



Applecross Senior High School

AECHE 2017

Enthalpy Changes and Combustion of Fuels Investigation Validation Test

Name: Solutions

Mark: _____/26 = _____%

Time Allowed: 55 minutes

Formulae and Data

$$\Delta H = mc\Delta T$$

$$n = \frac{m}{M}$$

$$c_{\text{water}} = \text{Specific heat of water} = 4.18 \text{ Jg}^{-1}\text{K}^{-1}$$

Show all working in your calculations

Background Information

A group of students performed an investigation to find the enthalpy change during the combustion of two fuels - hexane and ethanol. Their table of results is shown below:

Fuel Used	Initial temp/°C	Final temp/°C	Volume of water in conical flask	Initial mass of burner/g	Final mass of burner/g
Hexane	14°C	94°C	150 mL	37.77 g	36.62 g
Methanol	15°C	74°C	150 mL	37.25 g	35.50

1. Identify the **independent variable** for the investigation.

The fuel type

[1 mark]

2. Identify the **dependent variable** for the investigation

The rise in temperature of 150mL of water

(or) the mass of fuel used.

[1 mark]

3. State clearly two variables that should be **controlled** in this investigation.

Variable 1 Volume of water (150mL)
Water type (distilled) change in temperature.

Burning time
Variable 2 Material for flask (glass?)
Distance of burner to bottom of flask.

any 2

[2 marks]

4(a) Calculate the change in enthalpy (ΔH) for the combustion for Hexane (C_6H_{14}).

[Assume that 1.00g of water = 1mL of water]

$$1 \text{ mL of water} = 1.00 \text{ g} \rightarrow 150 \text{ mL} \rightarrow 150 \text{ g} \quad (1)$$

$$\Delta T = 94 - 14 = 80^\circ \text{C} \quad (1)$$

$$\Delta H = mc\Delta T = 150 \times 4.18 \times 80 = 50160 \text{ J} = 5.02 \times 10^4 \text{ J} \quad (1)$$

$$\text{or } \Delta H = 50.16 \text{ kJ}$$

[4 marks]

(b) Calculate the change of enthalpy per mole of Hexane (C_6H_{14}).

$$m(C_6H_{14}) = 37.77 - 36.62 = 1.15 \text{ g} \quad (1)$$

$$M(C_6H_{14}) = (12.01 \times 6) + (1.008 \times 14) = 86.172 \quad (1)$$

$$n_{C_6H_{14}} = \frac{m}{M} = \frac{1.15}{86.172} = 0.013345 \text{ mol}$$

$$\Delta H/\text{mol} = \frac{50.16}{0.013345} = 3759 \text{ kJ/mol} \quad (1)$$

$$\text{(or)} = 3.76 \times 10^6 \text{ J mol}^{-1}$$

[3 marks]

5(a) Calculate the change in enthalpy (ΔH) for the combustion for Methanol (CH_3OH).

[Assume that 1.00g of water = 1mL of water]

$$m_{H_2O} = 150 \text{ g}$$

$$\Delta T = 74 - 15 = 59^\circ \text{C} \quad (1)$$

$$\Delta H = mc\Delta T$$

$$= 150 \times 4.18 \times 59 \quad (1)$$

$$= 36993 \text{ J}$$

$$= 3.70 \times 10^4 \text{ J} \quad (1)$$

$$\text{or } = 37.0 \text{ kJ}$$

[3 marks]

(b) Calculate the change of enthalpy per mole of Methanol (CH_3OH).

$$m_{\text{CH}_3\text{OH}} = 37.25 - 35.50 = 1.75 \text{ g}$$

$$M_{\text{CH}_3\text{OH}} = 12.01 + (4 \times 1.008) + 16.0 = 32.042 \text{ g mol}^{-1} \quad (1)$$

$$n = \frac{m}{M}$$

$$= \frac{1.75}{32.042}$$

$$= 5.462 \times 10^{-2} \text{ mol.} \quad (1)$$

$$\frac{\Delta H}{\text{mol}} = \frac{36993}{5.462 \times 10^{-2}} = 6.77 \times 10^5 \text{ J mol}^{-1} \quad (1) \quad \text{or} \quad 6.77 \times 10^2 \text{ KJ mol}^{-1}$$

6. The theoretical values for the change in enthalpy of combustion of substances are often significantly different than the values obtained in investigations carried out in the school laboratory.

(a) Discuss in terms of validity, two reasons why these values differ from the theoretical values.

[2 marks]

The variables other than the independent and dependent variables have not been controlled. Loss of energy through convection in air, conduction of glass, incomplete combustion, size of flame, size of wick, evaporation of water.

(b) Outline a possible step that could be taken to reduce each error. * any 2 reasonable reasons

[2 marks]

- ① seal the water container
 - ② ensure sufficient O_2 supply
 - ③ control wick / flame size
 - ④ reduce ΔT to limit evaporation rate
- * any 2 reasonable steps.

(c) Comment of the reliability of this experiment.

[2 marks]

reliability is increased by completing more trials - this experiment only had 1 trial for each fuel, so it was not very reliable (results were not reliable).

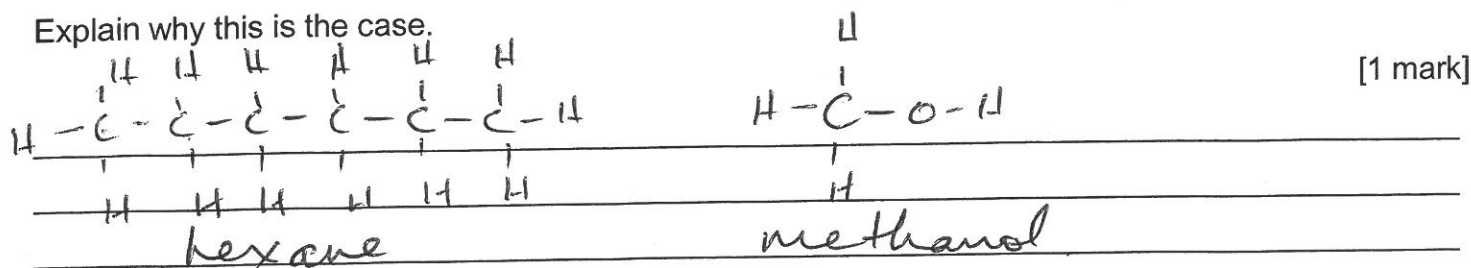
7. Are these reactions exothermic or endothermic. Explain your answer.

[2 marks]

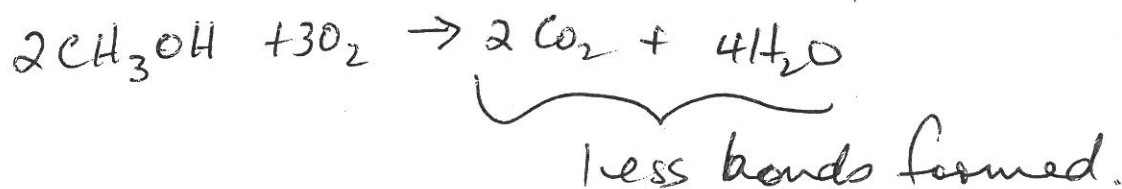
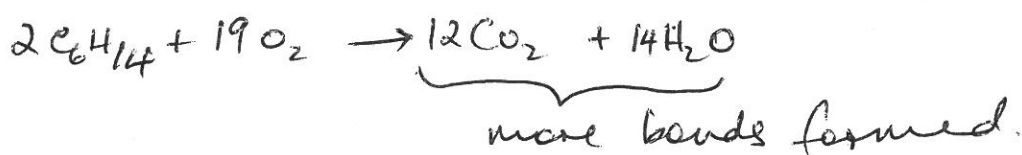
exothermic - heat energy was released
(1) (1)

8. The heat of combustion per mole of hexane is more than twice than that of methanol.

Explain why this is the case.



Hexane has many more atoms than methanol and can therefore form many more bonds. the hexane system will release more enthalpy than methanol.



→ 1 mark for discussing the number of bonds.
the more bonds ^{formed} results in more enthalpy released.