James Ruse Agricultural High School

Theory and Data Processing

Chemistry Assessment
Term 4 2013

General Instructions

- **Reading Time**: 5 minutes
- **Working Time**: 90 minutes
- **Complete both Theory and Data Processing in the time, 90 minutes.**
- Write using black or blue pen
- Board approved calculators may be used
- Write your Student Number on the answer booklets
- A Periodic Table and Data Sheet are provided.

Total Marks: 67

Theory Test
Total marks: 26
Take about 20 minutes to do this section

Data Processing
Total marks: 41
Take about 70 minutes

to do this section

Part A

Multiple Choice: 9 marks
Attempt Questions 1-9

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

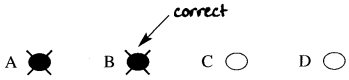
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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 – 9 in the Answer Box on page 7

Part A : Multiple Choice

1. Which reagent can be used to distinguish between an alkane and an alkene?

(A) Aqueous bromine

(B) Concentrated sulfuric acid

(C) Zeolites

(D) Zeigler-Natta catalyst

2. For which of the following elements are there no stable isotopes?

(A) Carbon

(B) Argon

(C) Europium

(D) Astatine

3. Which of the following statements is correct?

(A) Displacement of a metal ion from solution oxidizes the metal ion.

(B) Displacement of a metal ion from solution reduces the metal ion.

(C) Displacement of a metal -from solution oxidizes the metal.

(D) Displacement of a metal -from solution reduces the metal.

4. How can a new heavier element be created artificially?

(A) Bombard a metal atom with protons

(B) Bombard a metal atom with electrons.

(C) Bombard a metal atom with neutrons

(D) Bombard a metal atom with metal ions.

5. Which of the following changes is/are oxidation?

(i) MnO_4^- to Mn^{2+}
(ii) SO_2 to SO_4^{2-}
(iii) Cu to Cu^{2+}
(iv) $C_2O_4^{2-}$ to CO_2

(A) All of the above

(B) (i), (ii) and (iii) only

(C) (iii) and (iv) only

(D) (ii), (iii) and (iv) only

6. Which is the correct term used to describe the polymerisation of glucose into cellulose?

(A) Addition

(B) Hydration

(C) Condensation

(D Hydrolysis

7. Why is ethanol used in preference to water as the solvent in the production of perfume?

(A) Ethanol is cheaper to produce.

(B) Ethanol dissolves a greater variety of compounds more readily.

(C) Ethanol has a significantly lower density.

(D) Ethanol has no detectable odour.

8. The molar heat of combustion of pentan-1-ol is 2800 kJ mol^{-1}.

A quantity of pentan-1-ol was combusted, generating 108 kJ of heat.

What mass of pentan-1-ol was combusted?

(A) 2.29 g

(B) 2.86 g

(C) 3.32 g

(D) 3.40 g

9. Which is the dependent variable in a first-hand investigation to determine and compare the heat of combustion of three different liquid alkanols?

(A) Type of alkanol used

(B) Amount of water used

(C) Amount of alkanol used

(D) Temperature change in the water

Part B : Extended Response Questions (17 Marks)

Question 10 (5 marks)

The fictitious reduction potential of elements W, X, Y and Z are given:

	$E^0_{reduction}$ (V)
$W^{2+}(aq) + 2e^- \rightarrow W(s)$	+0.28
$X^{2+}(aq) + 2e^- \rightarrow X(s)$	-0.92
$Y^{2+}(aq) + 2e^- \rightarrow Y(s)$	-0.14
$Z^{+}(aq) + e^- \rightarrow Z(s)$	+ 0.42

(a) Choose two elements from W, X, Y and Z which will produce the highest voltage in a galvanic cell. What is the E^0_{cell} of such a combination? (2 marks)

……..

…….

…….

(b) Draw a working galvanic cell which uses the elements specified in (a). Label the following: (i) the positive electrode (ii) the direction of flow of anions.
Use an arrow to point to the relevant part (i) or where the process occurs (ii). (3 marks)

Question 11 (5 marks)

(a) Write a balanced chemical equation to show the fermentation of glucose to ethanol. Include states in the equation. (2 marks)

…….

(b) Outline the optimal conditions required for the fermentation of glucose to ethanol. (3 marks)

……..

…….

…….

……..

Question 12 (5 marks)

(a) Calculate the mass of ethanol that must be burnt to increase the temperature of 210 g of water by 65°C, if exactly half of the heat released by this combustion is lost to the surroundings. The heat of combustion of ethanol is 1367 kJ mol^{-1}. (3 marks)

……..

…….

…….

……..

……..

…….

…….

……..

……..

…….

(b) What are TWO ways to limit heat loss from the apparatus when performing a first-hand investigation to determine and compare heat of combustion of different liquid alkanols? (2 marks)

……..

……..

……

……

Question 13 (2 marks)

Explain the term “condensation polymer” using cellulose as an example.

……..

……..

……

……

……

……

End of theory, continue with Data Processing

Student Number.....

Data Processing Mark ……....

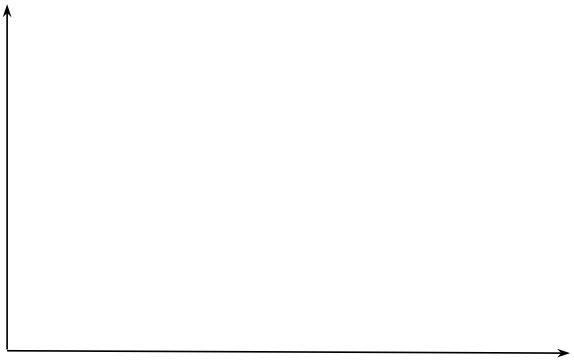
Data Processing - 41 marks

Question 1 (7 marks)

A 2.3 g sample of solid sodium metal is warmed in a reaction vessel with excess chlorine gas. A reaction occurs that produces sodium chloride solid. The initial potential energy (enthalpy) in the bonds of the reactants was 520 kJ mol^{-1} while the potential energy in the bonds forming in the product is 109 kJ/mol.

Energy equal to 376 kJ mol^{-1} was supplied to the reactants to cause the reaction to proceed.

(a) In the space below draw a fully labelled graph to show the enthalpy change as the reaction proceeded. (4 marks)



(b) How many moles of sodium chloride solid would have formed in the reaction? (1 mark)

…….

…….

(c) Using the available information, calculate the energy released from the reaction? Show working. (2 marks)

…….

…….

…….

Question 2 (11 marks)

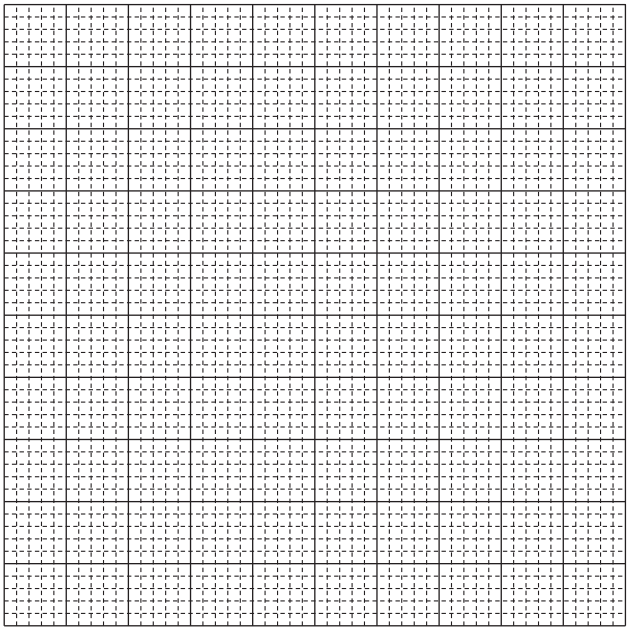
The heats of combustion of three alkanols were determined.

The results are shown in the table (the table is incomplete).

Alkanol	Heat released per gram of fuel (kJ)	Molar mass	Heat of combustion (kJ mol^{-1})
1-propanol	33.7		
1-butanol	36.2		
1-hexanol	39.0		

(a) Complete the table for the molar mass and the molar heat of combustion of the alkanols. (6 marks)

(b) Plot a graph of the heat of combustion versus the molecular weight of the three alkanols. (3 marks)



Molecular weight

(c) Use the graph to estimate to estimate the heat of combustion of 1- pentanol. (1 mark)

…….

(d) Give a reason for the shape of the graph. (1 mark)

…….

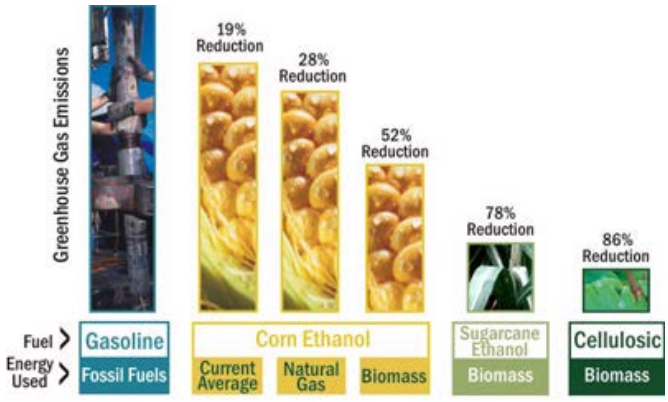
…….

…….

Continue to question 3

Question 3 (10 marks)

(a) Using the information in the graph below compare the reduction in greenhouse gas emissions from gasoline/fossil fuels to using sugar cane / ethanol biomass.(2 marks)



Source: Wang et al, *Environmental Research Letters*, Vol. 2, 024001, May 22, 2007

……

……

……

(b) What would be the advantage of using corn ethanol as a fuel compared to cellulosic biomass.

Show all working for calculation. (4 marks)

……

……

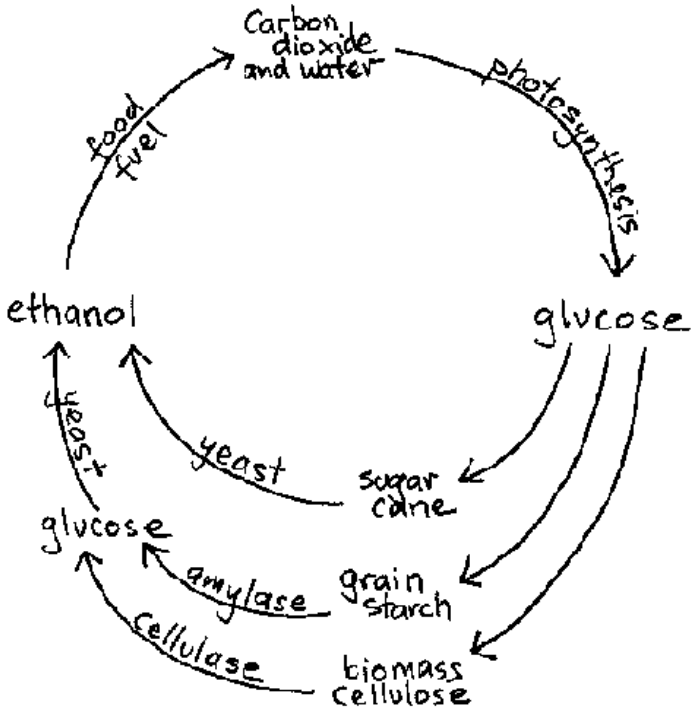
……

……

……

……

(c) Use the following flowchart, and your knowledge about the production of ethanol from sugarcane, to discuss the carbon neutrality of using ethanol as a fuel. (4 marks)



……

……

……

……

……

……

Question 4 (13 marks)

Batteries

Batteries are devices that produce electric current from a spontaneous chemical reaction. Batteries have a finite life due to occurrence of unwanted chemical or physical changes to, or the loss of, active materials of which they are made. These changes are usually irreversible and they affect the electrical performance of the cell. There are several factors that affect battery life and performance

Battery Calendar Life is the elapsed time before a battery becomes unusable whether it is inactive or in active use. The two key factors influencing calendar life are temperature and time.

Battery Shelf Life is the time an inactive battery can be stored before it becomes unusable, usually considered as having only 80% of its initial capacity.

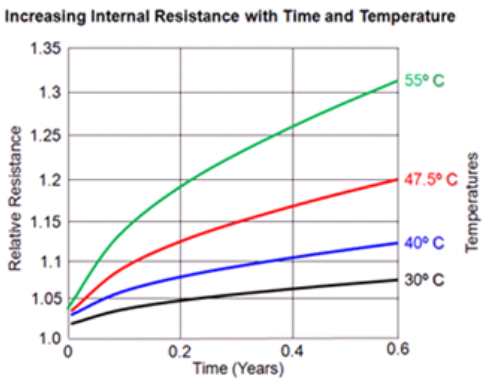
Battery Cycle Life is defined as the number of complete charge - discharge cycles a battery can perform before its capacity falls below 80% of its initial rated capacity. Key factors affecting cycle life are time **t** and the number **N** of charge-discharge cycles completed. Lifetimes of 500 to 1200 cycles are typical. The actual ageing process results in a gradual reduction in capacity over time.

Internal resistance of the cell is an alternative measure of cycle life. In this case the cycle life is defined as the number of cycles the battery can perform before its internal resistance increases by about 1.3 times or double its initial value when new.

Depth of Discharge (**DOD**) (%) – The percentage of **battery** capacity that has been discharged expressed as a percentage of maximum capacity.

Graph 1 is given below. Graphs 2,3,4 and 5 are on a separate data sheet.

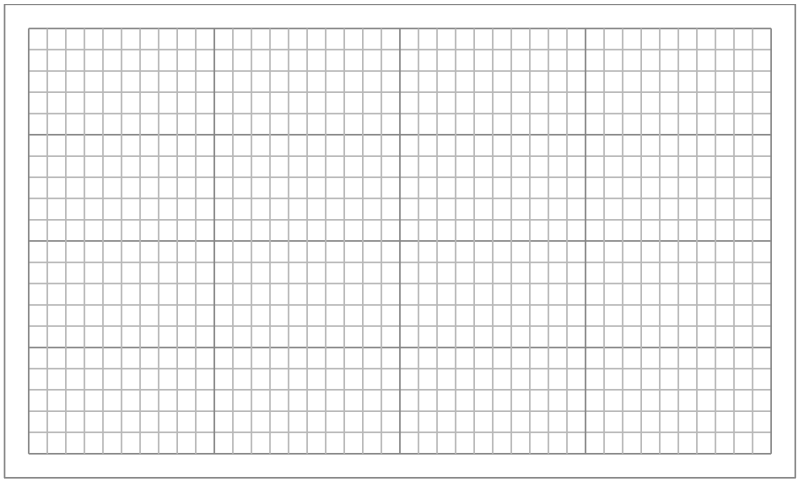
Graph 1



Use Graphs 1 to 5 to answer the following questions:

(a) In the space provided, create a table using the data of Graph 1. (3 marks)

(b) Use the grid to draw a graph that relates relative resistance against temperature at 0.6 years of battery life. (2 marks)



(c) Describe the relationship between internal resistance of a cell, time and temperature. (2 marks)

…….

…….

…….

(d) What can you conclude from these findings about the life of the battery? (1 mark)

……

……

……

(e) What is the optimum cell operating temperature for the battery that corresponds to Graph 2? (1 mark)

……

……

(f) Which ONE of the graphs detail(s) the voltage capability and cycle life of a specific battery as a function of temperature?.
Describe in detail the relationship(s) shown by your chosen graph. (2 marks)

……

……

……

……

(g) Based on the information presented in Graphs 1 to 5, explain what operating conditions must be used in order to ensure the maximum voltage obtainable and the maximum lifetime for batteries. Refer to the graph(s) in your explanation. (2 marks)

.....

.....

.....

.....

.....

.....

.....

.....

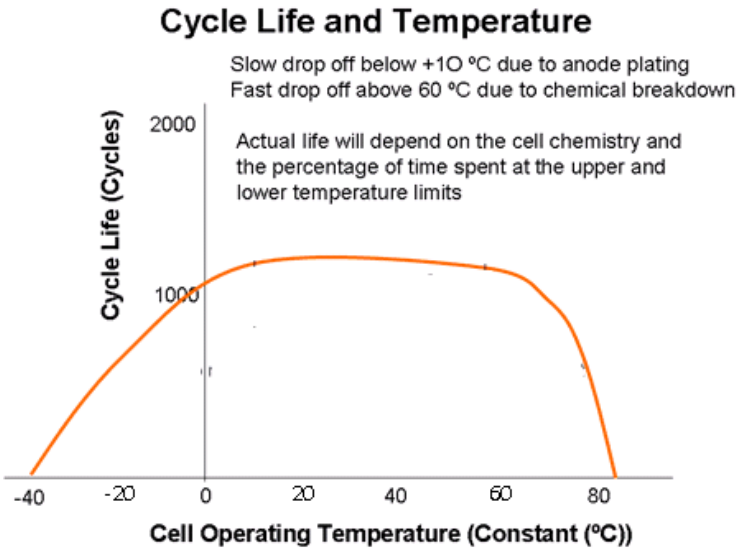
.....

.....

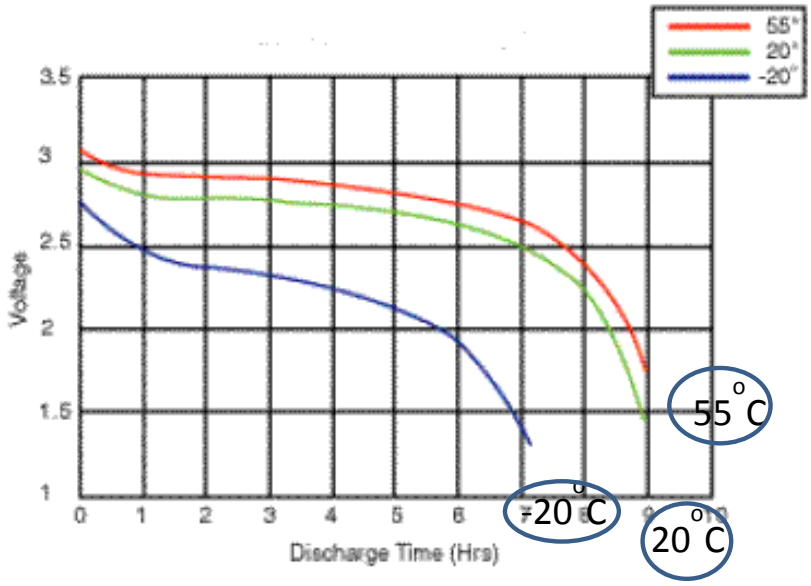
End of Data Processing

Data Sheet for question 4

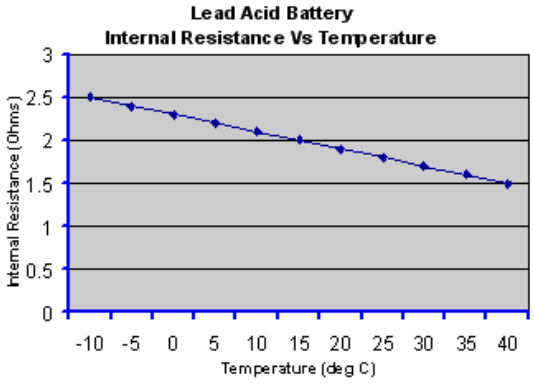
Graph 2



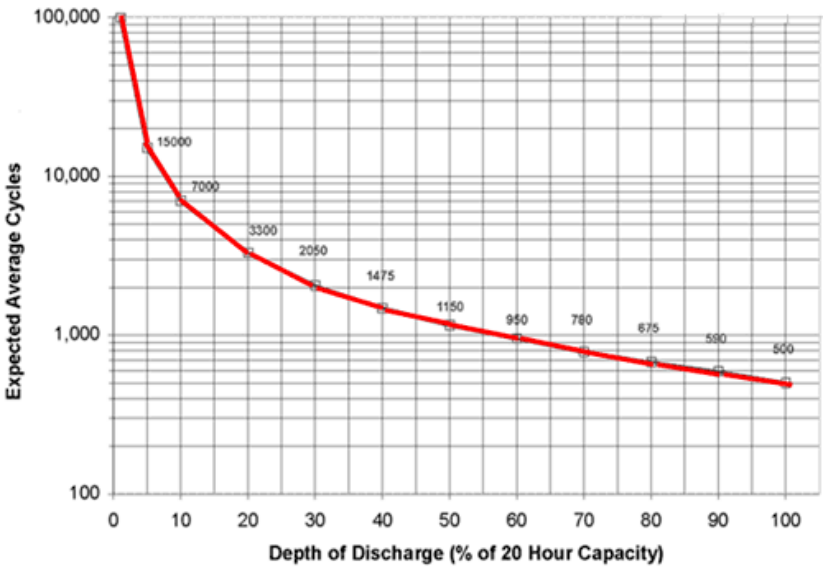
Graph 3



Graph 4



Graph 5


100,000
10,000
1,000
100
Expected Average Cycles
15000
7000
3300
2050
1475
1150
950
780
675
590
500
0
10
20
30
40
50
60
70
80
90
100
Depth of Discharge (% of 20 Hour Capacity)