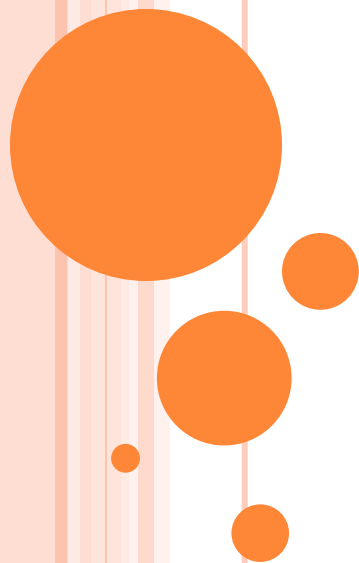


Experiment 2.

Periodic Table and Periodic Law

**Experimental
Procedure**

Lab 402



A. Periodic Trends in Physical Properties

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

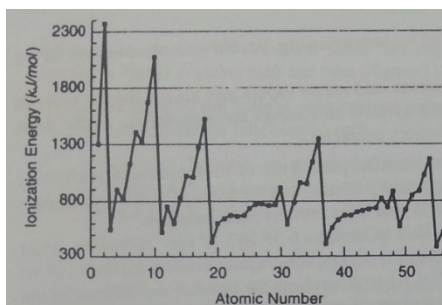


Figure 11.1 Ionization energies (kJ/mol) plotted against atomic number

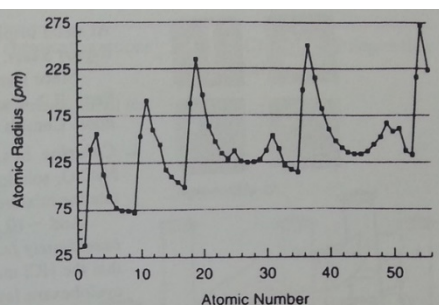


Figure 11.2 Atomic radii (pm) plotted against atomic number

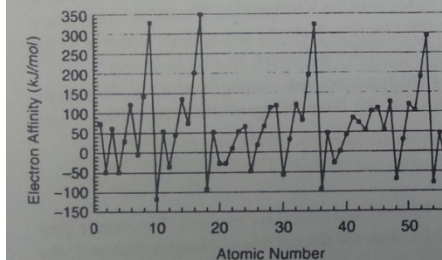


Figure 11.3 Electron affinities (kJ/mol) plotted against atomic number, defined here as energy released

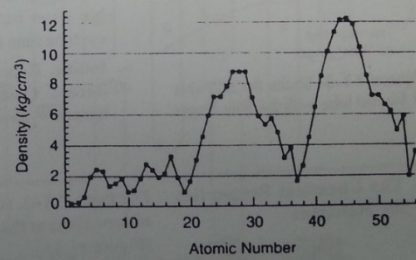


Figure 11.4 Density (kg/m³) plotted against atomic number



B. The Appearance of Some Representative Elements

- ***Prepare a hot bath for Part B.3.***

1. Samples of elements

- 1) Samples of the third period elements (Na, Mg, Al, Si, S) on the table
 - Na is stored under a non-aqueous liquid to prevent rapid air oxidation
 - Polish the Mg and Al metal strips with steel wool for better viewing.
- 2) Record your observations on the ***Report Sheet.***



2. Chlorine (In the fume hood or near the arm hood)

- 1) In a clean, 150 mm test tube, place 2 ml of a sodium hypochlorite, NaOCl, solution and 10 drops of cyclohexane.
- 2) Agitate the mixture.
- 3) Add ~ 10 drops of 6 M HCl (*Caution!*).
- 4) Agitate the mixture (with the stirring rod).
- 5) Note the color of the chlorine in the cyclohexane layer.
- 6) Record your observation and save the mixture for **Part C.1**.



3. Bromine (In the fume hood or near the arm hood)

- 1) Clean test tube, place 2 ml of 3 M KBr solution and 10 drops of cyclohexane
- 2) Add 5-10 drops of 8 M HNO₃ (*Caution !*)
- 3) Agitate the mixture and place the test tube in a hot water bath to increase the reaction rate
- 4) Note the color of the bromine in the cyclohexane layer.
- 5) Do not discard – save for **Part C.2.**



4. Iodine

- 1) Clean test tube, place 2 ml of 3 M KI solution and 10 drops of cyclohexane.
- 2) Add 5-10 drops of 8 M HNO₃ (*Caution !*).
- 3) Agitate the mixture and place the test tube in a hot water bath to increase the reaction rate.
- 4) Record compare the appearance of the three halogens dissolved in the cyclohexane.
- 5) Save for **Part C.3**.



C. The Chemical Properties of the Halogens

- *Prepare six clean, small (~100 mm) test tube.*

1. Chlorine and its reactions with bromide and iodide ions

1) In Clean two small test tubes

a) Add a pinch of solid **KBr** to the **first** test tube.

b) Add a pinch of solid **KI** to the **second** test tube.

2) Use a dropping pipet to withdraw the chlorine/cyclohexane layer from **Part B.2.**

3) Add an equal portion to the two test tubes.

4) Agitate the solution, observe, and record.

5) Write appropriate net ionic equations.



2. Bromine and its reactions with chloride and iodides ions

- 1) Clean two small test tubes.
 - a) Add a pinch of solid **NaCl** to the **third** test tube
 - b) Add a pinch of solid **KI** to the **fourth** test tube
- 2) Use a dropping pipet to withdraw the bromine/cyclohexane layer from **Part B.3.**
- 3) Add an equal portion to the two test tubes.
- 4) Agitate the solution, observe, and record.
- 5) Write appropriate net ionic equations.



3. Iodine and its reactions with chloride and bromide ions

- 1) In Clean two small test tubes,
 - a) Add a pinch of solid **NaCl** to the **fifth** test tube.
 - b) Add a pinch of solid **KBr** to the **sixth** test tube.
- 2) Use a dropping pipet to withdraw the iodine/cyclohexane layer from **Part B.4.**
- 3) Add an equal portion to the two test tubes.
- 4) Agitate the solution, observe, and record.
- 5) Write appropriate net ionic equations.



D. The Chemical Properties of the Halides

- *Prepare twelve clean, small (~100 mm) test tube*

1. The reactions of the halides with various metal ions

Label 12 clean, small test tubes

- Test tubes 1, 2 and 3 : a pinch of **NaF** and 10 drops of water
- Test tubes 4, 5 and 6 : a pinch of **NaCl** and 10 drops of water
- Test tubes 7, 8 and 9 : a pinch of **KBr** and 10 drops of water
- Test tubes 10, 11 and 12 : a pinch of **KI** and 10 drops of water



- a) Slowly add 10 drops of 2 M $\text{Ca}(\text{NO}_3)_2$ to test tubes 1, 4, 7 and 10.
- b) Slowly add 10 drops of 0.1 M AgNO_3 to test tubes 2, 5, 8 and 11.
- c) Add 1 drop of 6 M HNO_3 (Caution) and slowly add 10 drops of 0.1 M $\text{Fe}(\text{NO}_3)_3$ to the test tubes 3, 6, 9 and 12.
- d) Summarize your observations of the chemical activity for halides with the Ca^{2+} , Ag^+ and Fe^{3+} ions.



E. Chemical Reactivity of Some Representative Elements

- ***TA Demonstration Only***

1. Sodium

- 1) Place a pea-sized piece of aluminum foil and add 2 mL of 6 M NaOH in a 100-mm test tube.
- 2) Place it in a 250-mL beaker and cover the test tube up with a 150-mm test tube. It will bubble slowly. Allow the reaction to proceed for 5 minutes. Stopper the test tube.
- 3) Test the gas by holding the mouth of the inverted test tube over a Bunsen flame or another open flame. (A loud pop indicates the presence of hydrogen gas.)



2. Magnesium and aluminum

1) Reaction with acid

- Polish 5 cm strips of Mg and Al metal.
- Cut 5 mm pieces and place them into separate small test tubes.
- Add 1 mL of 6 M HCl to each test tube.
- Which metal reacts more rapidly? What is the gas that is evolved?

2) Reaction with base

- Add drops of 6 M NaOH to each test tube until a precipitate appears.
- Continue to add NaOH to the test containing the aluminum ion until a change in appearance occurs.
- Add the same number of drops to the test tube containing the magnesium ion .
- Add drops of 6 M NaOH until both solution are again colorless.



3. Solubilities of alkaline-earth cations

1) Solubility of alkaline-earth cations

- a) Place 10 drops of 0.1 M MgCl_2 , 0.1 M CaCl_2 and 0.1 M $\text{Sr}(\text{NO}_3)_2$ in three separate, clean test tubes.
- b) Count and drops of 0.10 M NaOH until a cloudiness appears in each test tube.
- c) Predict the trend in the solubility of the hydroxides of the Group 2A cations.

2) Solubility of the sulfates

- a) Place 10 drops of 0.1 M MgCl_2 , 0.1 M CaCl_2 and 0.1 M $\text{Sr}(\text{NO}_3)_2$ in three separate, clean test tubes
- b) Count and add drops of 0.10 M Na_2SO_4 until a cloudiness appears in each test tube
- c) Predict the trend in the solubility of the sulfates of the Group 2A cations



4. Sulfurous acid and sulfuric acid

- a) Place a double pinch of solid sodium sulfite, Na_2SO_3 , into a clean, small or medium-sized test tube.
- b) Add 5-10 drops of 6 M HCl.
- c) Test the evolved gas with wet blue litmus paper.
- d) Write the balanced equation for the reaction.
- e) Repeat the test, substituting solid sodium sulfate, Na_2SO_4 , for the Na_2SO_3 .



DISPOSAL:

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

CLEANUP:

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

