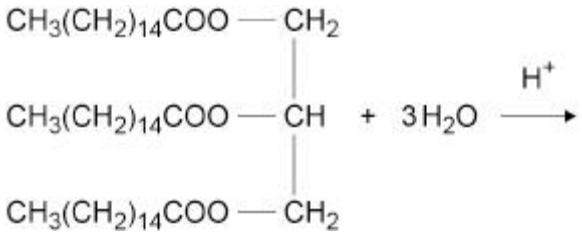
Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Q1.

This question is about biofuels.

Palmitic acid, $CH_3(CH_2)_{14}COOH$, 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 J K^{-1} 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.

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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.

$$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$$

Glucose has the structural formula shown.

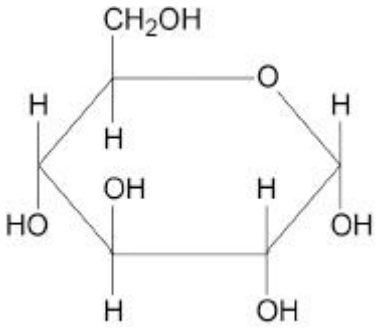


Table 1 shows some mean bond enthalpy values.

Table 1

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	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 Δ*H* for the fermentation of glucose. For this calculation you should assume that all the substances are in the gaseous state.

Δ*H* _____ 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

$$2\ CO_2(g) + 3\ H_2O(g) \rightarrow C_2H_5OH(g) + 3\ O_2(g)$$

Table 2 shows some standard enthalpies of formation.

Table 2

	$CO_2(g)$	$O_2(g)$	$C_2H_5OH(g)$	$H_2O(g)$
$\Delta f H^{\ominus}$ / 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)

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