Testing for unsaturation with bromine – teacher notes

In this experiment students use a solution of bromine in hexane to detect whether an organic compound is unsaturated. The hexane solution is made as described below. The solution mixes easily with non-polar organic compounds such as cyclohexane, cyclohexene and limonene. Unsaturated compounds rapidly decolorise the bromine.

Topic

Reactions of bromine and unsaturated organic molecules

Timing

15 minutes

Equipment

Apparatus

- Eye protection

For preparing a solution of bromine in hexane:

- Plastic well-plate, 24 wells (eg Sigma ref: CLS3526)
- Plastic pipette, standard form (eg Aldrich ref: 213, 500-3)

For testing for unsaturation:

- Plastic pipettes
- Plastic Petri dish

Chemicals

For preparing a solution of bromine in hexane:

- Potassium bromate(V), 0.1 mol dm^{-3}
- Potassium bromide, 0.2 mol dm^{-3}
- Hydrochloric acid, 1 mol dm^{-3}
- Hexane

For testing for unsaturation:

- Cyclohexane
- Cyclohexene
- Limonene
- Solution of bromine in hexane (see note 9 below for disposal)

Solutions should be contained in plastic pipettes. See the accompanying guidance on apparatus and techniques for microscale chemistry (https://rsc.li/3xOnY6G), which includes instructions for preparing a variety of solutions.

Preparing a solution of bromine in hexane

In this experiment elemental bromine is formed by a reverse disproportionation reaction between bromate, bromide and acid:

$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$

The bromine is then extracted into hexane in a plastic pipette which serves as a separating funnel. The resulting solution is decanted into a well-plate chamber and can then be used to test for unsaturation in organic compounds.

One particular safety advantage of this microscale technique is that it eliminates the need for bottles of bromine and its associated hazards. In addition, the experiment is quite fun to do and illustrates several important chemical principles such as disproportionation, extraction techniques and hydrophilic/hydrophobic properties.

Health, safety and technical notes

1. Read our standard health and safety guidance (https://rsc.li/3uV7wzz).
2. Wear eye protection throughout. Gloves would be sensible.
3. Care should be taken to ensure the solvents do not shoot out of the pipettes when inverted.
4. Cyclohexane – see CLEAPSS Hazcard HC045b. Cyclohexane is highly FLAMMABLE, a skin and respiratory IRRITANT and TOXIC to aquatic life.
5. Cyclohexene – see CLEAPSS Hazcard HC045c. Cyclohexene is a highly FLAMMABLE liquid and vapour, HARMFUL if ingested, TOXIC in contact with skin and for aquatic life.
6. Limonene – see CLEAPSS Hazcard HC045c. Limonene is FLAMMABLE as liquid and vapour, a skin IRRITANT and sensitiser and TOXIC to aquatic life.
7. Hexane – see CLEAPSS Hazcard HC045a. Hexane is highly FLAMMABLE liquid and vapour, a skin and respiratory IRRITANT, and TOXIC to the reproductive system. It is also a specific target organ toxin for the heart, CNS and respiratory system.
8. Ensure the laboratory is well-ventilated.
9. To dispose of the bromine solution, add 2 mol dm^{-1} sodium carbonate solution (see CLEAPSS Hazcard HC095A and CLEAPSS Recipe Book RB080) until the colour is discharged – the solution can then be washed to waste with plenty of running water.