Investigating the Heat Of Combustion of Different Alcohols

Introduction
In this experiment I will be testing to see if certain types of alcohol give of more heat combustion than others. A fuel is a material with one type of energy which can be transformed into another sable form. Alcohol is an organic compound in which a hydroxyl group is bound to a carbon atom. Combustion is the reaction between a fuel and oxygen that produces heat (and usually light).

Background Knowledge
The formula for combustion is:

Alcohol + Oxygen $\longrightarrow$ Carbon Dioxide + water + energy

$CH_3OH + O_2 \longrightarrow CO_2 + 2H_2O +$ energy

The energy to make or break a chemical bond is called the bond energy and is quoted in KJ/mol of bonds. We measure heat in degrees Celsius by using a thermometer. Different alcohols have different amounts of carbon bonds. The more carbon bonds, these alcohols have, the more energy is released when they are burnt.

Preliminary Experiment

Aim
I am going to investigate the heat combustion of fuels and use the results to plan an investigation.
The independent variable that I will change will be the type of alcohol.
I will record how much weight is lost in each alcohol to identify how much energy is used.
The alcohols I will use are:Methanol, Ethanol, Propanol, Butanol and Pentanol.

The variables I will keep the same are:
- Volume of alcohol- by using a measuring cylinder
- Volume of water- by using a measuring cylinder and measuring out 50mls of water each time.
- Size of container- by using the same container each time.
- Temp. of water- by using tap water out of the same tap.
- Temperature- by doing it in the same room

I won't time the experiment but I will wait for the water temperature to rise by 20° and then weigh the alcohol

Equipment

- Steel container- to put the water in
- Thermometer- so we can see when the water temperature has risen by 20°
- Spirit burner- To burn the alcohol and see how much weight is lost.
- Measuring cylinder- to always have the same amount of water each time.
- Stand- To hold the water above the spirit burner
- Goggles- to protect my eyes from the alcohol and fire.
- Scales- to measure the weight before and after the experiment.

Prediction

I predict that the more carbon bonds the alcohol has the less energy will be lost. Therefore the less carbon bonds the more energy is lost.
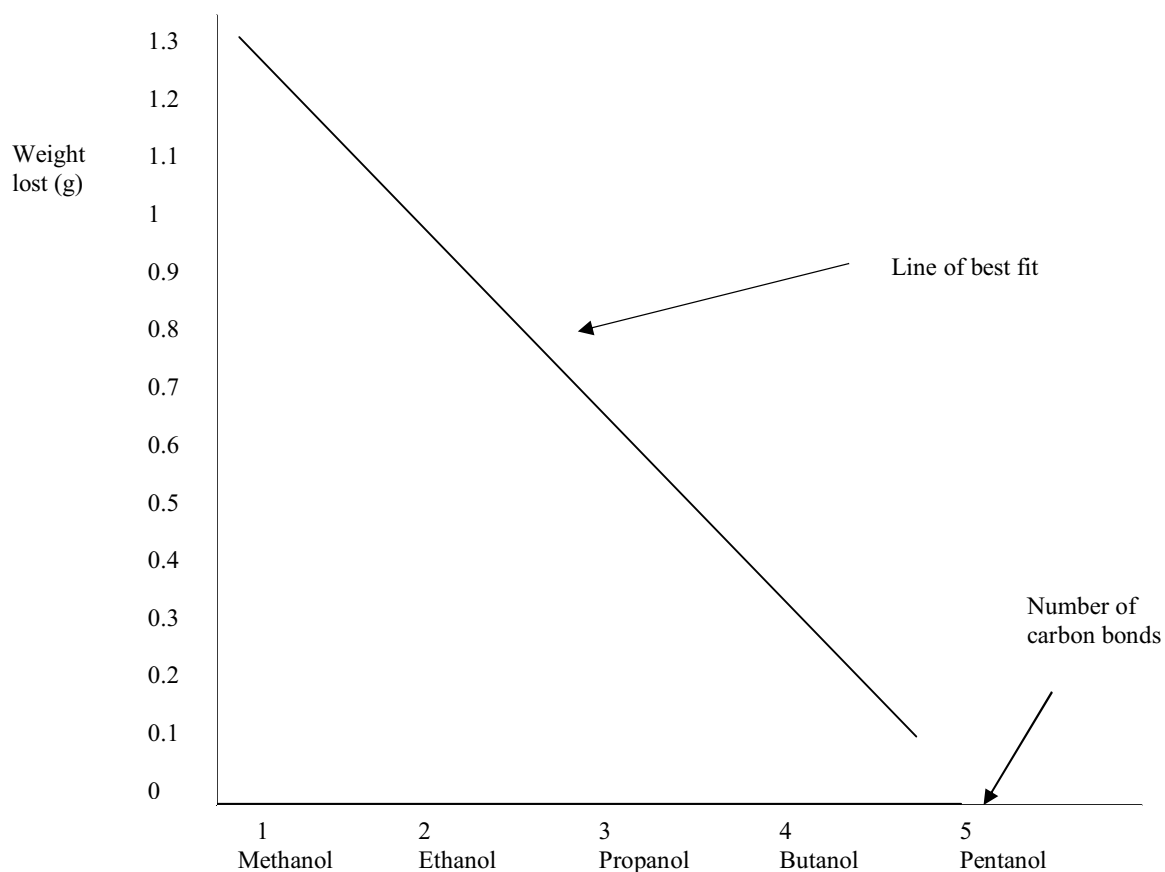
<u>**Results:**</u> **To raise the water temperature from 30° to 50°**

Alcohol	Attempt 1	Attempt 2	Attempt 3	Average
Methanol	1.16g	1.17g	0.5g	0.94g
Ethanol	0.63g	1.42g	1.03g	1.02g
Propanol	0.62g	0.73g	0.7g	0.68g
Butanol	0.52g	0.58g	0.59g	0.56g
Pentanol	0.59g	0.55g	0.62g	0.58g

<u>Conclusion:</u>

I have discovered that the alcohols with more carbon bonds loose less mass.

e.g Butanol = $C_4 H_9 OH$

              Looses less than

 Methanol = $C H_3 OH$

This is good for my actual experiment because it shows that 50mls of water is the right amount of water, but that I lose some energy from the spirit burner.

<u>Actual Experiment</u>

<u>Aim:</u>

I am going to investigate the heat combustion of fuels and use the results to draw graphs. I will see how much weight is lost in each alcohol and use that and the equation: Mass of water x 4.2 x 20 and divide it by the average weight lost to find the energy per gram.

<u>Variables:</u>

The independent variable that I will change will be the type of alcohol. The variables I will keep the same are:

- The volume of water- by using a measuring cylinder to measure out 50mls of water each time. If I don't it could be heated up more quickly or slowly.
- Size of Container- by using the same container each time. If I don't it could affect how quickly the water gets heated.
- Temp. of water- I don't have to keep this the same as long as I always measure the starting temperature and when it rises by 20° blow the spirit burner out.
- Temperature- by doing it in the same room each time. If I changed to a different room the temperature might be hotter or colder and affect the experiment.
- Time- I won't time the experiment but I will heat the water until it rises in temperature by 20° and then weigh the alcohol again.

<u>Equipment:</u>

- Steel container – to put the water in.
- Thermometer – So I can measure the temperature of the water.

- Spirit burner – To burn the alcohol and see how much weight is lost.
- Measuring Cylinder – To always have the same amount of water.
- Stand – To hold the container, with water in, above the spirit burner.
- Goggles – To protect my eyes from the alcohol and from the spirit burner.
- Scales – To measure the weight before and after the experiment.

Fair Test:
I am going to use 5 different alcohols, methanol, ethanol, Propanol, Butanol and Pentanol and measure how much weight they loose when they are burnt. I will repeat this three times and find the average. To make this a fair test I will repeat it three times on each alcohol keeping the amount of water the same. I will also make sure the water temperature rises by 20° in each test.

Method:
To carry out my experiment I will first collect all the equipment needed (see above). I will then set up the stand and measure the correct amount of water in the measuring cylinder and put it in the beaker. I will then get the alcohol that I need and put it under the beaker of water. Then I will light the spirit burner and measure the temperature of the water. When the water temperature has risen by 20^0 I will blow out the burner and weigh it. I will do this three times on each alcohol.

Safety:
I will have to carry out safety precautions like wearing goggles. This will protect my eyes if the water bubbles or if it spits. Other precautions may be: tying back long hair, so it won't catch on fire and to be standing at all times so that it easy to jump back if the experiment goes wrong.

Prediction:
I predict that as the number of carbon bonds increases the energy per gram will increase because when each carbon atom breaks it releases energy there fore a molecule with more carbon atoms will release more energy.

Results:

Alcohol	attempt 1	attempt 2	attempt 3	average	energy per gram
Methanol	1.3g	1.2g	1.2g	1.4g	3000
Ethanol	0.9g	1.7g	1.1g	1.233g	3406
Propanol	0.6g	0.8g	0.5g	0.633g	6635
Butanol	0.6g	0.6g	0.7g	0.633g	6635
Pentanol	0.3g	0.6g	0.5g	0.466g	9012

Graphs:
See figure 1.

Analysis:

This experiment has shown me that if a molecule has more carbon bonds then it has more energy per gram. I have drawn a scatter graph and plotted my results to show how the amount of carbon bonds affected the amount of energy per gram. I chose a scatter graph because there can only be one amount of carbon bonds in each alcohol. The graph shows that the more carbon bonds there are the more energy per gram there is. This confirms my prediction. The graph shows a positive correlation between the number of carbon bonds and the amount of energy per gram. This is because each carbon bond when broken gives off energy and therefore the more carbon bonds you have the more energy per gram you have.

I think that either the results for Butanol or Propanol are incorrect. Butanol has one more carbon bond than Propanol but the results I recorded show that they have the same amount of energy per gram.

Evaluation:

I think my methods of collecting the data were accurate because I collected each alcohol three times and then got an average. My graph is quite accurate apart from Propanol and Butanol which were odd because they were the same energy per gram when Butanol should have been more. I could have improved the accuracy of my experiment by using extra equipment so that I wouldn't lose any energy into the atmosphere. I think that the odd results happened because either the water temperature did not rise by 20^0 or more likely that I used the same alcohol without realising. Overall I think the investigation went well but it could be improved on next time by finding a way to stop the loss of energy.