

Name of the Student: _____

Max. Marks : 19 Marks

Time : 19 Minutes

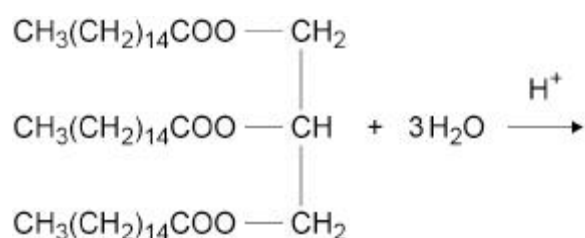
Q1.

This question is about biofuels.

Palmitic acid, $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$, can be made by hydrolysis of the triester in palm oil under acidic conditions.

Palmitic acid can be used as a biofuel.

- (a) Complete the equation for the hydrolysis of the triester in palm oil under acidic conditions.



(2)

- (b) Palmitic acid burns in air.

In a calorimetry experiment, combustion of 387 mg of palmitic acid increases the temperature of 0.150 kg of water from 23.9 °C to 37.5 °C

Calculate a value, in kJ mol^{-1} , for the enthalpy of combustion of palmitic acid in this experiment. Give your answer to the appropriate number of significant figures.The specific heat capacity of water is $4.18 \text{ J K}^{-1} \text{ g}^{-1}$ Enthalpy of combustion _____ kJ mol^{-1}

(5)

- (c) State how the value calculated in part (b) is likely to differ from data book values.

Give one reason, other than heat loss, for this difference.

Difference _____

Reason _____

(2)

- (d) A sample of a different biofuel, made from sewage sludge, is found to contain 37.08% carbon, 5.15% hydrogen and 24.72% oxygen by mass. The rest of the sample is sulfur.

Calculate the empirical formula of this biofuel.

Empirical formula _____

(3)

- (e) Complete combustion of the biofuel made from sewage sludge produces the greenhouse gas carbon dioxide.

Suggest **one** other possible environmental problem with the complete combustion of this biofuel.

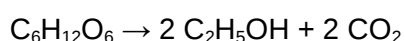
State the formula of the pollutant responsible for this problem.

Environmental problem _____

Formula _____

(2)

- (f) Ethanol is a biofuel that can be produced by the fermentation of glucose.



Glucose has the structural formula shown.

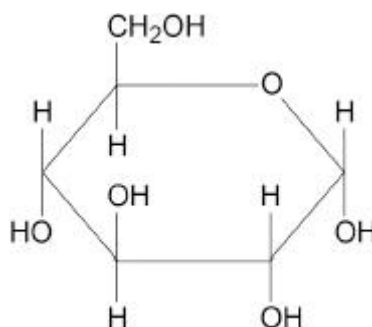


Table 1 shows some mean bond enthalpy values.

Table 1

	C-H	C-C	C-O	C=O	O-H
Mean bond enthalpy / kJ mol^{-1}	412	348	360	805	463

Use the equation and the data in **Table 1** to calculate an approximate value of ΔH for the fermentation of glucose. For this calculation you should assume that all the substances are in the gaseous state.

ΔH _____ kJ mol^{-1}
(3)

- (g) The carbon dioxide produced from fermentation can be reacted with steam to make more ethanol.

The equation for this reaction is

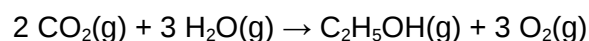


Table 2 shows some standard enthalpies of formation.

Table 2

	$\text{CO}_2(\text{g})$	$\text{O}_2(\text{g})$	$\text{C}_2\text{H}_5\text{OH}(\text{g})$	$\text{H}_2\text{O}(\text{g})$
$\Delta_f H^\ominus / \text{kJ mol}^{-1}$	-394	0	-235	-242

Use the data in **Table 2** to calculate a standard enthalpy change value for this reaction.

Standard enthalpy change _____ kJ mol^{-1}
(2)
(Total 19 marks)