# Teacher Guide

## Substituting alcohols

### Student’s age

The experiment is suitable for students aged 16–17 years old.

### Time required

90 min

### Introduction

The solubility of alcohols in water decreases, with increasing carbon chain length to hydroxyl group ratio. Short chain alcohols such as ethanol and propanol are completely soluble in water while an alcohol such as n-octanol is just slightly soluble in water. Even though they mix to some degree, mixing 1 mL of butan-1-ol, butan-2-ol or pentan-1-ol with 2 mL of water will create a system with two phases where the alcohol floats on top of the water. As a rule of thumb, alcohols with a 3:1 ratio of carbon atoms to hydroxyl groups are completely mixable with water.

Alcohols with short carbon chains, such as methanol and ethanol undergo almost complete combustion under the conditions in this laboratory. We can observe that they burn with a blue almost invisible flame. As the carbon chains get longer, we will observe yellow flames due to the incomplete combustion of the alcohols.

### Risk assessment

| **List significant hazards** | **Describe what could happen** | **Precautionary measures** | **Measures to be taken if something goes wrong** |
| --- | --- | --- | --- |
| methanol | A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of a flameA symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of a skull and bones.A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of a torso with a crack in the chest.  **H225** Highly flammable liquid and vapor  **H301 + H311 + H331** Toxic if swallowed, in contact with skin or if inhaled.  **H370** Causes damage to organs. | Work in a ventilated area. Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking. IF SWALLOWED: Immediately call a poison centre/doctor.  IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a poison centre/doctor. |  |
| ethanol | A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of a flameA symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of an exclamation mark. **H225** Highly flammable liquid and vapor | Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking. |  |
| propan-1-ol | A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of a flameA symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of test tubes from which there is liquid pouring out on a material and a hand  A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of an exclamation mark.  **H225** Highly flammable liquid and vapor.  **H318** Causes serious eye damage.  **H336** May cause drowsiness or dizziness | Wear eye protection. Work in a ventilated area. Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking. | Eye wash |
| propan-2-ol | A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of a flameA symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of an exclamation mark.  **H225** Highly flammable liquid and vapor.  **H319** Causes serious eye irritation.  **H336** May cause drowsiness or dizziness | Wear eye protection. Work in a ventilated area. Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking. | Eye wash |
| butan-1-ol | A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of a flameA symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of test tubes from which there is liquid pouring out on a material and a hand  A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of an exclamation mark.  **H226** Flammable liquid and vapor.  **H302** Harmful if swallowed.  **H315** Causes skin irritation.  **H319** Causes serious eye damage.  **H335** May cause respiratory irritation.  **H336** May cause drowsiness or dizziness | Wear eye protection. Work in a ventilated area. Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking. | Eye wash |
| butan-2-ol | A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of a flameA symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of an exclamation mark.  **H226** Flammable liquid and vapor.  **H319** Causes serious eye irritation.  **H335** May cause respiratory irritation.  **H336** May cause drowsiness or dizziness | Wear eye protection. Work in a ventilated area. Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking. | Eye wash |
| pentan-1-ol | A symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of a flameA symbol with the shape of a tilted square with white filling and a red outline. Inside the square there is black drawing of an exclamation mark.  **H226** Flammable liquid and vapor.  **H315** Causes skin irritation.  **H332** Harmful if inhaled.  **H335** May cause respiratory irritation. | Work in a ventilated area. Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking. | Eye wash |

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| **Date of assessment** | 9.2.2023 | **Written by** | CheSSE | **Class/lesson** | EXAMPLE |

### Results and discussion (Example)

The students write down their results from the two procedures they use to investigate some of the properties of alcohols. Circulate among the students, asking questions and offering them help with organizing experimental data.

Students use relevant principles of green chemistry to compare the old and the new procedure for investigating some of the properties of alcohols and evaluate which procedure is most “green”. They also take into consideration how suitable the procedures are in teaching students about some of the properties of alcohols. Finally, they present their findings for peers.

### Conclusion

In this phase the students summarize the results presented in the Results and Discussions phase and decide if they think it is a good idea to replace the old procedure with the new.