

SI Environmental Science - Full Discipline Demo

Energy Comparison of Fuels

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Environmental Science - Full Discipline Demo
Course	SI Environmental Science - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Categorize each fuel as a fossil fuel or biofuel.

	Fossil Fuel	Biofuel
⌵ Coal	1	2
⌵ Ethanol		
⌵ Natural gas		
⌵ Wood		
⌵ Crude oil		
⌵ Biodiesel		

Correct answers:

1 Coal Natural gas Crude oil

2 Ethanol Wood Biodiesel

Match each term to the best description.

⚡ Calorie	Molecule consisting of only carbon and hydrogen atoms with single bonds between all carbon atoms	1
⚡ Joule		
⚡ Saturated hydrocarbon	Molecule consisting of only carbon and hydrogen atoms with at least one double or triple bond between carbon atoms	2
⚡ Unsaturated hydrocarbon		
⚡ Combustion	The SI unit of energy	3
	The amount of heat energy required to raise the temperature of one gram of water by one degree Celsius	4
	The reaction between fuel molecules and oxygen to yield heat energy	5

Correct answers:

- 1 Saturated hydrocarbon 2 Unsaturated hydrocarbon 3 Joule
4 Calorie 5 Combustion

Exploration

During a combustion reaction, fuel reacts with ____ to produce heat.

- ☐ carbon dioxide
- ☒ oxygen
- ☐ water
- ☐ methane



Biofuel sources include ____.

- ☐ natural gas
- ☐ crude oil
- ☐ coal
- ☒ grains



Shorter chain saturated hydrocarbon molecules release more energy during combustion than longer chain saturated hydrocarbon molecules.

- ☐ True
- ☒ False



Exercise 1

Which fuel was more efficient (produced more calories per gram)? Reference your results recorded in Data Table 3 in your answer.

The candle was more energy efficient when compared to isopropanol, generating 4,414 cal/g compared to 1,421 cal/g for isopropanol as recorded in Data Table 3.

How are the molecular structures of isopropanol and paraffin related to their energy efficiencies? Reference your results recorded in Data Table 3 in your answer.

The paraffin molecule is a long chain, saturated hydrocarbon containing 20-40 carbon atoms, compared to isopropanol which is an alcohol containing only 3 carbon atoms. Long chain, saturated hydrocarbons release more energy when burned than other types of molecules as is supported by the efficiencies of paraffin (4,414 cal/g) and isopropanol (1,421 cal/g) recorded in Data Table 3.

Were the fuels burned in this exercise fossil fuels or biofuels? Include the definitions of fossil fuels and biofuels in your explanation.

Both paraffin and isopropanol are fossil fuels. Fossil fuels are derived from the decomposed remains of organisms that lived millions of years ago and are not considered to be renewable energy sources. Biofuels are derived from recently-living organisms and are considered renewable energy resources.

Data Table 1: Mass and Density of Distilled Water
(SAMPLE ANSWER BELOW)

Mass of 10 mL of Distilled Water (g)	Density of Water (g/mL)	Temperature of Water (°C)
9.81	0.981	20.0

Data Table 2: Fuel Mass and Water Temperature
(SAMPLE ANSWER BELOW)

Fuel source	Initial mass (g)	Final mass (g)	Initial water temperature (°C)	Final water temperature (°C)
Fuel canister (70% Isopropanol)	43.60	42.84	19.0	30.0
Tea candle (Paraffin)	17.03	16.83	19.0	28.0

Data Table 3: Calories Released per Gram of Fuel
(SAMPLE ANSWER BELOW)

Fuel source	ΔT (°C)	Calories absorbed by water (cal)	Grams of fuel consumed (g)	Calories/G
Fuel canister (70% Isopropanol)	11.0	1080	0.76	1420
Tea candle (Paraffin)	9.0	882	0.2	4414

Competency Review

Combustion reactions between fuel and oxygen produce ____.

- ☐ carbon dioxide
- ☐ water
- ☐ heat
- ☒ All of the above



Biofuels are synthesized from grains, plant oils, and marine algae.

- ☒ True ✓
- ☐ False

A ____ is the amount of heat energy required to raise the temperature of one gram of water by one degree Celsius.

- ☐ joule
- ☒ calorie ✓
- ☐ kilojoule
- ☐ kilocalorie

Hydrocarbon molecules contain one or more oxygen atoms.

- ☐ True
- ☒ False ✓

A(n) ____ hydrocarbon contains only single bonds.

- ☒ saturated ✓
- ☐ primary
- ☐ unsaturated
- ☐ secondary

Saturated hydrocarbons release more energy per molecule of fuel than unsaturated hydrocarbons for molecules of equal chain lengths.

- ☒ True ✓
- ☐ False

A 10.0 mL volume of water has a mass of 9.90 g. The density of the water is ____ g/mL.

- ☐ 1.00
- ☒ 0.990
- ☐ 9.10
- ☐ 10

✓

1.0 g of fuel was burned for 5 minutes increasing the temperature of 10 g of water with a density of 1 g/mL by 9°C. Assuming all heat was captured by the water, the fuel released ____ cal.

Note: $Q = \Delta T \times m \times c_p$

- ☐ 19
- ☒ 90
- ☐ 450
- ☐ 900

✓

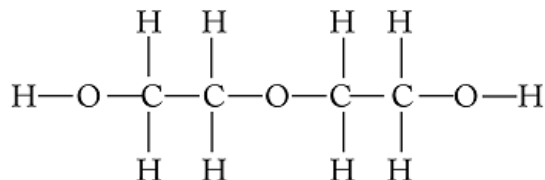
Paraffin wax is a more efficient fuel source than isopropanol.

- ☒ True
- ☐ False

✓

Extension Questions

Diethylene glycol ($C_4H_{10}O_3$) is an organic compound used as a fuel in heating cans. The molecular structure of diethylene is provided below. Apply your knowledge of energy efficiency (cal/g) based on molecular structure to predict the efficiency of diethylene compared the isopropanol and paraffin wax tested in the preceding laboratory exercise.



(SAMPLE ANSWER BELOW)

Diethylene glycol would be predicted to be more energy efficient than isopropanol because the diethylene glycol molecule is both longer and has more carbon bonds than the isopropanol molecule. Conversely, diethylene glycol would be predicted to be less energy efficient than paraffin

wax because a paraffin molecule is significantly longer with more carbon bonds than a diethylene glycol molecule.