Practical investigation 6.2

The heat of combustion of an alcohol

NAME: **CLASS:**

AIM

To find the heat of combustion of various alcohols.

THEORY

Alcohols are useful fuels. Both methanol and ethanol have been used as substitutes for petrol. In this experiment, the energy released by burning alcohols is used to heat water. Knowing that 4.18 J of energy is required to increase the temperature of 1 g (1 cm^3) of water by 1°C, the amount of energy released by the combustion of 1 mol of the alcohol can be calculated.

MATERIALS

Spirit burner containing methanol, ethanol or propanol
Steel can of capacity greater than 200 cm^3
Thermometer, 0°C to 100°C
250 cm^3 measuring cylinder
Retort stand, bosshead and clamp
Bench mat

SAFETY

Wear safety glasses and a laboratory coat for this experiment.
Methanol, ethanol and propanol are toxic and highly flammable (particularly methanol). Avoid skin contact and do not breathe their vapours.
Do not refill the spirit burners near an open flame.

Refer to Risk Assessment for Practical investigation 6.2.

METHOD

1 Using a retort stand, bosshead and clamp, set up a steel can 3–4 cm above the wick of a spirit burner.

2 Accurately measure 200 cm^3 of water, pour it into the can and record the temperature of the water.
3 Weigh the spirit burner and alcohol. Record the mass and the name of the alcohol used.

4 Light the wick of the spirit burner and allow the flame to heat the water in the can. Stir continuously and monitor the temperature of the water.
5 When the water temperature has increased by about 20°C, extinguish the burner and record the highest temperature reached by the water.
6 Allow the spirit burner to cool and measure its mass. Record this mass.
7 If time allows repeat steps 1–6 using the same spirit burner and alcohol.
8 Repeat steps 1–7 using a different alcohol.

RESULTS

Alcohol 1: _____

Alcohol 2: _____

	Alcohol 1 1st time	Alcohol 1 2nd time	Alcohol 2 1st time	Alcohol 2 2nd time
Initial temperature of water in can (°C) ± °C				
Final temperature of water in can (°C) ± °C				
Initial mass of spirit burner and alcohol (g) ± g				
Final mass of spirit burner and alcohol (g) ± g				
Qualitative observations				

QUESTIONS

No.	Question	Answer
1	Calculate the temperature change of the water in the can for each experiment you performed.	**Alcohol burned** / **Temperature change (°C) ± °C**

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<table>
<tr><th>No.</th><th>Question</th><th>Answer</th></tr>
<tr><td>2</td><td>Calculate the percentage uncertainty in each temperature change you have calculated in question 1.</td><td>
<table>
<tr><th>Alcohol burned</th><th>Percentage uncertainty in temperature change (%)</th></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
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<tr><td>3</td><td>State the percentage uncertainty in the volume of water (and hence the mass of water) in the can.</td><td></td></tr>
<tr><td>4</td><td>Using the formula $q = m \times c \times \Delta T$, where c = 4.18 J g^{-1} $°C^{-1}$, calculate the energy absorbed by the water in the can for each experiment that you performed.</td><td>
<table>
<tr><th>Alcohol burned</th><th>Energy change (J)
± %</th></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
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<tr><td>5</td><td>Using the masses of alcohol burner and alcohol before and after the experiment, calculate the mass of alcohol that was burned in each experiment.</td><td>
<table>
<tr><th>Alcohol burned</th><th>Mass of alcohol burned (g)
± g</th></tr>
<tr><td></td><td></td></tr>
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<table>
<tr><th>No.</th><th>Question</th><th>Answer</th></tr>
<tr><td>6</td><td>Calculate the percentage uncertainty in each mass calculated in question 5.</td><td>
<table>
<tr><th>Alcohol burned</th><th>Percentage uncertainty in mass (%)</th></tr>
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<tr><td>7</td><td>Calculate the amount of alcohol burned in each experiment, together with its percentage uncertainty.</td><td>
<table>
<tr><th>Alcohol burned</th><th>Amount of alcohol burned (mol)</th></tr>
<tr><td></td><td>± %</td></tr>
<tr><td></td><td>± %</td></tr>
<tr><td></td><td>± %</td></tr>
<tr><td></td><td>± %</td></tr>
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<tr><td>8</td><td>Calculate the heat of combustion for the alcohol burned in each experiment, and hence find the average of your repeated experiments.</td><td>
<table>
<tr><th>Alcohol burned</th><th>Heat of combustion (kJ mol^{-1})</th></tr>
<tr><td></td><td>± %</td></tr>
<tr><td></td><td>± %</td></tr>
<tr><td>Average result for
_____</td><td>± %</td></tr>
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<tr><td>Average result for
_____</td><td>± %</td></tr>
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No.	Question	Answer
9	Compare your results to the values for the heat of combustion in your data booklet or other literature sources. Use calculations of percentage difference between the literature values and your results to describe the accuracy of your results. (See chapter 5 of the coursebook.)	
10	Discuss why your results were not the same as the values in the literature.	
11	What changes could be made to the design of this experiment to improve the accuracy of your results?	

CONCLUSION