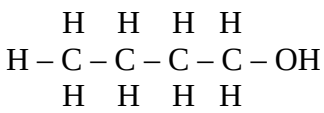
Theory Answers 2009 Term 4 Year 11 Chemistry Paper

Part A: Answer grid for multiple choice questions

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

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.

$$C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$$

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:

$Na_2O_2 + ClO_2 \rightarrow 2\ NaClO_2 + O_2$

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

	oxidant	*reductant*	*reduced product*	*oxidised product*
(A)	**ClO_2**	**Na_2O_2**	**$NaClO_2$**	**O_2**
(B)	Na_2O_2	ClO_2	O_2	$NaClO_2$
(C)	Na_2O_2	ClO_2	$NaClO_2$	O_2
(D)	$NaClO_2$	O_2	ClO_2	Na_2O_2

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.

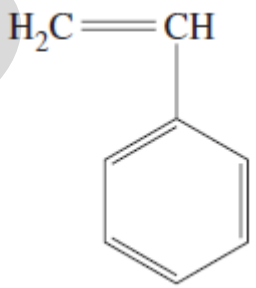
Sample Answer
20 drops of cyclohexene was added to a test tube with 5 drops of bromine water and 20 drops of cyclohexane was added to a test tube with 5 drops of bromine water. The bromine water was decolourised immediately in the cyclohexene as the addition reaction forming 1,2 dibromocyclohexane is 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.

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

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)

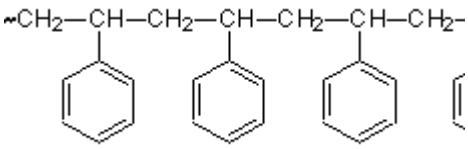
Styrene *1 mark*

(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

Marking Criteria	***Marks***
Describes one use in terms of its properties	***3***
Describes one use OR ***Identifies one use in terms of its properties***	***2***
Identifies one use	***1***

(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 (**if inappropriate -1**)	
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_2

The reaction results in the reduction of the PbO_2 to $PbSO_4$ and the oxidation of Pb to $PbSO_4$

Overall reaction: $Pb(s) + PbO_2(s) + 4\ H^+(aq) + 2\ SO_4^{2-}(aq) \rightarrow 2\ PbSO_4(s) + 2\ H_2O(l)$

Vanadium cell:
At the cathode: $V_2O_5\ (aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2\ VO_2\ (aq) + H_2O\ (l)$
At the anode: $2\ VO(aq) + H_2O\ (l) \rightleftharpoons V_2O_3\ (aq) + 2\ H^+(aq) + 2e^-$

Overall reaction
$V_2O_5 + 2\ VO \rightleftharpoons 2\ VO_2 + V_2O_3$

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)	***1.2***	***0.9***	***1.0***
Initial temperature of water (º)	23	23	23
Final temperature of water (º)	36	36	36
Rise in temperature of water (º)	***13***	***13***	***13***
Mass of water heated (g)	100	100	100

Criteria	***Marks***
Both rows correct	***2***
One row correct	***1***

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

Name of alkanol used	methanol	ethanol	1-propanol
Heat released by burning fuel in experiment (J)	***5434***	***5434***	***5434***
Heat released by burning 1 gram of fuel (J)	***4528***	***6038***	***5434***
Formula of the fuel	***CH_3OH***	***C_2H_5OH***	***C_3H_7OH***
Molar mass of fuel (g)	***32***	***46***	***60***
Heat released by burning the molar mass of fuel (kJ mol^{-1})	***144.9***	***277.7***	***326.0***

Criteria	***Marks***
All 5 rows correctly completed	***5***
4 rows correctly completed	***4***
3 rows correctly completed	***3***
2 rows correctly completed	***2***
1 row correctly completed	***1***

(carry through errors paid)

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

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

Criteria	***marks***
Both answers correct according to calculations	***1***

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

$$C_3H_7OH_{(l)} + 9/2\ O_{2(g)} \rightarrow 3CO_{2\ (g)} + 4H_2O_{\ (g)}$$

Criteria	***Marks***
Correctly balanced equation and subscripts	***2***
Correctly balanced equation	***1***

(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

Criteria	*Marks*
2 reasons explained	*2*
1 reason explained	*1*

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

Energy per gram of octane = 5460/114
Energy per kg of octane = 5460/114 X1000 = 47,894.7 kJ

Energy per gram of ethanol = 1370/46
Energy per kg of ethanol = 1370/46 X1000 = 29,782.6 kJ

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

Criteria	*Marks*
Correct fuel and working shown for both fuels	*2*
Correct working for one fuel	*1*

(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)

$C_2H_5OH_{(l)} + 3O_2 \rightarrow 2CO_{2\,(g)} + 3H_2O_{\,(g)}$

$C_8H_{18(l)} + 25/2\ O_{2(g)} \rightarrow 8CO_{2(g)} + 9\ H_2O_{(g)}$

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

Criteria	*Marks*
Correct equations for both fuels and conclusion	*2*
Correct equation for one fuel	*1*

(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_2 released between days 1 and 7 (1 mark)

Sample Answer :

Mass of $CO_{2(g)}$ released = (381.05 – 370.39)g = 10.66g
Moles of $CO_{2(g)}$ released = 10.66g / 44.01g/mol = 0.2422 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

$C_6H_{12}O_{6(aq)} \dashrightarrow 2CH_3CH_2OH_{(aq)} + 2CO_{2(g)}$

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

Moles of glucose fermented = ½ moles of $CO_{2(g)}$ produced = 0.1211 mol

Mass of glucose fermented = 180.16 X 0.1211 = 21.82 g

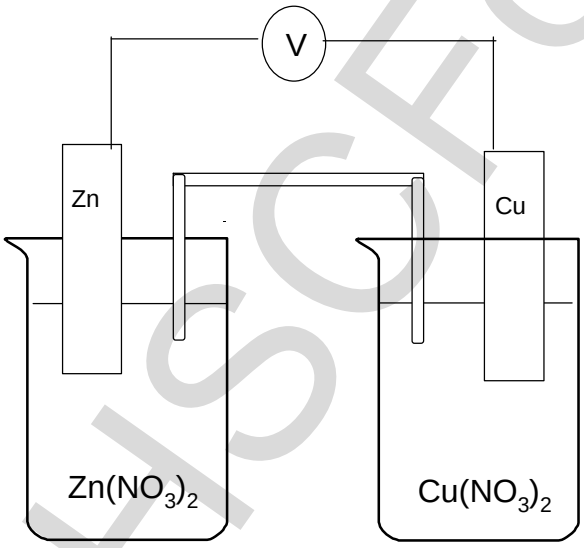
Marking Criteria

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.

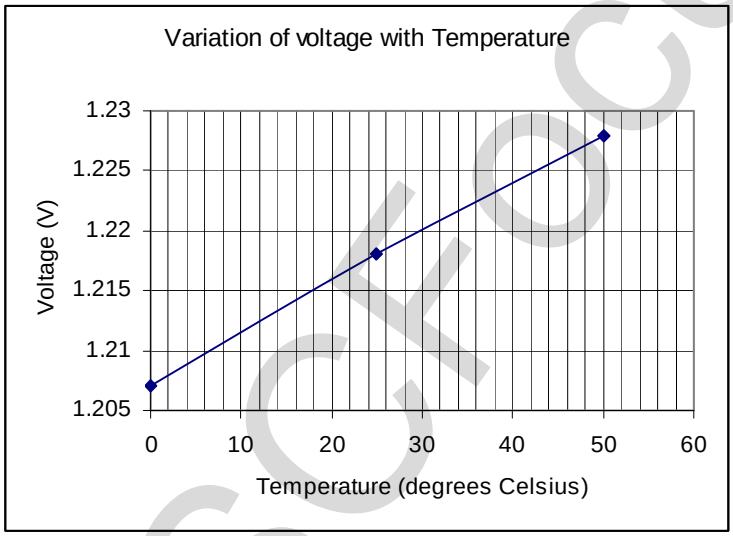
Experiment 1. Keeping the temperature and the $[Zn^{2+}]$ constant, the students measured the potential of the cell at various Cu^{2+} concentrations.

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 results of both experiments are given in the table below:

Experiment	*molL^{-1} X $^{2+}$*	*molL^{-1} M $^{2+}$*	*Temperature (^{o}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	**1**
correct plotting and line of best fit	**1**
correct orientation of variables	**1**



(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 Cu^{2+}. (2 marks). If the 10-fold qualifier is not included in the statement then only 1 mark is awarded.