# Lesson Element

# Explaining Observations: rates of reaction of halogenoalkanes

In this activity you will carry out a series of small-scale experiments and then use your observations to compare and explain the reactivity of three different halogenoalkanes, R-X (where R = an alkyl group and X = a halogen atom).

You can investigate the reactivity by following the rate of hydrolysis (reaction with water) of each of the compounds in the presence of silver ions, Ag+(aq). Silver ions react with halide ions(X–) to form silver halide precipitates.

Hydrolysis reaction: R-X + H2O 🡪 R-OH + H+ + X–

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## Task 1 Investigating the precipitation reaction with halide salts

**Wear eye protection.**

Carry out the following reactions on the laminated card circles (provided on the Student Information Sheet). Note the colours of the precipitates formed.

Circle **A**: 1 drop of chloride solution + 2 drops of silver nitrate solution.

Circle **B**: 1 drop of bromide solution + 2 drops of silver nitrate solution

Circle **C**: 1 drop of iodide solution + 2 drops of silver nitrate solution

1. Name the precipitates formed in each reaction.
2. Write an ionic equation for each reaction.
3. Suggest why, in each case, a precipitate of the *silver halide* forms.[You may find it helpful to use diagrams in your answers to 3 and 4.]
4. Explain why, in each case, a precipitate forms **immediately** on addition of the silver nitrate solution. [You may find it helpful to use diagrams in your answers to 3 and 4.]

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## Task 2 Investigating the rate of hydrolysis of halogenoalkanes

**Wear eye protection. Avoid inhaling fumes. No naked flames.**

1. Label 4 small test-tubes **A**-**D**. Prepare the tubes as follows:

* Tube **A**: 0.5 cm3 of ethanol\* + 2 drops of 1-chlorobutane
* Tube **B**: 0.5 cm3 of ethanol\* + 2 drops of 1-bromobutane
* Tube **C**: 0.5 cm3 of ethanol\* + 2 drops of 1-iodobutane
* Tube **D**: 1.5 cm3 of silver nitrate solution.

[\*Note: halogenoalkanes are immiscible with water but do mix with ethanol. Ethanol is just being used here as a *mutual solvent* for the reagents.]

1. Stand tubes **A**-**D** in a beaker one-third filled with hot water (~ 45-50 oC but not critical) for 3-4 minutes.
2. Working quickly, add 3 drops of silver nitrate (from tube **D**) to each of tubes **A**-**C**.
3. Note how quickly and the order in which the precipitates appear in tubes **A**-**C**.
4. Draw the structures of a 1-halogenobutane (use ‘X’ to represent the halogen).

Use the data on the following page and/or your ideas from Task 1 to help you answer questions 2-6.

1. Name the precipitates formed in each tube, **A**-**C**.
2. Explain why a precipitate does not *immediately* form in each tube, **A**-**C**.
3. Explain why a precipitate does *eventually* form in each case.
4. Explain the order in which the precipitates form. Which factor, *bond enthalpy* or *bond polarity* is more important in determining the relative reactivity of these halogenoalkanes?
5. Suggest a mechanism for the hydrolysis reaction.

# Student Information Sheet

**Data/drop-chemistry card**

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|  |  |  |
| **Circle A** | **Circle B** | **Circle C** |

|  |  |
| --- | --- |
| **Bond** | **Bond enthalpy values**  **/ kJ mol-1** |
| C-C | 347 |
| C-H | 413 |
| C-O | 358 |
| C-Cl | 346 |
| C-Br | 290 |
| C-I | 228 |
| Cl-Cl | 243 |
| Br-Br | 193 |
| I-I | 151 |

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| --- | --- | --- | --- | --- | --- |
| **H**  **2.1** | | **Relative electronegativities**  (Pauling scale) | | | |
|  | **C**  **2.5** | | **N**  **3.0** | **O**  **3.5** | **F**  **4.0** |
|  |  | |  |  | **Cl**  **3.0** |
|  |  | |  |  | **Br**  **2.8** |
|  |  | |  |  | **I**  **2.5** |