Student Number……
Theory Mark /20……
Data Processing Mark/30……..

James Ruse Agricultural High School

Theory and Data Processing

Chemistry Assessment
Task 1 Term 4 2008

General Instructions

- **Reading Time**: 10 minutes
- **Working Time**: 80 minutes
- **Complete both Theory and Data Processing in the working time, 80 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 Source Sheet are attached to the back of the paper. These may be removed for your convenience.

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.

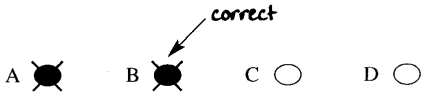
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

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.



▸ Mark your answers for Questions 1 – 5 in the Answer Box on page 5

Theory Paper - 20 marks

1. Which of the following reagents could be used to distinguish an alkane from an alkene?

   (A) yeast

   (B) concentrated H_2SO_4

   (C) limewater

   (D) bromine water

2. What is the *systematic* name of the monomer from which polyvinylchloride is produced?

   (A) chloroethane

   (B) vinylchloride

   (C) monovinylchloride

   (D) chloroethene

3. What is the oxidation state of carbon in glucose?

   (A) 0

   (B) 2

   (C) 4

   (D) 6

4. Which of the following is a transuranic element?

   (A) technetium-99

   (B) promethium-141

   (C) plutonium – 239

   (D) radium – 226

5. In order to determine the heat of combustion of 1-propanol, some 1-propanol is put in a spirit burner, ignited and used to heat a measured mass of water in a calorimeter. The results of this investigation are provided in the table.

Mass of fuel combusted (g)	1.776
Mass of water (g)	200
Initial temperature of water (^oC)	18
Final temperature of water (^oC)	35

What is the heat of combustion for 1-propanol according to the results of this investigation?

(A) 14.2 kJ/mole

(B) 16.5 kJ/mole

(C) 481 kJ/mole

(D) 854 kJ/mole

Student No. .....

Part A: Answer grid for multiple choice questions

1.	A O	B O	C O	D O
2.	A O	B O	C O	D O
3.	A O	B O	C O	D O
4.	A O	B O	C O	D O
5.	A O	B O	C O	D O

Part B : Extended Response Questions (15 Marks)

6.(a) Write a balanced formulae equation for the fermentation of glucose. (1 mark)

.....

(b) Describe two conditions necessary for the fermentation of glucose. (2 marks)

.....

.....

.....

7. Evaluate the use or potential use of a named biopolymer, with regard to its properties. (3 marks)

.....

.....

.....

.....

.....

.....

8. Polyethylene is an example of a commercially important polymer.

Outline the major steps in the industrial production of polyethylene. Include any relevant equations in your answer. (3 marks)

.....

.....

.....

.....

.....

.....

9. (a) Give an equation for the production of a medical radioisotope. (1 mark)

.....

(b) Explain its use in medicine in terms of its chemical property. (2 marks)

.....

.....

.....

.....

(c) Analyse the benefits and problems associated with the use of this isotope in medicine. (3 marks)

.....

.....

.....

.....

.....

.....

.....

.....

End of Theory Paper

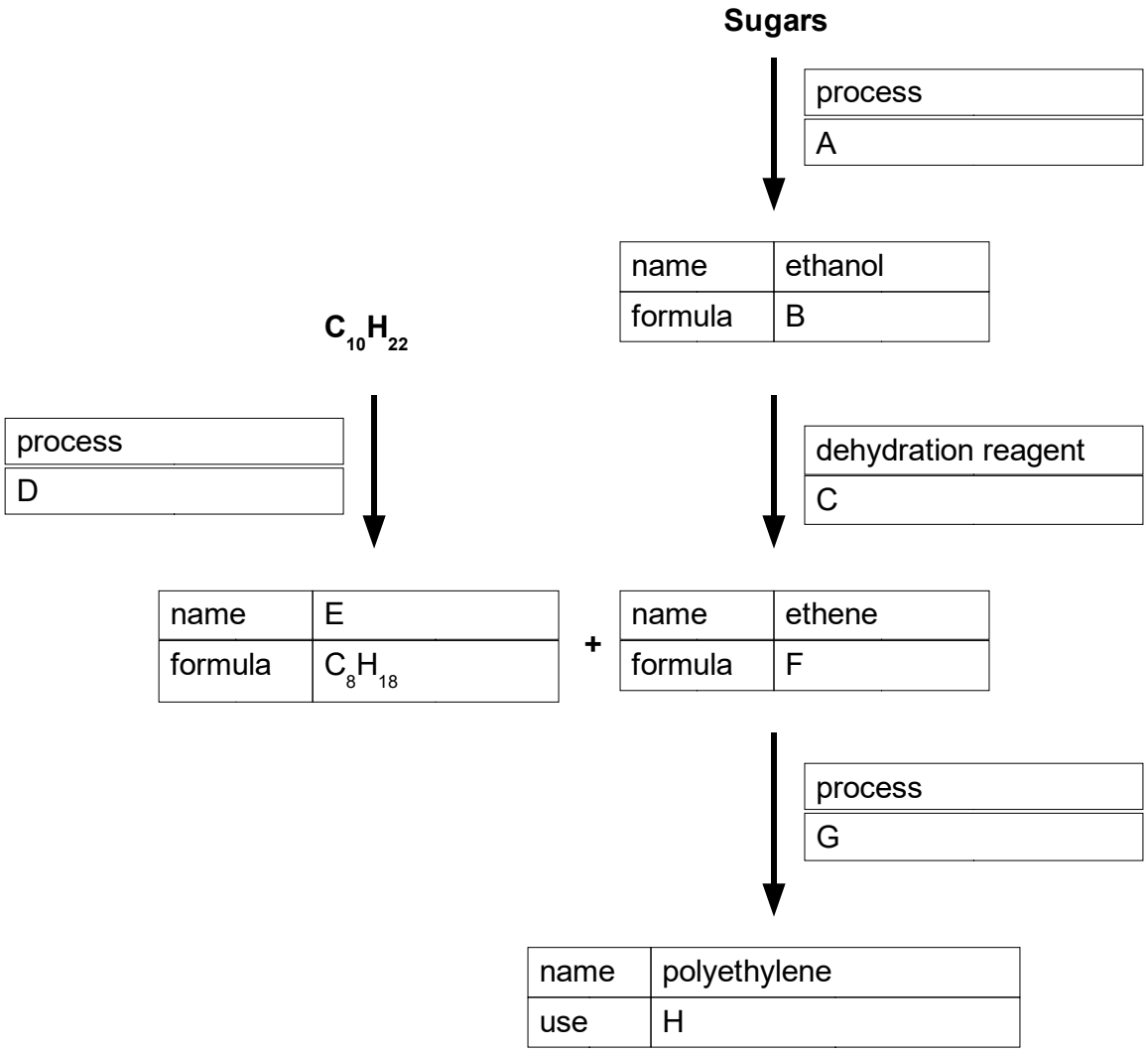
This page is deliberately left blank

Data Processing Paper - 30 marks

1. Ethene may be considered a starting material for many useful products. It can be obtained a number of ways ; through catalytic cracking of longer chained alkanes or via fermentation of sugars to produce ethanol which then undergoes dehydration to become ethene.

   Ethene can undergo addition polymerization to become polyethylene, a plastic with many uses.

   Complete the following flowchart by identifying A- H in the boxes provided.
   (4 marks)



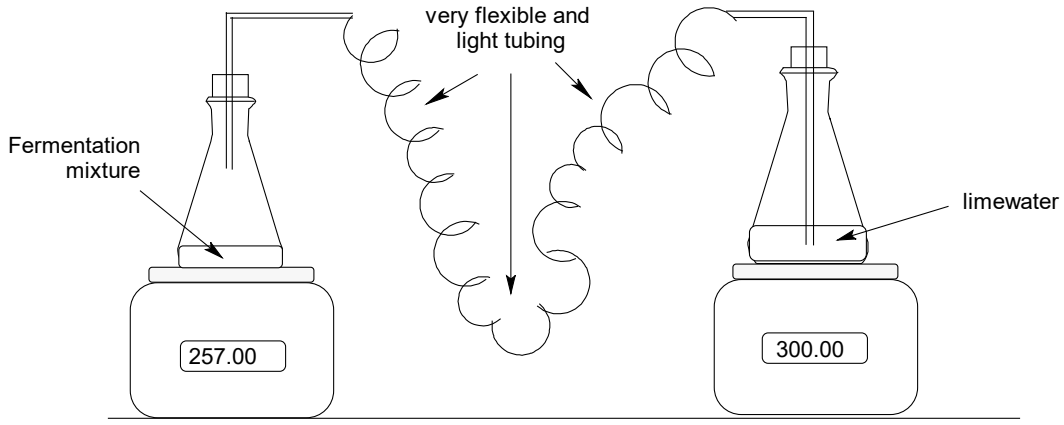
2. **Introduction**

A group of students was asked to design an experiment to monitor the progress of fermentation of glucose.

To prepare the fermentation mixture, they dissolved 10g glucose in 100g of warm water (37^0) and then added 2.0g of yeast. They immediately stoppered the flask (flask 1) and weighed it. Gas emission from flask 1 was monitored by channeling the gas into flask 2 containing 150g of limewater.
The flasks were kept on the balances for the duration of the experiment.
Flask 1 had an empty mass of 145.00g and flask 2 had an empty mass of 150.00g.
They monitored the fermentation for 100 minutes.

Diagram

The experimental set-up is shown below.



Data Results Table

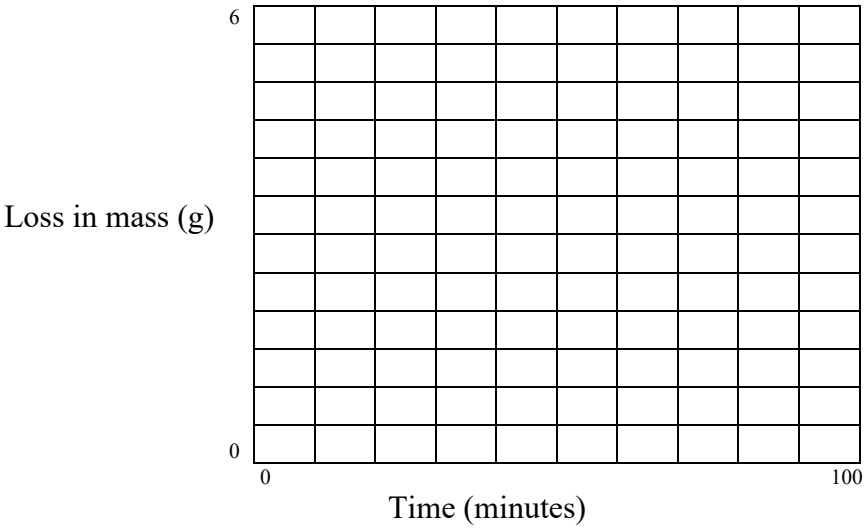
Time (minutes)	*Mass of flask 1 + contents (g)*	*Mass of flask 2 + contents (g)*	*Loss in mass (flask 1)*	*Gain in mass (flask 2)*
0	257.00	300.00	0.00	0.00
10	256.00	300.65	1.00	0.65
30	253.85	301.90	3.15	1.90
50	252.85	302.80	4.15	2.80
70	252.25	303.30	4.75	3.30
90	252.15	303.20	4.85	3.20

(a) Identify the gas released from the reaction in flask 1 and describe the observation in flask 2 that confirms this identification. (2 marks)

.....

.....

(b) Graph the results of the loss in mass in flask 1 on the grid provided. (2 marks)



(c) Assuming all mass lost from flask 1 was product gas, calculate the volume of gas released at 25^0 and 100kPa. (2 marks)

.....

.....

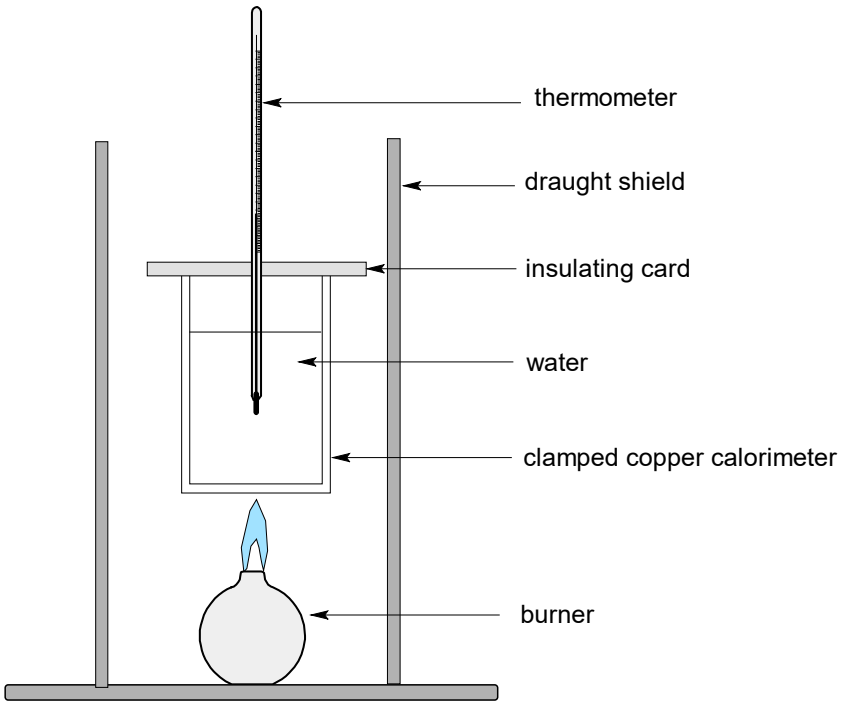
.....

(d) The mass lost from flask 1 is not equal to the mass gain in flask 2. Suggest a reason for this difference. (1 mark)

.....

.....

3. The apparatus used to determine and compare the heats of combustion for two alkanols is represented in the diagram.



State two variables that would need to be controlled in order to scientifically compare the heats of combustion of the two alkanol fuels using the above apparatus. (2 marks)

.....

.....

.....

4. Use the information provided on the Data Source Sheet at the end of the paper to answer each part of this question. (5 marks)

(a) Describe the trend in the reduction of greenhouse gas emissions for ethanol-based vehicle fuels. (1 mark)

.....

.....

(b) Justify the shift from corn-based sources to cellulose-based sources for the future production of ethanol-based vehicle fuels. (2 marks)

.....

.....

.....

(c) With reference to Figure 1, describe why the production of ethanol for vehicle use costs more per litre of fuel than the production of petrol. (1 mark)

.....

.....

.....

(d) Describe the implications of the data provided in Figure 2 with respect to using E85 as a vehicle fuel instead of E10 or petrol ("automotive gasoline"). (1 mark)

.....

.....

.....

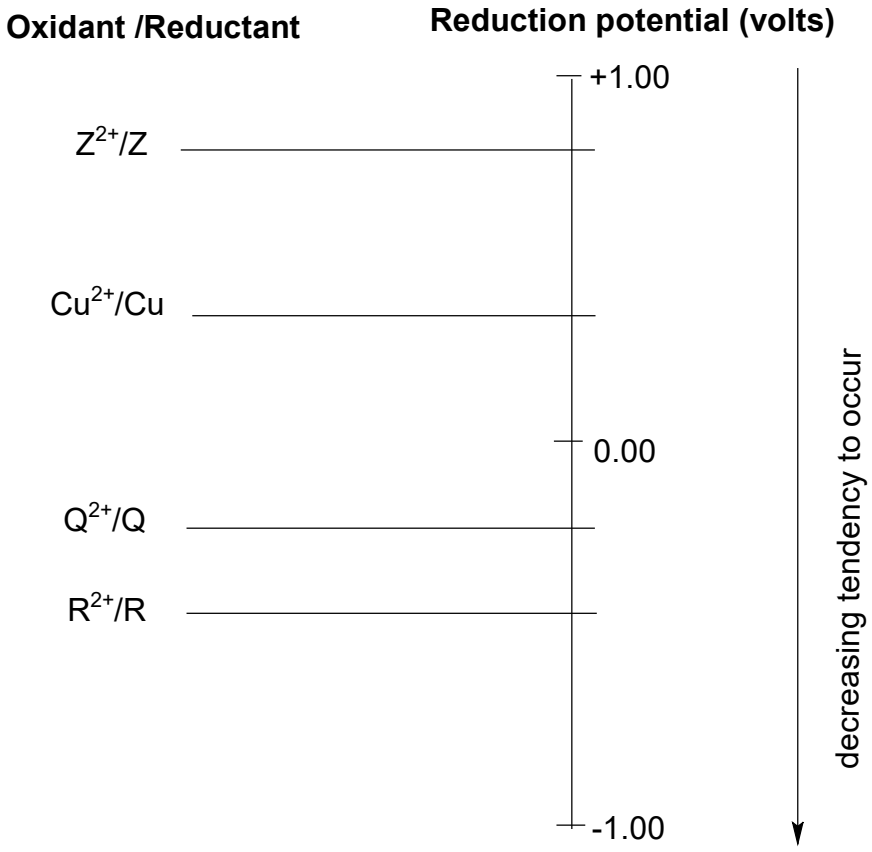
Data Processing continues over the page ……

Use Diagram 1 to answer questions 5 and 6.

5. Shown below is a diagram depicting the reduction potential of several substances: Z^{2+}, Cu^{2+}, Q^{2+} and R^{2+} (all have concentrations of 1 mol L^{-1})

DIAGRAM 1

Oxidant/ Reductant **Reduction potential (volts)**



(a) The reduction half-equation for Cu^{2+} /Cu is shown below including its reduction potential

	Reduction potential
$Cu^{2+} + 2e^- \rightarrow Cu(s)$	$+0.34\ v$

Similarly, write a reduction half equation for Z^{2+} (1mark)
Do not worry at this stage with the reduction potentials

.....

(b) List the four oxidants shown in Diagram 1.

(2 marks)

(i)..... (ii)..... (iii) ..... (iv) .....

(c) Consider the magnitude of the reduction potential. Which of the oxidants has the greatest tendency to be reduced? Explain your answer. (2 marks)

.....

.....

.....

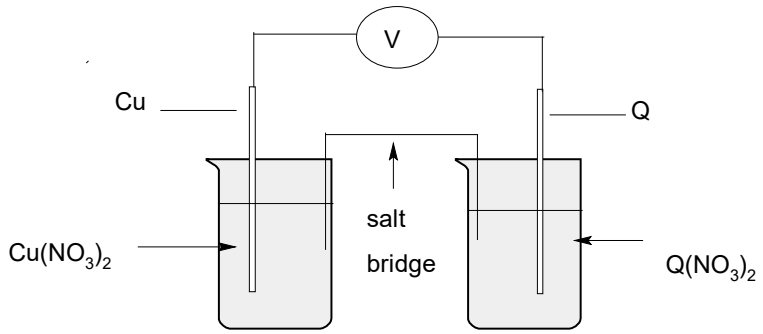
.....

Data Processing continues over the page……..

6. When two metals are connected (via wire and salt bridge) to each other , a galvanic cell is formed. The metal ion with the more positive reduction potential will be reduced at the cathode.

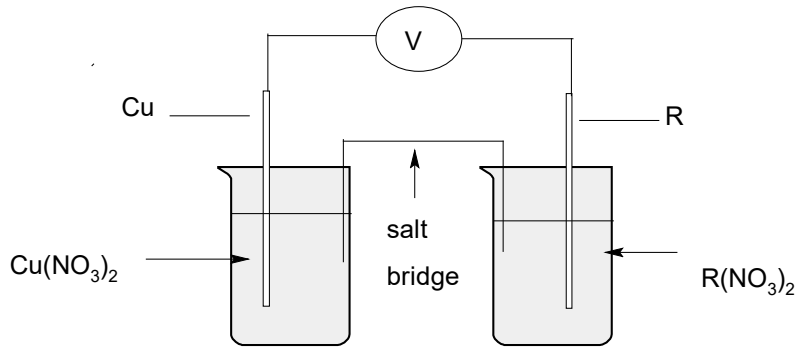
(i) Examine the following cells and then answer the questions following:

Cell A



voltmeter reading : +0.58 V

Cell B



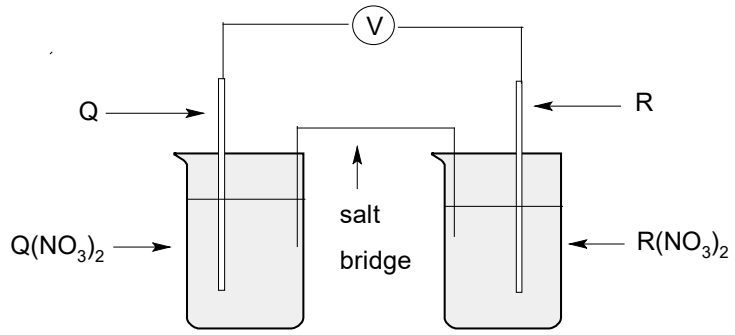
voltmeter reading : + 0.78 V

(a) Using the above information, complete the Table of Results (4 marks)

Cell	***Anode reaction***	***Cathode reaction***	***Cell potential (volts)***	***Reduction Potential of oxidant***
A				

(b) For the following cell:
(i) Label the anode
(ii) Calculate the cell potential
(iii) Write a balanced chemical equation for the reaction

(3 marks)



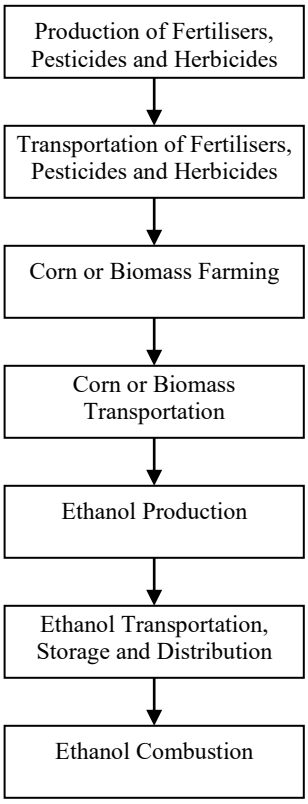
.....

.....

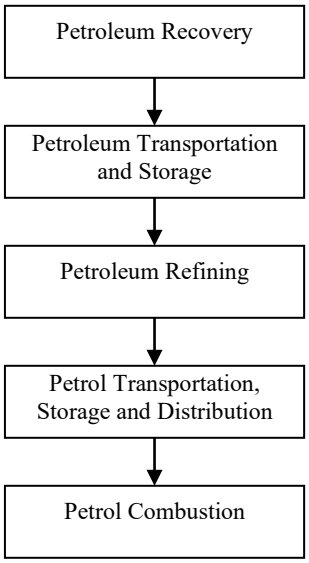
End of Data Processing

End of Test

This page is deliberately left blank



Corn- or Biomass-to-Ethanol Fuel Cycle



Petroleum-to-Petrol Fuel Cycle

Figure 1 Corn or Biomass-to-Ethanol and Petroleum-to-Petrol Motor Vehicle Fuel Flow Charts

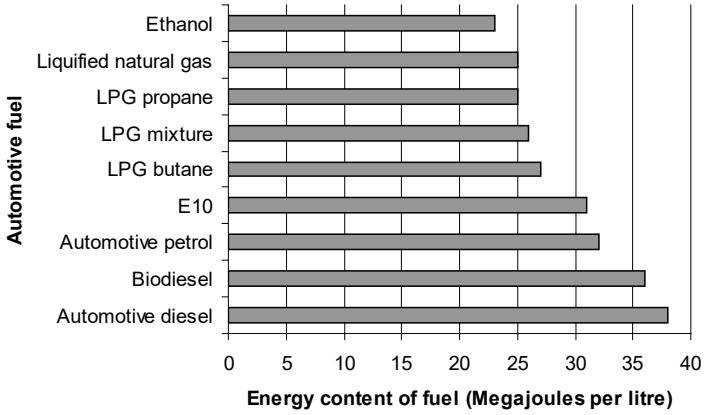


Figure 2 The Energy Content of Motor Vehicle Fuels

Table 1 Mixture ratios and petrol fuel acronyms for ethanol-based vehicle fuels

Mixture	Petrol fuel acronym
10% ethanol and 90% petrol by volume	E10
85% ethanol and 15% petrol by volume	E85
95% ethanol and 5% petrol by volume	E95

Table 2
Reductions in greenhouse gas emissions and energy use by ethanol blends (percentage relative to emissions and energy use of petrol) per mile of motor vehicle use

	Ethanol Blend Fuel					
	E10	E85	E95	E10	E85	E95
Corn-Based Ethanol: Current Case						
	Dry Milling			Wet Milling		
Petroleum	6.4%	74.9%	87.7%	6.1%	72.5%	85.0%
GHG emissions	1.3%	18.8%	24.9%	0.8%	13.7%	19.1%
Fossil energy	2.7%	35.0%	44.3%	2.7%	34.4%	42.3%
Corn-Based Ethanol: Near-Future case						
	Dry Milling			Wet Milling		
Petroleum	6.4%	75.6%	88.1%	6.2%	73.7%	86.1%
GHG emissions	1.8%	25.5%	32.0%	1.6%	23.8%	30.1%
Fossil energy	3.2%	40.7%	49.1%	3.3%	42.5%	51.0%
Cellulosic Ethanol: Near-Future Case						
	Woody Biomass			Herbaceous Biomass		
Petroleum	5.8%	69.6%	81.4%	6.0%	71.4%	83.5%
GHG emissions	8.9%	102.2%	118.2%	5.7%	67.6%	79.3%
Fossil energy	6.7%	79.0%	92.0%	5.9%	70.4%	82.3%
Cellulosic Ethanol: Future Case						
	Woody Biomass			Herbaceous Biomass		
Petroleum	7.2%	71.3%	83.1%	7.4%	72.7%	84.7%
GHG emissions	9.8%	91.0%	105.1%	7.6%	67.5%	78.8%
Fossil energy	8.5%	74.5%	86.6%	8.2%	70.6%	82.1%

Note: Example of reading the data in Table 2 is as follows: Under the near-future case for E85, dry milling corn-based ethanol reduces petroleum use by 75.6%, reduces greenhouse gas emissions (GHG) by 25.5%, and reduces fossil fuel energy consumption by 40.7%. These figures are percentages relative to the emissions and energy use of petrol.

References

Downstream Petroleum 2005. Australian Institute of Petroleum. Retrieved 15 October, 2008 from the World Wide Web: http://www.aip.com.au/pdf/Downstream_Petroleum_2005_Report.pdf

Wang, M., Saricks, C., & Santini, D. (1999). *Effects of fuel ethanol use on fuel-cycle energy and greenhouse gas emissions.* Centre for Transportation Research, Argonne National Laboratory, ANL/ESD-38, Argonne, Ill.

2008 Year 11 Term 4 Answers

Theory

Part A: Answer grid for multiple choice questions

1.	A O	B O	C O	D ✓
2.	A O	B O	C O	D ✓
3.	A ✓	B O	C O	D O
4.	A O	B O	C ✓	D O
5.	A O	B O	C ✓	D O

Outcomes :

H11, H9, H13, H13, H9

6. (a) $C_6H_{12}O_6\ (aq) \rightarrow 2CH_3CH_2OH\ (aq) + 2CO_2\ (g)$

Outcome criteria	Marks
Writes a balanced formulae equation.	1

(b) Conditions include: yeast enzymes, anaerobic conditions, heat (about 35^oC)

Outcome criteria	Marks
States two conditions required for fermentation.	2
States one condition required for fermentation.	1

7. **Outcomes H4, H5, H9**
Evaluate the use, or potential use of a named biopolymer, relating to it's properties.
Sample Answer

Biopol is a biopolymer. Biopol can be used to make biodegradeable plastic containers as it can be molded into shapes. It has advantages as a replacement for polyethylene as its use will have a positive impact on the environment as it is biodegradable and is made from renewable resources.

Marking criteria	*Marks*
Identifies a named biopolymer , relates usage to property and makes a judgement about usage.	3
Identifies a named biopolymer and relates usage to property	2
Identifies a named biopolymer	1

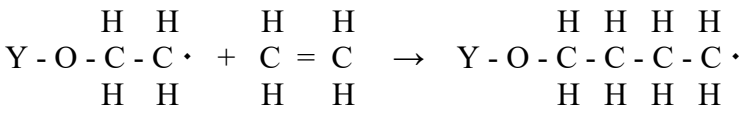
8. **Outcomes : H5, H9**

Polyetheylene is an example of a commercially important polymer.

Outline the three major steps in it's production from ethylene, and include any relevant equations in your answer. (3 marks)

Sample Answer

The three stages of polyethylene production are initiation, propagation and termination.
Initiation - An initiator molecule starts the reaction by opening the double bond of the ethylene monomer. This forms a free radical ethylene.
Propagation - The monomers add on to the first to form a chain.



Termination - When two free radical chains combine a complete molecule forms and the process stops (is terminated)

Marking criteria	*Marks*
Outlines three stages and includes one equation	*3*
Outlines three stages OR two stages and one equation	*2*
Gives one equation OR Outlines one stage OR identifies the three stages	*1*

9.For a named commercial radioisotope:

(a) Describe its commercial production (2 marks) **Outcome(s) : H7**

Sample Answer: *iodine-123*

Iodine -123 is produced in a cyclotron using protons as projectiles and xenon-124 as target:

$$^{124}_{54}Xe + {}^{1}_{1}p \rightarrow {}^{123}_{55}Cs + 2\left({}^{1}_{0}n\right)$$

$$^{123}_{55}Cs \rightarrow {}^{123}_{54}Xe + {}^{0}_{1}e^{+}$$

$$^{123}_{54}Xe \rightarrow {}^{123}_{53}I + {}^{0}_{1}e^{+}$$

Criterion/ia	*Mark(s)*
Correct technique of production	1
Correct equation(s)	1

(b) Explain its use in medicine in terms of its chemical property (2 mark)

Outcome(s): H11, H4

Sample Answer:

Iodine-123 is used in the detection and treatment of thyroid diseases. This application is due to the ability of iodine-123 (or any iodine isotope for that matter) to be incorporated by the thyroid gland.

Criterion/ia	*Mark(s)*
Correct use of the isotope	1
Correct use related to chemical property of the isotope	1

(c) Analyze the benefits and problems associated with the use of this isotope in medicine. (4 marks) **Outcomes: H3, H4**

Sample Answer

Benefits of the use of iodine-123

- *treatment and/or diagnosis of thyroid malfunction can be accomplished without invasive surgery*
- *minimal damage of healthy cells occur because of the localised nature of action of iodine-123*
- *short half-life ensures that the isotope is removed from the body within a few days*

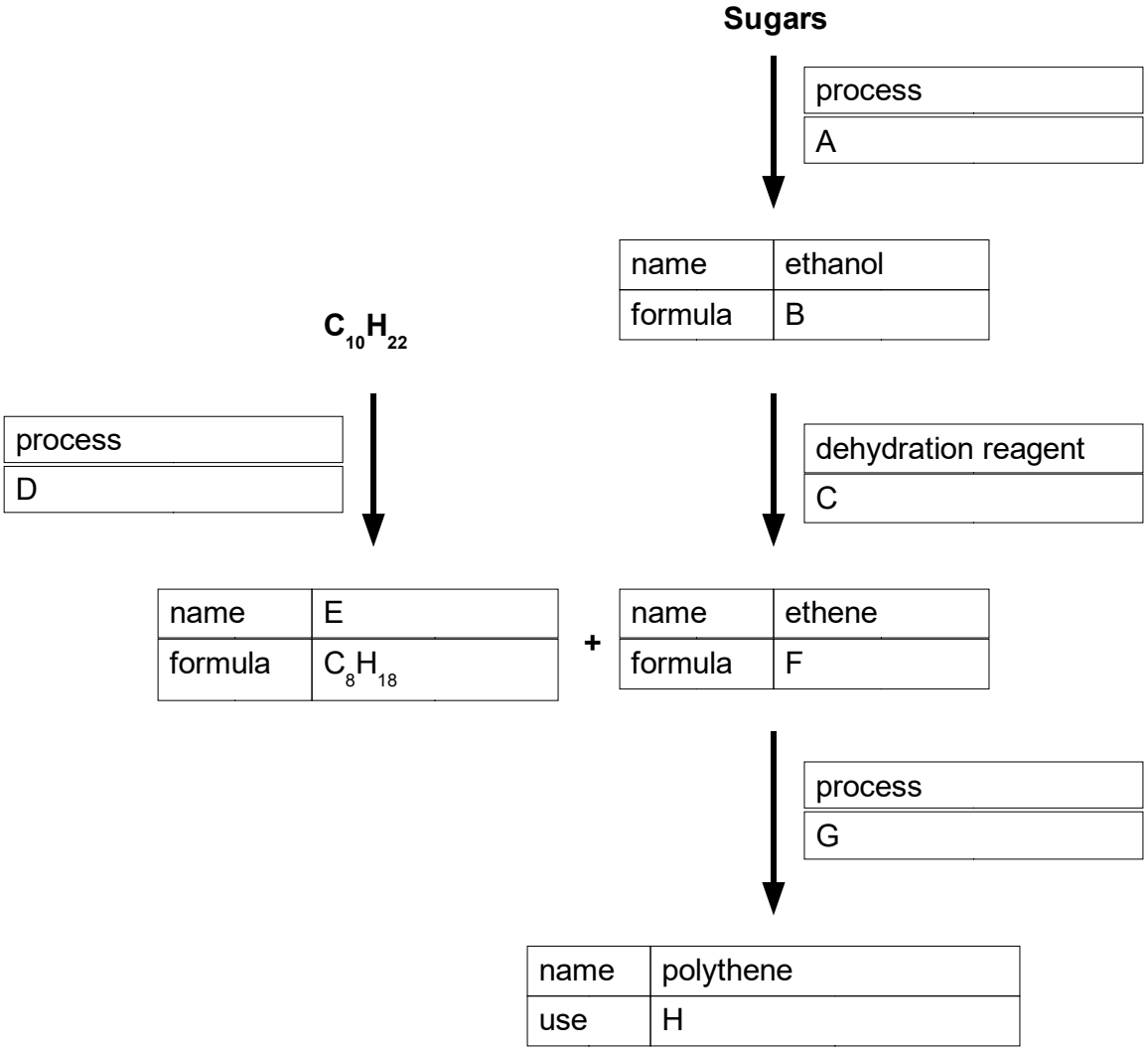
Problems associated with the use of iodine-123

- *medical workers are also exposed to the radiation and care should be taken to protect them*
- *cancerous as well as healthy cells of the patient are often exposed to radiation*

Criterion/ia	*Mark(s)*
Two benefits discussed (1 mark for each benefit)	2
Two problems discussed (1 mark for each problem)	2

Data Processing

1. Complete the following flowchart by identifying A- H in the boxes provided.



A Fermentation	B C_2H_5OH	C Concentrated H_2SO_4	D Catalytic Cracking
E Octane	F C_2H_4	G Polymerisation	H plastics

Marking criteria	*Marks*
8 correct answers	4
6 or 7 correct answers	3
4 or 5 correct answers	2
2 or 3 correct answers	1

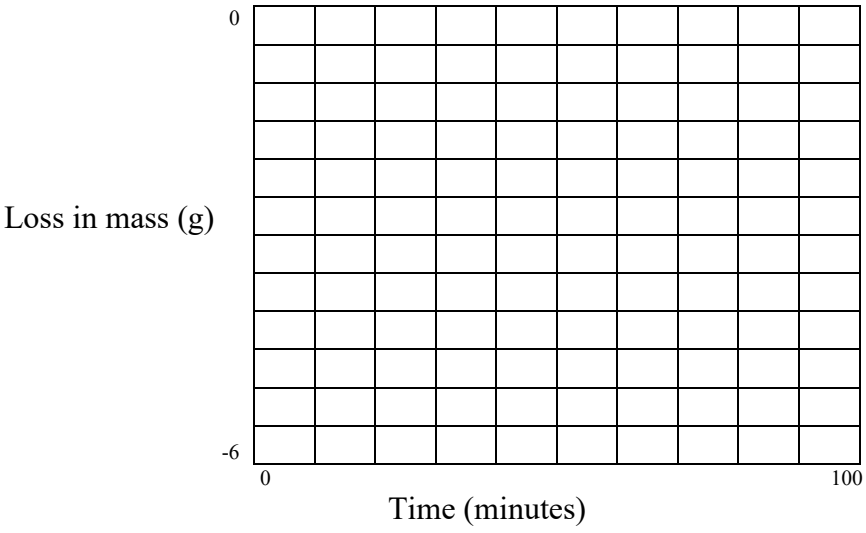
Outcomes : H9

2. **Outcomes : H13**

(a) Identify the gas released from the reaction in flask 1 and describe the observation in flask 2 that confirms this identification. (2 marks)

CO_2 (1 mark) Limewater turns milky (1 mark)

(b) Graph the results of the loss in mass in flask 1 on the grid provided. (2 marks)



(c) Assuming all mass lost from flask 1 was product gas, calculate the volume of gas released at 25^0 and 100kPa. (2 marks)

Mass lost from flask 1 = 4.85g

Mol CO_2 = mass/molar mass = 4.85/44 = 0.11 mol (1 mark)

Volume CO_2 = mol x 24.79 = 2.73 L (1 mark)

(d) The mass lost from flask 1 is not equal to the mass gain in flask 2. Suggest a reason for this difference. (1 mark)

Sample Answer

CO_2 gas has escaped from the system or Saturation of the limewater (1 mark)

3. The distance from the top of the wick to the underside of the can; type of can used; amount of water used; combustion time; type of can surface on underside (no carbon deposit).

Outcome criteria	Marks
Provides two examples of variables that need to be controlled.	2
Provides one example of a variable that needs to be controlled.	1

4. (a) There is an increasing reduction in the greenhouse emissions for increasing amounts of ethanol in vehicle fuels.

Outcome criteria	Marks
Students must state the negative correlation between reduction in GHG emissions and increasing amounts of ethanol in vehicle fuels.	1

(b) The shift from corn-based ethanol to cellulosic ethanol reduces the amount of GHG emissions and the amount of fossil fuel energy consumption.

Outcome criteria	Marks
Provides two benefits for shifting to cellulosic ethanol.	2
Provides one benefit for shifting to cellulosic ethanol.	1

(c) Ethanol production requires more transportation steps of materials (e.g., of fertilisers, insecticides, biomass or corn) than petrol production; this requirement could result in more energy used in the production of ethanol than that of petrol. Corn or biomass farming may require considerable amounts of energy.

Outcome criteria	Marks
States one reason for ethanol production requiring more energy than petrol production in accordance with the information provided in Figure 1.	1

(d) E85 does not produce as much energy as E10 or petrol and thus more E85 would need to be used per km travelled than the amount of E10 or petrol required per km.

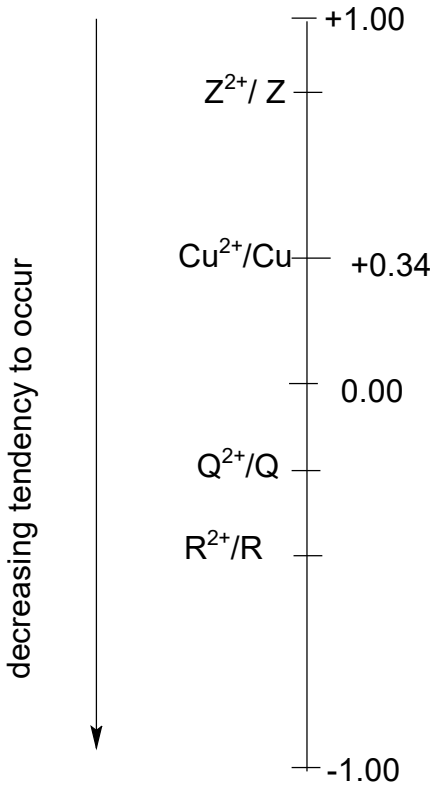
Outcome criteria	Marks
States one implication regarding the use of E85 in accordance with the information provided in Figure 2.	1

5. Outcomes: H7, H8, H10,H13,

Shown below is a diagram depicting the reduction potential of several substances: Z^{2+}, Cu^{2+}, Q^{2+} and R^{2+} (all have concentrations of 1 mol L^{-1})

DIAGRAM 1

Oxidant/ Reductant Reduction potential (volts)



1. The reduction half-equation for Cu^{2+} /Cu is shown below including its reduction potential

	Reduction potential
$Cu^{2+} + 2e^- \rightarrow Cu(s)$	*+0.34 v*

Similarly, write a reduction half equation for Z^{2+} (1 mark)
Do not worry at this stage with the reduction potential

Sample Answer:

$Z^{2+} + 2e^- \rightarrow Z(s)$

Criterion/ia	*Mark(s)*
Balanced equation with the correct number of electrons	1

2. List the four oxidants shown in Diagram 1 above.

(2 marks)

Possible Answer:

Cu^{2+} Z^{2+} Q^{2+} R^{2+}

Criterion/ia	*Mark(s)*
All four oxidants with the correct oxidation state for each	1
Two oxidants with correct oxidation state for each	1

3. Consider the magnitude of the reduction potential. Which of the oxidants has the greatest tendency to be reduced? Explain your answer. (1 mark)

Sample Answer

Z^{2+}

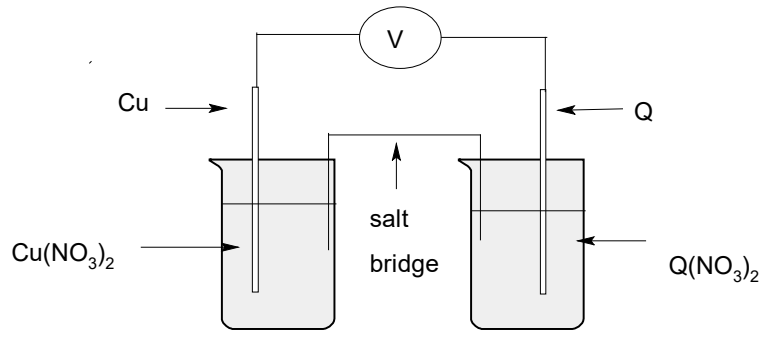
It has the most positive reduction potential, which means it has the greatest tendency to be reduced, meaning, it has the highest ability to oxidise another substance in the process of itself being reduced.

Criterion/ia	*Mark(s)*
Correct reasoning relating highest positive reduction potential to the greatest tendency to be reduced	1

4. When an oxidant/reductant pair is connected (via wire and salt bridge) to another oxidant reductant pair, a galvanic cell is formed. The oxidant with the more positive reduction potential (of the pair) will be reduced at the cathode.

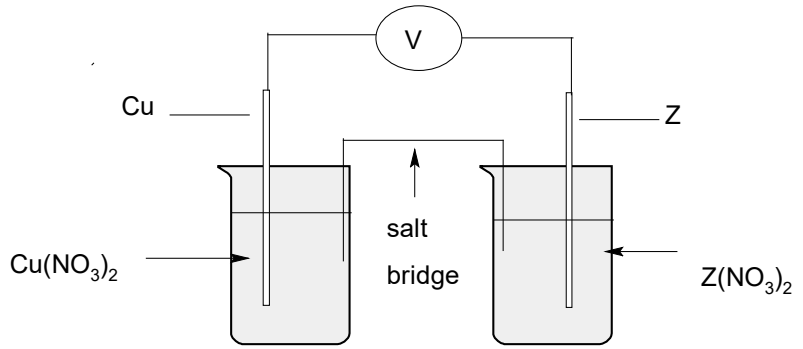
(i) Examine the following cells and then answer the question following:

Cell A



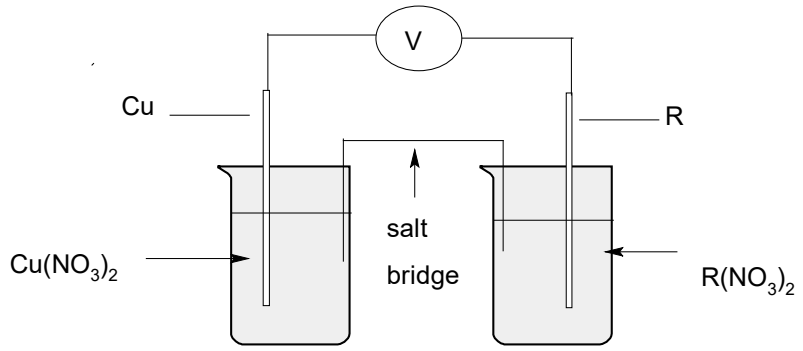
voltmeter reading : +0.58 V

Cell B



voltmeter reading: + 0.46 V

(c) Cell C



voltmeter reading : + 0.78 V

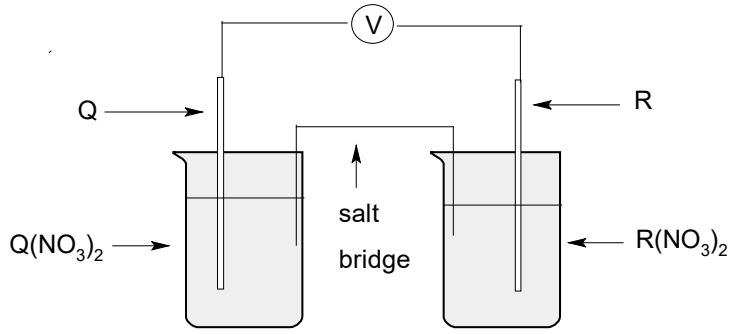
(a) Using the above information, complete the Table of Results (5 marks)

Cell	***Reductant***	***Oxidant***	***Cell potential (voltmeter reading)***	***Reduction Potential of oxidant***
A	*Q*	Cu^{2+}	0.58	*-0.24*
B	*Cu*	Z^{2+}	0.46	*+0.80*
C	*R*	Cu^{2+}	0.78	*-0.44*

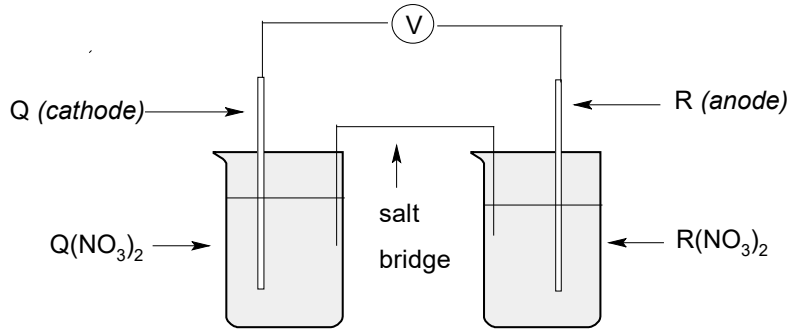
Criterion/ia	*Mark(s)*
9 correct -	5
7-8	4
5-6	3
3-4	2
2	1
1	0

(b) For the following cells:
(i)Label the anode
(ii)Calculate the cell potential
(iii)Write a balanced chemical equation for the reaction

(3 marks)



Possible Answer



.

(ii) E^o *cell* $= E^o_{cathode} - E^o_{anode} = -0.24 - (-0.44) = +0.20$ *V*

(iii) $Q^{2+}(aq) + R(s) \rightarrow R^{2+}(aq) + Q(s)$

or $Q(NO_3)_2(aq) + R(s) \rightarrow R(NO_3)_2(aq) + Q(s)$

Criterion/ia	*Mark(s)*
Correct label of anode/cathode	1
Correct calculation of potential	1
Correct equation with correct subscript	1

(d) E85 does not produce as much energy as E10 or petrol and thus more E85 would need to be used per km travelled than the amount of E10 or petrol required per km.

Outcome criteria	Marks
States one implication regarding the use of E85 in accordance with the information provided in Figure 2.	1