

Name of the Student: \_\_\_\_\_

Max. Marks : 19 Marks

Time : 19 Minutes

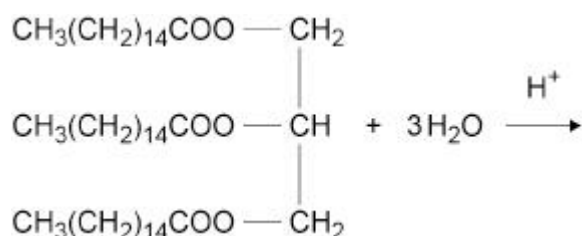
Q1.

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  $\text{kJ mol}^{-1}$ , 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 \_\_\_\_\_  $\text{kJ mol}^{-1}$ 

(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.

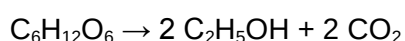
Environmental problem \_\_\_\_\_

\_\_\_\_\_

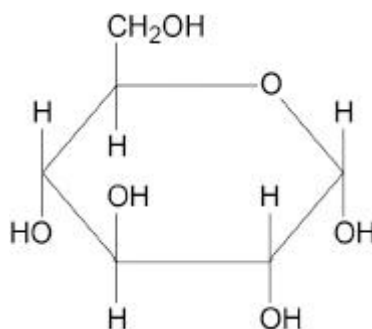
Formula \_\_\_\_\_

(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**

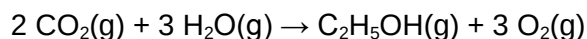
|                                              | C-H | C-C | C-O | C=O | O-H |
|----------------------------------------------|-----|-----|-----|-----|-----|
| Mean bond enthalpy /<br>kJ mol <sup>-1</sup> | 412 | 348 | 360 | 805 | 463 |

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

$\Delta H$  \_\_\_\_\_ kJ mol<sup>-1</sup>  
(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**

|                                             | CO <sub>2</sub> (g) | O <sub>2</sub> (g) | C <sub>2</sub> H <sub>5</sub> OH(g) | H <sub>2</sub> O(g) |
|---------------------------------------------|---------------------|--------------------|-------------------------------------|---------------------|
| $\Delta_f H^\ominus$ / kJ mol <sup>-1</sup> | -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<sup>-1</sup>  
(2)  
(Total 19 marks)