

## Teacher Resource Bank

GCE Chemistry

PSA9: AS Organic Chemistry

- Investigate the Combustion of Alcohols



## AS Organic Chemistry

### PSA9 Investigate the combustion of alcohols

## Technical Sheet

**To investigate the enthalpies of combustion of an homologous series of straight-chained alcohols.**

Whenever possible, students should work individually.

If it is essential to work in a pair or in a small group, because of the availability of apparatus, supervisors must be satisfied that they are able to assess the contribution from each student to the practical activity.

### Requirements

- metal calorimeter (copper or aluminium)
- 100 cm<sup>3</sup> measuring cylinder
- thermometer (-10 °C to 110 °C)
- clamp and stand
- graph paper
- spirit burners containing:
  - methanol
  - ethanol
  - propan-1-ol
  - butan-1-ol

Each student should carry out the experiment on two different alcohols and then the class results could be pooled.

**Centres are expected to carry out and be responsible for their own safety risk assessments.**



## Student Sheet

**It is the responsibility of the student to carry out and be responsible for their own safety risk assessment before carrying out these experiments.**

**Wear safety glasses at all times. Assume that all of the reagents and liquids are toxic, corrosive and flammable.**

### Experiment

- Using a measuring cylinder, place 50 cm<sup>3</sup> of water into the metal calorimeter and record the temperature of the water. Leave the thermometer in the water.
- Clamp the calorimeter, so that its base will be just above the wick of a spirit burner.
- Choose a spirit burner, noting which alcohol it contains, and weigh it.
- Adjust the wick of the spirit burner so that only about 5 mm of it protrudes from the neck of the burner.
- Ignite the alcohol at the wick and immediately place the burner beneath the clamped calorimeter.
- Allow the alcohol to burn until the temperature of the water has **risen by approximately 35 °C** and record the final temperature.
- Carefully extinguish the spirit burner (using the cover provided) and reweigh it to determine the mass of alcohol that has burned in the experiment.
- Record the identity of the alcohol, the mass of alcohol burned and the temperature rise in your experiment.
- Repeat the experiment with a second alcohol.

### Analysing the data

The ability to calculate values for  $\Delta H_c$  for the two alcohols that you have used is NOT part of the PSA but this is a useful task to complete.

Your teacher can help you with this part of the work.

Assuming that complete combustion has occurred for the first of your chosen alcohols, calculate a value, in  $\text{kJ mol}^{-1}$ , for the heat of combustion,  $\Delta H_c$ , for that alcohol.

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Wear Eye  
Protection

To do this you will need to

- calculate the change in temperature,  $\Delta T$ , of the 50 cm<sup>3</sup> of water.
- calculate the heat change, in joules, that has occurred, by using the expression

Heat Change = Mass x Specific Heat Capacity x Temperature Change

$$\text{Heat change} = m c \Delta T$$

*In this experiment we will ignore heat absorbed by the metal calorimeter and that lost to the surroundings.*

You need the **mass of water, m (quoted in g)**, which has changed in temperature, in addition to the **temperature change,  $\Delta T$  (quoted in Kelvin)**, in order to be able to calculate the heat change.

For water the specific heat capacity,  **$c = 4.18 \text{ J K}^{-1} \text{ g}^{-1}$**  and the value that you obtain for the heat change will be in **joules**. You can convert this value into kilojoules by dividing it by 1000.

- calculate the mass of alcohol that was burned in your experiment.
- calculate the relative molecular mass of the alcohol.
- convert the heat change,  $q$ , which is the heat change from burning the mass of alcohol, into an enthalpy change in  $\text{kJ mol}^{-1}$

Repeat the calculation to determine the heat of combustion for the second alcohol that you have used.

Report your results to your teacher.



## Teacher Notes and Marking Guidance

The specific marking guidance in the specification is as follows

**2 marks:** All areas of the task are carried out competently.

Masses and volumes are measured precisely and within the required range.

Initial/final temperatures are measured precisely.

The range and trend in enthalpies is as expected for the series.

**1 mark:** One of the areas of the task is performed poorly.

Masses or volumes are measured imprecisely or not in the required range **OR**

Temperatures are measured imprecisely **OR**

The range or trend in enthalpies is not as expected for the series.

**0 marks:** At least two of the areas of the task are performed poorly.

Masses or volumes are measured imprecisely or not in the required range.

Temperatures are measured imprecisely.

The range or trend in enthalpies is not as expected for the series.

### Guidance for Teachers and Students

Teachers are expected to exercise professional judgement in assessing the competence of their candidates in following the instructions.

Candidates should have been given guidance in the correct use of equipment and this guidance **can continue during the practical session** for which this PSA forms a part.

If, however, the guidance required is fundamental or frequent, then the student should **not** be awarded 2 marks.

Judgement of 2 marks, 1 mark or 0 marks will depend on whether the candidate has carried out the activity safely, particularly with regard to measuring out and transferring water to the calorimeter and to recording weighings and temperatures to an appropriate precision in addition to safe handling of the spirit burners.

Students should not be judged on their ability to calculate values for enthalpy changes nor on their ability to follow through with a discussion on the trend in enthalpies of combustion found for this series of alcohols. They should be judged on their ability to follow the instructions and to carry out the practical task safely and in a way which leads to the production of valid results to contribute to a class set of data.

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It is important to remember when marking these practical exercises that PSA is about student competence and that for a student to score full marks on this exercise **perfection is neither expected nor required.**