

James Ruse Agricultural High School

Student Number.....

Theory Mark .....

Data Processing Mark.....

*Theory and Data  
Processing*

# Chemistry Assessment Task 1 Term 4 2009

## General Instructions

- **Reading Time:** 5 minutes
- **Working Time:** 85 minutes
- **Complete both Theory and Data Processing in the time, 85 minutes.**
- Write using black or blue pen
- Board approved calculators may be used
- Write your Student Number at the top of this page
- A Periodic Table and Data Sheet are attached to the back of the paper

**Total Marks 50**

## Part A

### Multiple Choice: 5 marks Attempt Questions 1-5

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

**Sample:**  $2 + 4 =$  (A) 2 (B) 6 (C) 8 (D) 9  
A  B  C  D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A  B  C  D

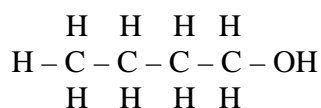
If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.

A  B  C  D   
*correct* ↙

▶ **Mark your answers for Questions 1 – 5 in the Answer Box on page 8**

## Theory Paper - 20 marks

1. What is the IUPAC name for the following alkanol?



- (A) propanol  
(B) 1-propanol  
(C) butanol  
(D) 1-butanol

2. The following represents the catalytic cracking of a hydrocarbon.



Which of the following correctly identifies a product of this reaction and the homologous series to which it belongs?

- (A) octane          alkanes  
(B) octene          alkenes  
(C) ethane          alkanes  
(D) decane          alkanes

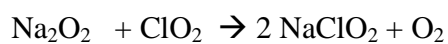
3. Which process could be used to describe the conversion of ethylene to ethanol?

- (A) combustion  
(B) addition  
(C) dehydration  
(D) fermentation

4. Which of the following is a major component of biomass?

- (A) Ethene
- (B) Cellulose
- (C) Ethanol
- (D) Natural gas

5. Given the following reaction:



Which of the following choices correctly describes the reactants and products of the reaction?

	<i>oxidant</i>	<i>reductant</i>	<i>reduced product</i>	<i>oxidised product</i>
(A)	$\text{ClO}_2$	$\text{Na}_2\text{O}_2$	$\text{NaClO}_2$	$\text{O}_2$
(B)	$\text{Na}_2\text{O}_2$	$\text{ClO}_2$	$\text{O}_2$	$\text{NaClO}_2$
(C)	$\text{Na}_2\text{O}_2$	$\text{ClO}_2$	$\text{NaClO}_2$	$\text{O}_2$
(D)	$\text{NaClO}_2$	$\text{O}_2$	$\text{ClO}_2$	$\text{Na}_2\text{O}_2$

Student No. ....

**Part A: Answer grid for multiple choice questions**

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| 2. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 3. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 4. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 5. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |

**Part B : Extended Response Questions (15 Marks)**

Question 6 (4 marks)

During your study of Production of Materials you performed a first hand investigation to compare the reactivities of an alkane and an alkene.

Describe the experiment you performed and explain the results of your investigation.

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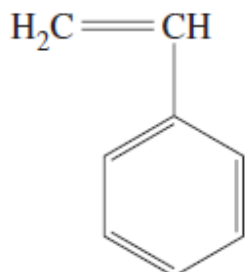
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**Question 7 (5 marks)**

Below is the structure of a commercially significant monomer



- (a) Identify the common name of this monomer. (1 mark)

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- (b) Describe one use of the polymer made from this monomer in terms of its properties. (3 marks)

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- (c) Draw the structure of the polymer made from the above monomer. Use three monomers to show this structure. (1 mark)

**Question 8 (5 marks)**

The syllabus required you to study the structure and chemistry of either the lead acid cell or the dry cell. It also required you to be able to compare one of these cells with another one from a list: (*button cell, fuel cell, vanadium redox cell, lithium cell and the Gratzel cell*)

Choose one of these cells and compare it with the lead acid battery or the dry cell and evaluate them in terms of their chemistry and environmental impact.

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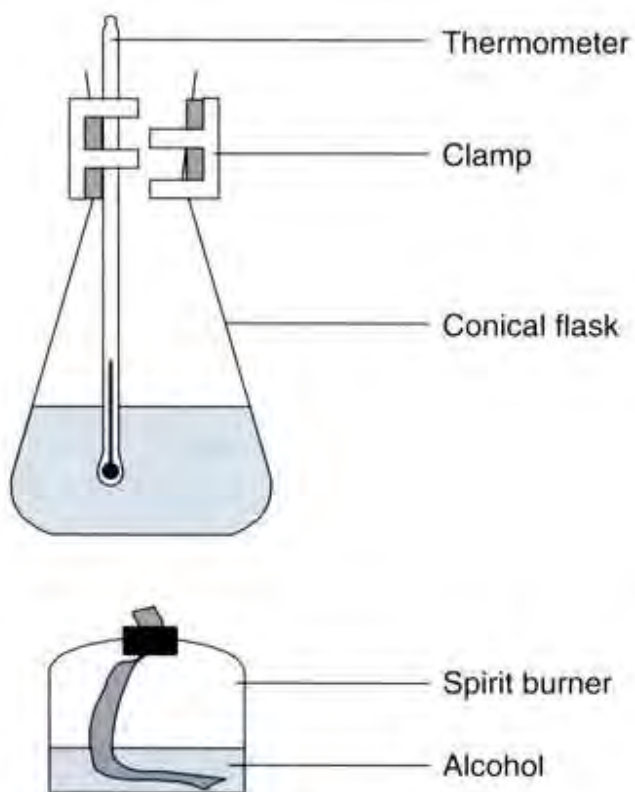
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## *Data Processing Paper - 30 marks*

### **Question 1 20 marks**

Aim: To determine and compare the heats of combustion of three liquid alkanols per gram and per mole.

Method:



Methanol, ethanol and 1-propanol were burned in separate spirit burners and used to heat a container of water. The volume of water heated by each alkanol was 100.0 ml.



(a) Complete the results table below. (1 mark)

Alkanol burning	Methanol	Ethanol	1-propanol
Initial mass of burner (g)	250.0	250.0	250.0
Final mass of burner (g)	248.8	249.1	249.0
Mass of alkanol burnt (g)			
Initial temperature of water (°C)	23	23	23
Final temperature of water (°C)	36	36	36
Rise in temperature of water (°C)			
Mass of water heated (g)	100	100	100

(b) Complete the calculations table below (5 marks)

Name of alkanol used	methanol	ethanol	1-propanol
Heat released by burning fuel in experiment (J)			
Heat released by burning 1 g of fuel (J)			
Molecular formula of the fuel			
Molar mass of fuel (g)			
Heat released by burning the molar mass of fuel ( $\text{kJ mol}^{-1}$ )			

(c) Which fuel releases the most heat (i) per gram .....

(ii) per mole burned?.....

(1 mark)

(d) Assuming complete combustion, write an equation for the combustion of 1-propanol, including the enthalpy value as determined in (b). (2 marks)

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(e) Explain why your calculated values are well below the value given in data books (2 marks)

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(f) If the data value for the molar heat of combustion for petrol (assume this consists of octane) is  $5460 \text{ kJ mol}^{-1}$  and for ethanol is  $1370 \text{ kJ mol}^{-1}$ , which fuel would release the most energy per kg of fuel? Show all working (2 marks)

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(g) Which of the fuels in (f) requires more oxygen for complete combustion? Show the equations for each fuel in your answer. (2 marks)

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- (h) Explain with reference to your answer to question (f) & (g) whether these are advantages or disadvantages for using ethanol as an alternative car fuel. (4 marks)

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**Question 2 (4 marks)**

A student studying the mass change that occurs during fermentation added glucose, water and yeast to a flask and stoppered the flask with some cotton wool.

The student measured the mass of the flask daily for seven days. The table shows the data collected.

Day	Mass(g)
1	381.05
2	376.96
3	373.42
4	370.44
5	370.42
6	370.40
7	370.39

- (a) Calculate the total moles of CO<sub>2</sub> released from day 1 to day 7. (1 mark)

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- (b) Calculate the mass of glucose that underwent fermentation between days 1 and 7. Include a balanced chemical equation in your answer. (3 marks)

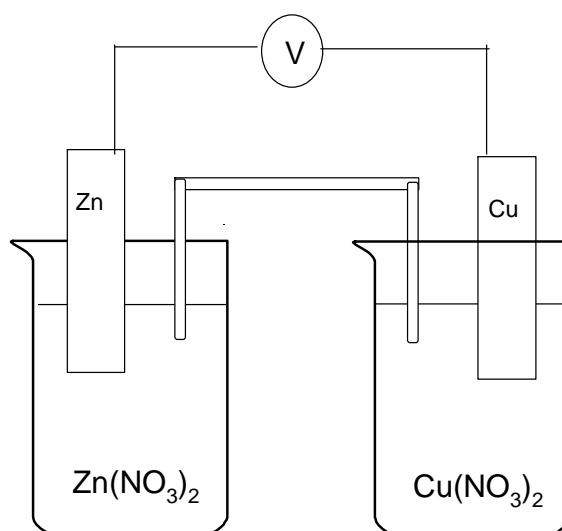
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**Question 3 (6 marks)**

A group of students wanted to study the effect of concentration and temperature on the potential of a galvanic cell consisting of copper ions/copper electrode and zinc ions and zinc electrode:  
The set-up they used is shown below:



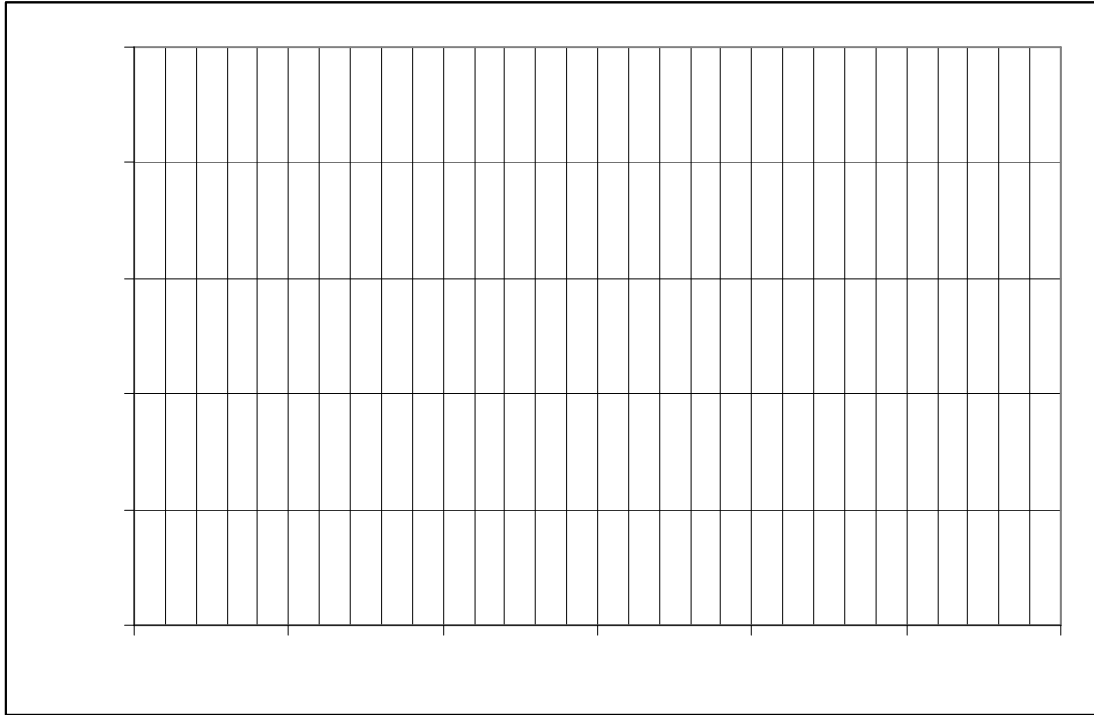
Two experiments were performed.

**Experiment 1.** Keeping the temperature and the  $[Zn^{2+}]$  constant, the students measured the potential of the cell at various  $Cu^{2+}$  concentrations.

**Experiment 2.** The concentration of the  $Cu^{2+}$  ion and the  $Zn^{2+}$  were kept constant and the change in potential was monitored with the change in temperature. The result of both experiments are given in the table below:

<i>Experiment</i>	<i>molL<sup>-1</sup> Zn<sup>2+</sup></i>	<i>molL<sup>-1</sup> Cu<sup>2+</sup></i>	<i>Temperature (°C)</i>	<i>Cell voltage (V)</i>
1	0.01	0.001	25	1.07
1	0.01	0.010	25	1.10
1	0.01	0.100	25	1.13
1	0.01	1.00	25	1.17
2	$10^{-5}$	0.1	5	1.21
2	$10^{-5}$	0.1	25	1.22
2	$10^{-5}$	0.1	50	1.23

- (a) Use the grid below to graph the temperature and voltages in **Experiment 2** . Label your graph. (3 marks)



- (b) Identify the trend in cell voltages measured in Experiment 2. (1 mark)

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- (c) Use the results of Experiment 1 to describe the variation of the voltage with concentration. (2 marks)

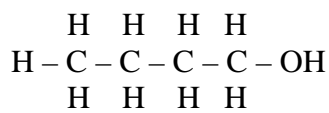
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*End of Test*

**Part A: Answer grid for multiple choice questions**

- |    |                                    |                                    |                         |                                    |
|----|------------------------------------|------------------------------------|-------------------------|------------------------------------|
| 1. | A <input type="radio"/>            | B <input type="radio"/>            | C <input type="radio"/> | D <input checked="" type="radio"/> |
| 2. | A <input checked="" type="radio"/> | B <input type="radio"/>            | C <input type="radio"/> | D <input type="radio"/>            |
| 3. | A <input type="radio"/>            | B <input checked="" type="radio"/> | C <input type="radio"/> | D <input type="radio"/>            |
| 4. | A <input type="radio"/>            | B <input checked="" type="radio"/> | C <input type="radio"/> | D <input type="radio"/>            |
| 5. | A <input checked="" type="radio"/> | B <input type="radio"/>            | C <input type="radio"/> | D <input type="radio"/>            |
| 6. | A <input type="radio"/>            | B <input type="radio"/>            | C <input type="radio"/> | D <input checked="" type="radio"/> |

1. What is the correct name for the following alkanol?



- (A) propanol  
(B) 1-propanol  
(C) butanol  
(D) **1-butanol**

2. The following represents the catalytic cracking of a hydrocarbon.



Which of the following correctly identifies a product of this reaction and the homologous series to which it belongs?

- (A) **octane**      **alkanes**  
(B) octene      alkenes  
(C) ethane      alkanes  
(D) decane      alkanes

3. Which word could be used to describe the conversion of ethylene to ethanol?

(A) combustion

**(B) addition**

(C) dehydration

(D) fermentation

4. Which of the following is a major component of biomass?

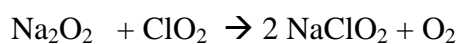
(A) Ethene

**(B) Cellulose**

(C) Ethanol

(D) Natural gas

5. Given the following reaction:



Which of the following choices correctly describes the reactants and products of the reaction?

	<i>oxidant</i>	<i>reductant</i>	<i>reduced product</i>	<i>oxidised product</i>
(A)	<b>ClO<sub>2</sub></b>	<b>Na<sub>2</sub>O<sub>2</sub></b>	<b>NaClO<sub>2</sub></b>	<b>O<sub>2</sub></b>
(B)	Na <sub>2</sub> O <sub>2</sub>	ClO <sub>2</sub>	O <sub>2</sub>	NaClO <sub>2</sub>
(C)	Na <sub>2</sub> O <sub>2</sub>	ClO <sub>2</sub>	NaClO <sub>2</sub>	O <sub>2</sub>
(D)	NaClO <sub>2</sub>	O <sub>2</sub>	ClO <sub>2</sub>	Na <sub>2</sub> O <sub>2</sub>

Outcomes : H13

## Part B : Extended Response Questions (14 Marks)

### Question 6 (4 marks)

During your study of Production of Materials you performed a first hand investigation to compare the reactivities of an alkane and an alkene.

Describe the experiment you performed and explain the results of your investigation.

*Sample Answer*

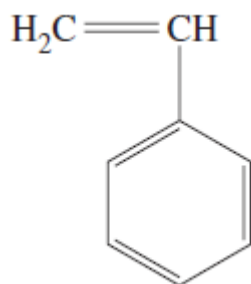
*20 drops of cyclohexene was added to a test tube with 5 drops of bromine water and 20 drops of cyclohexane was added to a test tube with 5 drops of bromine water. The bromine water was decolourised immediately in the cyclohexene as the addition reaction forming 1,2 dibromocyclohexane is much faster as the double bond is very reactive. The bromine water was unchanged in the alkane as this reaction is slow and requires an uv catalyst.*

<i>Marking Criteria</i>	<i>Marks</i>
<i>Describes a valid experiment and explains results achieved</i>	<i>4</i>
<i>Identifies results and describes a valid experiment OR Explains results and outlines a valid experiment</i>	<i>3</i>
<i>Identifies results and outlines a valid experiment OR Describes a valid experiment OR Explains results</i>	<i>2</i>
<i>Identifies results or outlines a valid experiment</i>	<i>1</i>

**Outcomes : H6, H9, H11**

### Question 7 (5 marks)

Below is the structure of a commercially significant monomer



(a) Identify the common name of this monomer. (1 mark)

*Styrene            1 mark*



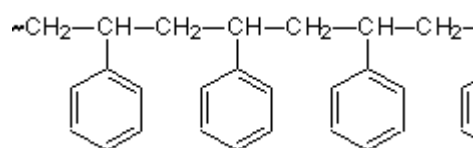
- (b) Describe one use of the polymer made from this monomer in terms of its properties. (3 marks)

Sample Answer

Polystyrene is used for the backing of TVs as it is rigid because of the bulky side chains on the polymer, and an electrical insulator

<i>Marking Criteria</i>	<i>Marks</i>
<i>Describes one use in terms of its properties</i>	<i>3</i>
<i>Describes one use OR Identifies one use in terms of its properties</i>	<i>2</i>
<i>Identifies one use</i>	<i>1</i>

- (c) Draw the structure of the polymer made from the above monomer. Use three monomers to show this structure. (1 mark)



**Outcomes: H5, H9**

### Question 8 (5 marks)

The syllabus required you to know the structure and chemistry of either the lead acid cell or the dry cell. It also required you to be able to compare one of these cells with another one from a list: (*button cell, fuel cell, vanadium redox cell, lithium cell and the Gratzel cell*) Choose one of these cells that may be **fairly** (similar size comparable applications etc) compared with the lead acid battery or the dry cell and evaluate them in terms of chemistry and environmental impact.

#### Marking Guideline

Criteria	Mark(s)
Correct choice of cells of comparable size and application ( <b>if inappropriate -1</b> )	
Gives the chemistry (describes or gives the equation of the chemistry for the two cells)	2
Gives two environmental impact for each of the two cells	2
Overall evaluation of which is better in terms of environmental impact of the two cells	1

#### Sample Answer:

*Choice: The dry cell and the button cell or the vanadium cell and the lead acid battery may be compared.*

*Chemistry:*

*Lead –acid battery: anode: Pb and cathode is PbO<sub>2</sub>*

*The reaction results in the reduction of the PbO<sub>2</sub> to PbSO<sub>4</sub> and the oxidation of Pb to PbSO<sub>4</sub>*

*Overall reaction: Pb(s) + PbO<sub>2</sub>(s) + 4 H<sup>+</sup>(aq) + 2 SO<sub>4</sub><sup>2-</sup>(aq) → 2 PbSO<sub>4</sub>(s) + 2 H<sub>2</sub>O(l)*

*Vanadium cell:*

*At the cathode: V<sub>2</sub>O<sub>5</sub>(aq) + 2H<sup>+</sup>(aq) + 2e<sup>-</sup> ⇌ 2 VO<sub>2</sub>(aq) + H<sub>2</sub>O(l)*

*At the anode: 2 VO(aq) + H<sub>2</sub>O(l) ⇌ V<sub>2</sub>O<sub>3</sub>(aq) + 2 H<sup>+</sup>(aq) + 2e<sup>-</sup>*

*Overall reaction*

*V<sub>2</sub>O<sub>5</sub> + 2 VO ⇌ 2 VO<sub>2</sub> + V<sub>2</sub>O<sub>3</sub>*

*Environmental impact of the two cells:*

*The lead acid battery is cheap and relatively compact but has limited rechargeability and hence, the lead used in the manufacture of the battery can end up in the environment. Lead being a toxic substance can be a source of pollution.*

*The vanadium redox cell is expensive to set-up and requires a pump to operate, however it has greater rechargeability: It can be recharged by simply replacing the spent electrolyte. It can also be recharged by connecting it to the mains or from renewable energy sources. Like lead, however, vanadium ion is toxic to many species of marine organism and humans.*

**Outcomes:**H16,H13,H8,H7

## Data Processing Paper

### Question 1 20 marks

Aim: To determine and compare the heats of combustion of three liquid alkanols per gram and per mole.

Method:

Methanol, ethanol and 1-propanol were burned in separate spirit burners and used to heat a container of water. The volume of water heated by each alkanol was 100.0 ml.

(a). Complete the results table below. (2 marks)

Alkanol burning	Methanol	Ethanol	1-propanol
Initial mass of burner (g)	250.0	250.0	250.0
Final mass of burner (g)	248.8	249.1	249.0
Mass of alkanol burnt (g)	<b>1.2</b>	<b>0.9</b>	<b>1.0</b>
Initial temperature of water (°)	23	23	23
Final temperature of water (°)	36	36	36
Rise in temperature of water (°)	<b>13</b>	<b>13</b>	<b>13</b>
Mass of water heated (g)	100	100	100

<i>Criteria</i>	<i>Marks</i>
<i>Both rows correct</i>	<b>2</b>
<i>One row correct</i>	<b>1</b>

(b) Complete the calculations table below (5 marks)

Name of alkanol used	methanol	ethanol	1-propanol
Heat released by burning fuel in experiment (J)	<b>5434</b>	<b>5434</b>	<b>5434</b>
Heat released by burning 1 gram of fuel (J)	<b>4528</b>	<b>6038</b>	<b>5434</b>
Formula of the fuel	<b>CH<sub>3</sub>OH</b>	<b>C<sub>2</sub>H<sub>5</sub>OH</b>	<b>C<sub>3</sub>H<sub>7</sub>OH</b>
Molar mass of fuel (g)	<b>32</b>	<b>46</b>	<b>60</b>
Heat released by burning the molar mass of fuel (kJ mol <sup>-1</sup> )	<b>144.9</b>	<b>277.7</b>	<b>326.0</b>
<b>Criteria</b>	<b>Marks</b>		
<b>All 5 rows correctly completed</b>	<b>5</b>		
<b>4 rows correctly completed</b>	<b>4</b>		
<b>3 rows correctly completed</b>	<b>3</b>		
<b>2 rows correctly completed</b>	<b>2</b>		
<b>1 row correctly completed</b>	<b>1</b>		

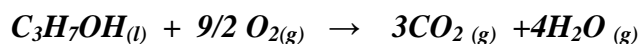
( carry through errors paid)

(c) Which fuel releases the most heat (i) per gram ...*ethanol*.....

(ii) per mole burned?.....*1-propanol*..... (1 mark)

<b>Criteria</b>	<b>marks</b>
<b>Both answers correct according to calculations</b>	<b>1</b>

(d) Assuming complete combustion, write an equation for the combustion of 1-propanol, including the enthalpy value. (2 marks)



<b>Criteria</b>	<b>Marks</b>
<b>Correctly balanced equation and subscripts</b>	<b>2</b>
<b>Correctly balanced equation</b>	<b>1</b>

- (e) Give reasons to explain why your calculated values are well below the value given in data books (2 marks)

*Some of the heat produced may have been lost to the atmosphere and flask and not have heated the water*

*Incomplete combustion may have occurred and thus a lower enthalpy obtained*

<i>Criteria</i>	<i>Marks</i>
<i>2 reasons explained</i>	<i>2</i>
<i>1 reason explained</i>	<i>1</i>

- (f) If the data value for the molar heat of combustion for petrol (assume this consists of octane) is  $5460 \text{ kJ mol}^{-1}$  and for ethanol is  $1370 \text{ kJ mol}^{-1}$ , which fuel would release the most energy per kilogram of fuel? Show all working (2 marks)

$$\text{Energy per gram of octane} = 5460/114$$

$$\text{Energy per kg of octane} = 5460/114 \times 1000 = 47,894.7 \text{ kJ}$$

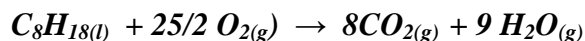
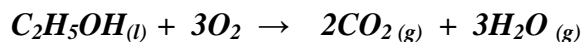
$$\text{Energy per gram of ethanol} = 1370/46$$

$$\text{Energy per kg of ethanol} = 1370/46 \times 1000 = 29,782.6 \text{ kJ}$$

*Therefore, petrol (octane) releases the most energy per kilogram of fuel.*

<i>Criteria</i>	<i>Marks</i>
<i>Correct fuel and working shown for both fuels</i>	<i>2</i>
<i>Correct working for one fuel</i>	<i>1</i>

- (g) Which fuel requires more oxygen for complete combustion per mole of fuel, ethanol or petrol (octane)? Show both equations in your answer. (2 marks)



*Therefore, petrol (octane) requires the most oxygen for complete combustion*

<i>Criteria</i>	<i>Marks</i>
<i>Correct equations for both fuels and conclusion</i>	<i>2</i>
<i>Correct equation for one fuel</i>	<i>1</i>

(h) Explain with reference to your answer to question f & g concerning the energy released per kg and the oxygen required per mole of each fuel explain whether these are advantages or disadvantages for using ethanol as an alternative car fuel. (4 marks)

*As ethanol has a lower energy released per kilogram this is a disadvantage as more fuel would have to be transported to produce the same amount of energy (or a car with octane will be able to go a greater distance than a car with the same mass of ethanol)*

*As ethanol requires less oxygen for complete combustion and this is an advantage as it will be less polluting, burns more cleanly- less carbon monoxide and less carbon produced*

Criteria	Marks
Correct conclusion-disadvantage for Q6 and explanation Correct conclusion- advantage for Q7 And explanation	4
Three of the above	3
Two of the above	2
One of the above	1

### Question 2 (4 marks)

A student studying the mass change that occurs during fermentation added glucose, water and yeast to a flask and stoppered the flask with some cotton wool.

The student measured the mass of the flask daily for seven days. The table shows the data collected.

Day	Mass(g)
1	381.05
2	376.96
3	373.42
4	370.44
5	370.42
6	370.40
7	370.39

(a) Calculate the moles of CO<sub>2</sub> released between days 1 and 7 (1 mark)

Sample Answer :

$$\text{Mass of CO}_{2(g)} \text{ released} = (381.05 - 370.39)\text{g} = 10.66\text{g}$$

$$\text{Moles of CO}_{2(g)} \text{ released} = 10.66\text{g} / 44.01\text{g/mol} = 0.2422 \text{ mol}$$

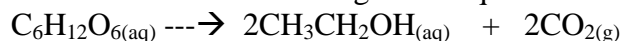
Marking Criteria

Criteria	Mark
Correct calculation of moles	1

- (b) Calculate the mass of glucose that underwent fermentation between days 1 and 7. Include a balanced chemical equation in your answer. (3 marks)

Sample Answer :

Glucose ferments according to the equation



The molecular weight of glucose is :  $(6 \times 12.01 + 12 \times 1.008 + 6 \times 16.00) = 180.16 \text{ gmol}^{-1}$

Moles of glucose fermented =  $\frac{1}{2}$  moles of  $\text{CO}_2(\text{g})$  produced = 0.1211 mol

Mass of glucose fermented =  $180.16 \times 0.1211 = 21.82 \text{ g}$

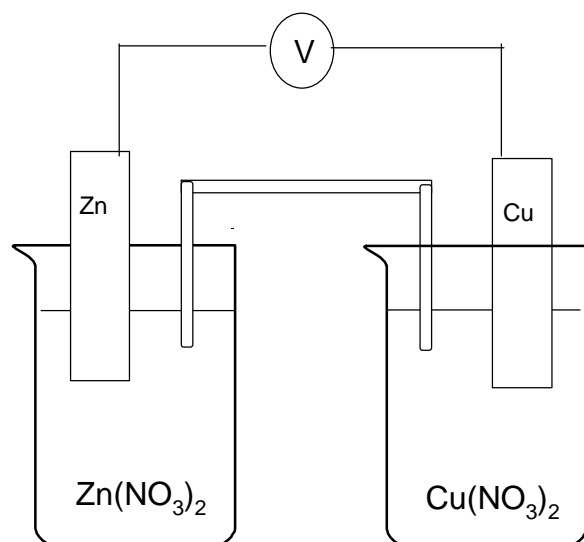
Marking Criteria

Criteria	Mark
Correct equation, moles of glucose, mass of glucose fermented in g	3
Two of the above correct	2
One of the above correct	1

### Question 3 (6 marks)

**Outcomes:** H10, H11, H13, H14,

A group of students wanted to study the effect of concentration and temperature on the potential of a galvanic cell consisting of copper ions/copper electrode and zinc ions and zinc electrode: The set-up they used is shown below:



Two experiments were performed.

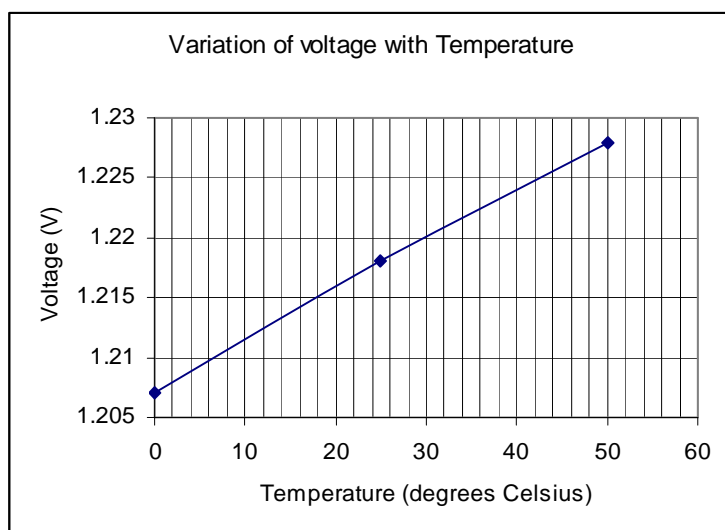
**Experiment 1.** Keeping the temperature and the  $[\text{Zn}^{2+}]$  constant, the students measured the potential of the cell at various  $\text{Cu}^{2+}$  concentrations.

**Experiment 2.** The concentration of the  $\text{Cu}^{2+}$  ion and the  $\text{Zn}^{2+}$  were kept constant and the change in potential was monitored with the change in temperature. The results of both experiments are given in the table below:

Experiment	$\text{molL}^{-1} X^{2+}$	$\text{molL}^{-1} M^{2+}$	Temperature ( $^{\circ}\text{C}$ )	Cell voltage (V)
1	0.01	0.001	25	1.07
1	0.01	0.010	25	1.10
1	0.01	0.100	25	1.13
1	0.01	1.00	25	1.17
2	$10^{-5}$	0.1	5	1.207
2	$10^{-5}$	0.1	25	1.218
2	$10^{-5}$	0.1	50	1.228

- (a) Use the grid below to graph the data presented in **Experiment 2** . Label your graph(3 marks)

Criteria	Mark(s)
correct label and units	<b>1</b>
correct plotting and line of best fit	<b>1</b>
correct orientation of variables	<b>1</b>



- (b) Identify the trend in cell voltages measured in experiment 2.

*Sample Answer:*

*as shown by the graph, as the temperature decreases, the voltage decreases, keeping all other variables constant. (1 mark)*

- (c) Use the results of **Experiment 1** to describe in detail the variation of the voltage with concentration. (2 marks)

*Sample Answer*



*The data shows that the potential of the cell increases for every 10-fold increase in the concentration of  $\text{Cu}^{2+}$ . (2 marks). If the 10-fold qualifier is not included in the statement then only 1 mark is awarded.*