This laboratory exercise is used to introduce the differences in alkanes by using the more convenient form “alcohol”. By placing an –OH on each alkane, we raise the boiling point so the students can use liquids instead of gases and combust them in relative safety.

The assignment was used with senior secondary school students to provide a vehicle for out-of-class research and interpretation of results in meaningful ways that relate to practical societal issues. They are led from a theoretical consideration of heats of combustion to understanding characteristics of an effective fuel.

Data for various alcohols are given below, but it should be the responsibility of the students to find Literature Values for each alcohol that they use.

[NOTE: Safety requirements are NOT discussed in this document. Safe practice is the sole responsibility of the person using these instructions.]

EXPERIMENT: To establish a relation between the molecular structure and the heats of combustion of a series of alcohols.

PROCEDURE:

1. Use the apparatus consisting of two nested cans and an alcohol lamp.
2. Find the mass of the lamp containing the alcohol.
3. Place a 125 mL sample of cold water in the small can and record the temperature. (the colder the better)
4. Light the lamp and **immediately** place it under the can of cold water.
5. Heat the water to about 80^{o}C (or until you are confident that a significant amount of alcohol has been burned.
6. Note the colour of the flame.
7. When the flame is put out, find the mass of the lamp.
8. Repeat the procedure for the other alcohols in the series.

INTERPRETATIONS:

1. From the differences in masses of the lamps before and after burning, calculate the mass (then the # of moles) of alcohol burned.

2. From the temperature difference of the water, calculate the number of joules of heat released per mole of alcohol burned.

3. From the ΔH_{rx} calculated in #2, and from data in your text, calculate the Enthalpy of Formation of each alcohol.

4. Calculate the experimental error involved in the final answer (of course!), and analyse the experiment for shortcomings in the method and their effects on your final values.

5. Using data from the Handbook of Chemistry and Physics , or NIST webbook and your experimental data, plot a graph of ΔH_{rx} or ΔH_{comb} vs # of Carbon atoms in each molecule. (Or use any other relationship that might be revealing...like the # of covalent bonds in the molecule). Use this to comment on the relation:
   (a) between your experimental and literature values.
   (b) between ΔH and the molecules in the series.

6. Consider which of the alcohols might make the best fuel ....on a kJ/kg basis, or on any other basis that might seem appropriate.

ASSIGNMENT:

Write a formal lab report including the above points of interpretation and any others you feel would prove interesting or revealing. If you have done the experiment with other students, DO NOT submit identical interpretations or discussion. DO feel free to analyse the data in a creative way. Originality in approach is prized (Nobel-ly) in science!

DUE DATE: The report must be submitted no later than one week from the completion of the experiment. (Note: early submissions are welcome!)

EXPERIMENT: COMBUSTION OF ALCOHOLS

DATA FROM http://webbook.nist.gov/chemistry/name-ser.html

[All values are in **kJ/mole**]

ALCOHOL	**HEAT OF COMBUSTION**	**HEAT OF VAPORIZATION**	**HEAT OF FORMATION**
Methyl	-725	+37	-237
Ethyl	-1368	+42	-277
Propyl	-2021	+47	-304
Butyl	-2670	+51	-328
Pentyl	-3330	+56	-358
Hexyl	-3978	+62	-384
Heptyl	-4638	+67	-404
Octyl	-5290	+71	-428
Nonyl	-5945	+77	-459
Decyl	-6601	+81	-480

Denatured Ethyl -1271 (For 15% Methyl & 85% Ethyl)

ALKANE	**HEAT OF COMBUSTION**		
Methane	-880	Hexane	-4100
Ethane	-1540	Heptane	-4800
Propane	-2200	Octane	-5450
Butane	-2600	Nonane	-5650
Pentane	-3500	Decane	-6700