9.2.P PRACTICALS

3.P6 Identify data sources, choose resources and perform a first-hand investigation to determine and compare heats of combustion of at least three liquid alkanols per gram and per mole

Note to teacher: we only did two alkanols

AIM

To determine the differences in heat energy released when ethanol and 1-propanol is combusted.

HYPOTHESIS

That ethanol has a lower amount of energy released than 1-propanol.

EQUIPMENT

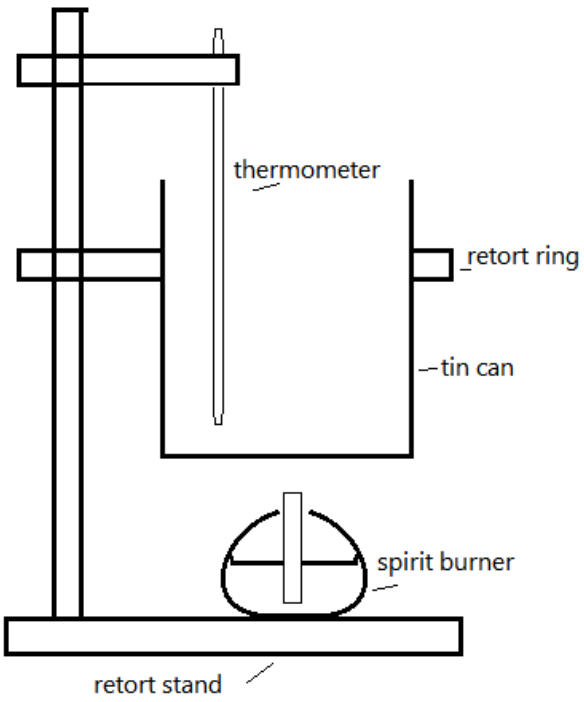
- Tin can
- 100 mL measuring cylinder
- Thermometer
- Spirit burners with ethanol and 1-propanol
- Retort stand and retort ring
- Matches
- Stirring rod

SAFETY

- Ethanol and 1-propanol are highly flammable and toxic, and thus should be lighted correctly and not inhaled.

METHOD

1. Set apparatus as shown on the right.
2. Use the measuring cylinder, add exactly 50 mL to the tin can and measure the initial temperature.
3. Weigh the spirit burner with its liquid content and cap.
4. Light the wick under the tin can and stir water with a stirring rod.
5. Record the thermometer reading after the temperature has risen around 10°C and extinguish flame by placing on the cap.
6. Reweigh the burner and record its final mass.
7. Repeat the experiment for other fuels.
8. Repeat the experiment.



RESULTS

Results for Ethanol

Initial weight of ethanol, spirit burner and cap (g)	95.570
Initial temperature (°C)	20
Final temperature (°C)	36
Final weight of ethanol, spirit burner and cap (g)	95.350

$$\text{Ethanol used} = 95.570 - 95.548 = 0.22\text{g}$$
$$\Delta H = -mC\Delta T$$
$$= -50 \times 4.18 \times (36 - 20)$$
$$= -3344 \text{ j}$$

$$\text{Heat of combustion per gram} = \frac{3344}{0.22} = \mathbf{-15.2\ kJ/g}$$
$$\text{Molar heat of combustion} = (12.01 \times 2 + 1.008 \times 6 + 16) \times -15.2$$
$$= \mathbf{-700.2\ kJ/mol}$$

Results for 1-Propanol

Initial weight of propanol, spirit burner and cap (g)	204.91
Initial temperature (°C)	19
Final temperature (°C)	51
Final weight of propanol, spirit burner and cap (g)	204.58

$$\text{Propanol used} = 204.91 - 204.58 = 0.33\text{g}$$
$$\Delta H = -mC\Delta T$$
$$= -50 \times 4.18 \times (51 - 19)$$
$$= -6688 \text{ j}$$

$$\text{Heat of combustion per gram} = \frac{6688}{0.33} = \mathbf{-20.2666\ kJ/g}$$
$$\text{Molar heat of combustion} = (12.01 \times 3 + 1.008 \times 8 + 16) \times -20.2666$$
$$= \mathbf{-1218\ kJ/mol}$$

DISCUSSION

The results followed a trend. As the molecular weight of the alkanol increases, the amount of heat released from combustion increases. This is because there are more bonds that are broken in longer chains, thus resulting in more energy released.

The results were also relatively different from the true values of molar heat of combustion. Both figures, however, were off by around 40%. This was because the experiment was not very valid. The tin can, although allowing water to absorb the heat more, was also a good conductor for the removal of heat, thus reducing the temperature of the water and the change was not be controlled. The experiment also could have been more accurate by using data loggers to monitor the change in temperature. Additionally, the experiment could have been repeated and compared with other students to ensure reliability.

CONCLUSION

As the molecular weight of alkanol increases, the heat of combustion increases, shown through ethanol and 1-propanol.