | <b>#6</b><br>(+5 drops of 0.10 M $\text{Na}_2\text{SO}_4$<br>+ a pinch of solid $\text{Na}_2\text{SO}_4$ ) |

**Step 1:** Place 10 drops of each cation in three separate, clean 100-mm test tubes.

**Step 2:** Count and add 5 drops of 0.10 M NaOH or 0.10 M  $\text{Na}_2\text{SO}_4$  until a cloudiness appears in each test tube. You can observe a change in appearance about one of three cations.

**Step 3:** Add 1 ~ 2 drops of 1.0 M NaOH or a pinch of solid  $\text{Na}_2\text{SO}_4$  to determine the order of one of two cations.

**Step 4:** Predict the trend in the solubility of the hydroxides (★15) and the sulfates (★16) of the Group 2A cations.

#### E.4. Sulfurous acid and sulfuric acid (In a hood or near arm hood)

| Solubility                                     | 5 drops of 6 M HCl |
|--|--------------------|
| <b>PART E.4-a)</b><br>$\text{Na}_2\text{SO}_3$ | #1                 |
| <b>PART E.4-b)</b><br>$\text{Na}_2\text{SO}_4$ | #2                 |

**Step 1:** Place a double pinch of each solid in two separate, clean 100-mm test tubes.

**Step 2:** Add 5 drops of 6 M HCl.

**Step 3:** Test the evolved gas with wet blue litmus paper. Write a balanced equation for the reaction.  
(★17)

**Step 4:** Account for any differences or similarities in your observations. (★18)

## **DISPOSAL:**

Dispose of the waste water / halogen mixtures in the Waste Halogens container in the chemical hood.

## **CLEANUP:**

Rinse the test tubes with copious amounts of tap water And twice with distilled water. Discard the rinses in the container.