Efficiency of Combustion

Assessment Type	**MYP Criterion Level**
Inquiring, designing, processing, and evaluating scientific investigations	MYP 5

MYP Assessment Criteria	**MYP Command Terms Used**
Criterion B: Inquiring and designing Criterion C: Processing and evaluating	describe, outline, explain, design, select, collect, organize, transform, present, interpret, discuss

MYP Global Context

Scientific and Technical Innovation: Industrialization

MYP Key Concept(s)	**MYP Related Concept(s)**
Relationships	Energy, Consequences

MYP Branch of Science

Chemistry

MYP Topics and Skills

- Scientific writing
- Designing logical and safe methods
- Analyzing data
- Evaluating methodologies

Prior Knowledge Needed

- Experimental calorimetry
- Homologous series; alcohols
- Energy changes related to making and breaking bonds
- Complete and incomplete combustion
- $Q = mc\Delta T$

Assessment Description

In this assessment, students inquire and design a scientific investigation looking into how the chain length of alcohol affects the energy released during combustion. Students then complete the experiment based on the method they have planned and collect, process, and evaluate the data and methodology to produce a written report.

Materials Needed

- Lab report template, if needed, particularly for learning support students.
- Practical equipment list and experimental recommendations can be found in the task specific instructions.

Task-specific instructions / Recommendations

- A formative assessment using calorimetry energy change using ammonium chloride.
- It is recommended that students work in pairs for this experiment, but an individual written report should be produced.
- The Criterion B report could be submitted before beginning the C or done as one project.
- Various scaffolded lab report templates are available in the support documents if needed.
- Alternative experiments suggested in the teacher guidance section.
- An extension to this task can be done using enthalpy kJ mol^{-1} moles.

Inquiry Statement
In understanding the **relationship** between matter and **energy**, chemists explain the **consequences** of **industrialization**.

ATL Skill(s):	Critical Thinking
Key Concept(s):	Relationships
Related Concept(s):	Energy, Consequences
Global Context and **Exploration:**	Science and Technical Innovation: Industrialization

(**G**)oal	The goal is to **investigate** the relationship between matter and energy using the concepts of the carbon chain length of an alcohol and the energy produced in combustion.
(**R**)ole	You are a graduate chemist, working in the purchasing department for a large hiking and camping chain store "Camp-tivating Supplies".
(**A**)udience	Your audience is the Vice President of Purchasing for the company, Trey L. Blaiser.
(**S**)ituation	With your chemistry background, Mr. Blaiser has tasked you to investigate the most energy efficient, liquid alcohol for your company to purchase for selling in their stores. In order to do this, you must investigate the energy per gram produced (kJ g^{-1}) during combustion of different alcohols (based on carbon chain length).
(**P**)roduct	**Design** an appropriate experiment to demonstrate the relationship between carbon chain length and enthalpy of combustion. You will **collect**, **analyse** and **evaluate** the data and produce a lab report that demonstrates this relationship.
(**S**)tandards	Your performance needs to meet all of the MYP 5, Criteria B and C.

Possible choices for Independent Variable	Possible choices for Dependent Variable
• Carbon chain length of alcohol (selection from 1-8)	• Energy per gram of fuel (kJ g^{-1}) • **Extension**: Enthalpy of fuel (kJ mol^{-1})

Alcohol Available for Experiment	
Name	**Number of Carbons**
Methanol	1
Ethanol	2
Propan-1-ol	3
Butan-1-ol	4
Pentan-1-ol	5
Hexan-1-ol	6
Heptan-1-ol	7
Octan-1-ol	8

***Edit as needed depending on availability*

Useful Equations

Calculate energy produced during combustion:

$$\boldsymbol{Q = mc\Delta T}$$

Q = heat energy produced during combustion (in J)
m = mass of substance (water) being heated (in g)
c = specific heat capacity of water (4.18 J g^{-1} °C^{-1})
ΔT = temperature change of the water (°C)

Calculate energy per gram of combustion the fuel (kJ g^{-1}):

$$\boldsymbol{Energy = \frac{(Q \div 1000)}{\Delta m}}$$

Q = heat energy produced during combustion (in J)
$\boldsymbol{\Delta m}$ = change in mass of fuel (used during combustion) (g)

Extension: Calculate enthalpy (Δ*H*) of combustion of the fuel (kJ mol^{-1}):

$$\boldsymbol{\Delta H = \frac{(Q \div 1000)}{n}}$$

$\boldsymbol{n}$ = moles of fuel used during combustion calculated using the following equation

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

$\boldsymbol{\Delta m}$ = change in mass of fuel (used during combustion) (g)
M = Molar mass (g mol^{-1})