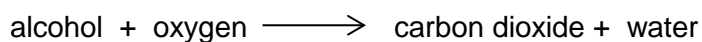


Determination of the amount of energy released by a fuel

Introduction

Fuels react with oxygen when they burn, releasing energy. You will burn four different alcohols and compare the energy they give off.



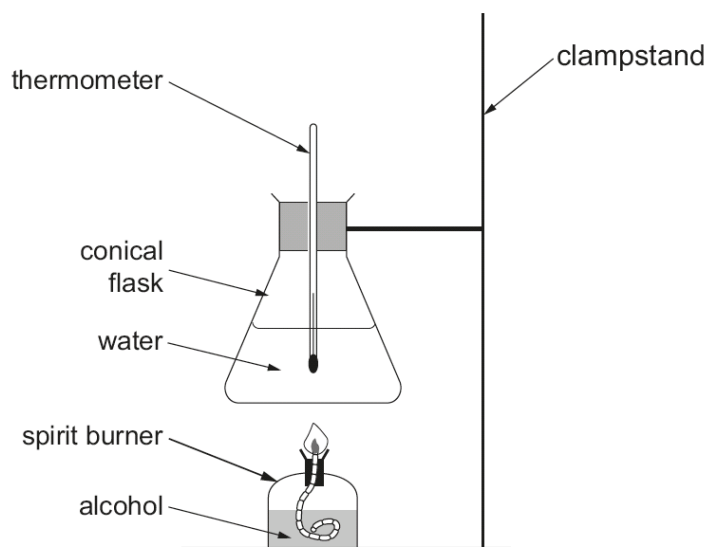
Apparatus

clamp stand, clamp and boss
 250cm³ conical flask
 100cm³ measuring cylinder
 thermometer

Access to:

electronic balance ± 0.01 g
 4 \times spirit burners containing methanol, ethanol, propanol, butanol

Diagram of Apparatus



Method

1. Measure 100 cm³ of water into the conical flask.
2. Clamp the flask at a suitable height so the spirit burner can be placed below it (as shown in the diagram - make sure that the thermometer does not touch the bottom of the flask).
3. Record the temperature of the water.
4. Record the mass of the spirit burner (including the lid and alcohol).
5. Place the spirit burner under the conical flask and light it.
6. Allow the burner to heat the water until the temperature rises by about 40 °C. Record the temperature of the water.
7. Extinguish the flame carefully and record the mass of the burner.
8. Repeat steps 1-7 with each of the other alcohols.

Analysis

1. Calculate the temperature rise for each fuel.
2. Calculate the mass of each alcohol burnt.
3. Calculate the energy released for each alcohol using the following equation.

$$\text{Energy released from alcohol per gram (J)} = \frac{\text{mass of water (g)} \times \text{temperature increase (}^{\circ}\text{C)} \times 4.2}{\text{mass of alcohol (g)}}$$

Risk Assessment

Hazard	Risk	Control measure
Methanol is harmful and highly flammable	May set light to / burn individuals or equipment Vapour can cause irreversible damage	Work in a well ventilated lab Wear eye protection and ensure work station is clear
Ethanol is highly flammable	May set light to / burn individuals or equipment	Work in a well ventilated lab Wear eye protection and ensure work station is clear
Propanol is highly flammable and an irritant	May set light to / burn individuals or equipment	Work in a well ventilated lab Wear eye protection and ensure work station is clear
Butanol is highly flammable and harmful if swallowed	Vapour may irritate respiratory system and may irritate skin if spilt	Work in a well ventilated lab Wear eye protection and ensure work station is clear Rinse immediately if spilt on skin

Teacher / Technician notes

Methanol - Refer to CLEAPSS hazcard 40B

Ethanol - Refer to CLEAPSS hazcard 40A

Propanol - Refer to CLEAPSS hazcard 84A

Butanol - Refer to CLEAPSS hazcard 84B

Pentanol should not be used as a fume cupboard is needed - Refer to CLEAPSS hazcard 84C.

Spirit burners should not be used for more than one alcohol. Make sure that the wick fits tightly in the holder and the holder sits tightly in the container.

Students should not fill or refill spirit burners.

An extension activity could be to plot a graph of the number of carbon atoms in the alcohol against the energy released per gram.

No repeats are planned in this experiment, but can be carried out if time allows.
Alternatively, groups can compare results to discuss reproducibility.

Students should design their own table, but a suggested table format is shown below.

Alcohol	Initial mass of burner (g)	Final mass of burner (g)	Change in mass of burner (g)	Initial temperature (°C)	Final temperature (°C)	Temperature increase (°C)	Energy released per gram (J)

Working scientifically skills covered

1. Development of scientific thinking

Explain every day and technological applications of science: evaluate associated personal, social, economic and environmental implications and make decisions based on the evaluation of evidence and arguments.

2. Experimental skills and strategies

Carry out experiments appropriately having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations.

Evaluate methods and suggest possible improvements and further investigations.

3. Analysis and Evaluation

Carrying out and representing mathematical analysis.

Evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.

4. Scientific vocabulary, quantities, units, symbols and nomenclature

Use SI units and IUPAC chemical nomenclature unless inappropriate.