STRUCTURE-REACTIVITY RELATIONSHIPS: NUCLEOPHILIC SUBSTITUTION REACTIONS

UNKNOWNS

n-butyl chloride (1-chlorobutane)
n-butyl bromide (1-bromobutane)
sec-butyl chloride (2-chlorobutane)
sec-butyl bromide (2-bromobutane)
tert-butyl chloride (2-chloro-2-methylpropane)
tert-butyl bromide (2-bromo-2-methylpropane)
chlorobenzene
benzyl chloride

EXPERIMENTAL PROCEDURE - Work in pairs but hand in individual reports

- **Gloves should be worn when working with the alkyl halides.**
- **Alkyl halides are toxic and have harmful vapours.**
- **Avoid skin contact and avoid breathing the vapours.**
- **Perform the reactions in the fumehood, keep the samples in the fumehood.**

Notes : **Be very careful not to cross contaminate any samples or equipment.**
Make sure to use clean and dry test tubes.
Be as consistent as possible with the amounts used *otherwise comparison becomes more difficult.*

Label two sets of **CLEAN**, **DRY small** test tubes with the identification number for each of the unknown organic halides (one set is for SN1 reactivity and one set is for SN2 reactivity). Place 3 drops of the corresponding unknown organic halide in the appropriate test tube in each set. The test tubes should be kept stoppered as much as possible throughout the experiment (to prevent evaporation). You will need upto 10 mL of 15% NaI/acetone solution for one set of tubes and upto 10 mL of 1% aqueous ethanolic $AgNO_3$ solution for the other set. These are approximate volumes, but it is important to be consistent from one sample to the next within each set. You will find it useful to calibrate 2 of your Pasteur pipettes to 1 mL (*i.e.* fill them to one 1mL and mark it with a sharpie line or tape).

a) NaI-acetone (SN2 reactivity)

Starting with your first unknown, add 1 mL of the NaI solution, noting the time of addition. Add the solution in one portion (*i.e.* not dropwise) and then shake the test tube to ensure mixing (you may see an initial precipitate appear during the addition that disappears on mixing :this is **NOT** the precipitate that you are looking for). When precipitation begins to occur record the time as closely as possible and then record the time when the tube becomes opaque (*e.g.* you can not see a pencil dot on a piece of paper through the solution). If any tubes in the NaI-acetone series are still clear after 15 minutes, loosen the stoppers and place the tubes in a beaker of hot water (50 ^oC) and note any changes that occur after 6 minutes. Ensure that you do not evaporate volatile contents or subsequent precipitation may result from

concentration effects rather than the reaction products. If there is a precipitate, look at the precipitate and record your observations.
Repeat the process for each of the unknown halides.

b) $AgNO_3$ - ethanol/water (SN1 reactivity)

Repeat the above procedures using a **CLEAN**, **DRY** set of test tubes using 1 mL of the silver nitrate solution as the reaction medium. Remember to shake the test tubes to ensure mixing after adding the reagent to the alkyl halide. Watch carefully for any rapid changes and then observe the samples periodically. If possible, observe the time both for the first distinguishable turbidity and also for a definite precipitate. If there is a precipitate, look at the precipitate and record your observations.

Based on your results for the unknowns from both sets of reaction data, deduce the identity of each unknown and match to the appropriate structure (the report template contains some hints on how you might need to procede in order to be able to do this).

CLEAN UP

- Dispose of all solutions in the drum for organic waste in the fume-hood.

REFERENCES

1. https://www.chem.ucalgary.ca/courses/351/Carey5th/Ch04/ch4-3.html
https://www.chem.ucalgary.ca/courses/351/Carey5th/Ch08/ch8-0.html

REPORT

Before writing any Chem 351 laboratory report, we strongly recommend that you review section 8 in the introductory section of the student laboratory manual that discusses how to write reports and/or from "writing reports" on the course website. Students often don't get the grades they would like because they make errors that are addressed in that section of the manual. These are avoidable errors.
The report for this experiment uses the report templates (WORD) and this is due to the appropriate D2L Dropbox by the start time for your laboratory session the following week (*i.e.* you have one week to complete the report). You can start work on this before the laboratory period starts. You might want to bring your lecture notes or a text for reference. Remember that more it not necessarily better. It is important to be accurate and concise rather than verbose and vague. Proper English should be used and it should be written in your own words.