James Ruse Agricultural High School

Theory and Data Processing

Chemistry Assessment
Term 4 2012

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 68

Theory Test
Total marks: 36
Take about 40 minutes to do this section

Data Processing
Total marks: 32
Take about 50 minutes to do this section

Part A

Multiple Choice: 10 marks
Attempt Questions 1-10

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

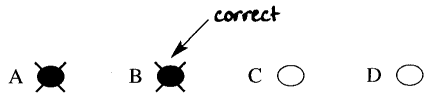
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

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 ○

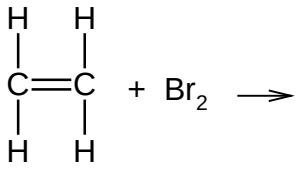
If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word ~~correct~~ and drawing an arrow as follows.



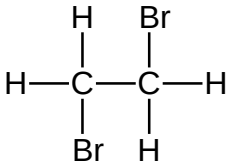
▸ Mark your answers for Questions 1 – 10 in the Answer Box on page 7

Part A : Multiple Choice

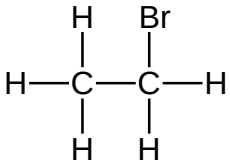
1. Which is the correct product of the following reaction?



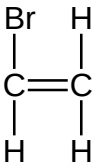
(A)



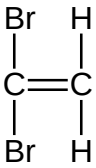
(B)



(C)



(D)



2. What is one advantage of catalytic cracking?

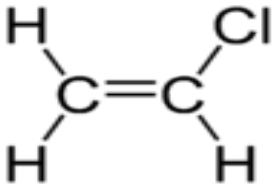
(A) Lower temperature can be used which results in saving energy.

(B) Hydrocarbons are decomposed to form carbon dioxide and water.

(C) It speeds up the process of fractional distillation.

(D) Higher yields of ethylene are favoured by higher temperatures.

3. What is the systematic name of the following compound ?



(A) vinylchloride

(B) chloroethane

(C) chloroethene

(D) 1-chloroethene

4. Which is the polymer formed by an addition reaction of ethenylbenzene ?

(A) polyethylene

(B) polyvinylchloride

(C) polystyrene

(D) polyvinylacetate

5. In a fermentation experiment, 10.8 g of glucose was completely converted to ethanol and carbon dioxide.

What is the volume of carbon dioxide produced at 25^0C ?

(A) 2.97 L

(B) 1.49 L

(C) 0.06 L

(D) 0.12 L

6. Which of the following shows the pathway for the industrial production of ethanol from sugar cane?

(A) fractional distillation → catalytic cracking → hydration

(B) crushing → fractional distillation → fermentation

(C) crushing → hydrolysis → fermentation → fractional distillation

(D) catalytic cracking → fermentation → fractional distillation

7. Which is the oxidant and which is the reductant in the following reaction?

$$2\ Ca_3(PO_4)_2\ (s)\ +\ 6\ SiO_2\ (s)\ +\ 10\ C\ (s)\ \longrightarrow\ 6\ CaSiO_3\ (s)\ +\ 10\ CO\ (g)\ +\ P_4\ (g)$$

	Oxidant	*Reductant*
(A)	SiO_2	$Ca_3(PO_4)_2$
(B)	C	SiO_2
(C)	$Ca_3(PO_4)_2$	C
(D)	C	$Ca_3(PO_4)_2$

8. Assuming that the initial concentrations of dissolved species are all 1.0 mol L^{-1}, which of the following reactions will NOT occur spontaneously at 25 ^{o}C?

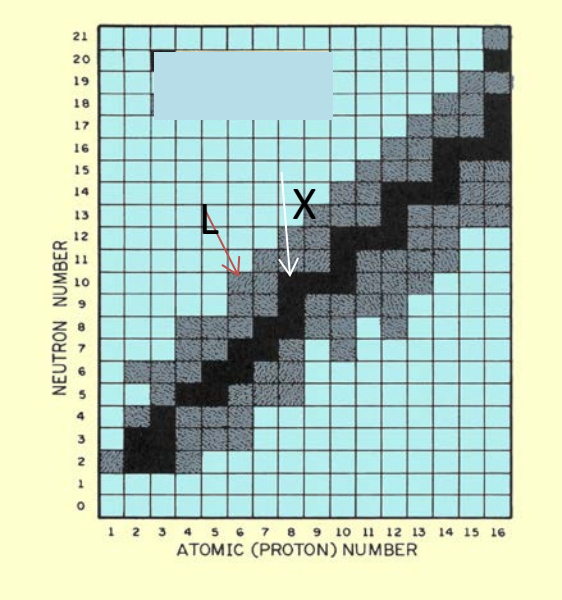
(A) $Ca\ (s)\ +\ Mg^{2+}\ (aq)\ \longrightarrow\ Ca^{2+}(aq)\ +\ Mg\ (s)$

(B) $2\ Ag^{+}\ (aq)\ +\ Ni\ (s)\ \longrightarrow\ 2\ Ag\ (s)\ +\ Ni^{2+}\ (aq)$

(C) $Cu^{+}\ (aq)\ +\ Fe^{3+}(aq)\ \longrightarrow\ Cu^{2+}(aq)\ +\ Fe^{2+}(aq)$

(D) $2\ Br^{-}\ (aq)\ +\ Sn^{2+}\ (aq)\ \longrightarrow\ Br_2\ (l)\ +\ Sn\ (s)$

Use the following diagram to answer questions 9 and 10.



9. Which of the following choices is the correct representation of isotopes *L* and *X*?

(A)	${}^{10}_{6}L$	${}^{10}_{8}X$
(B)	${}^{16}_{6}L$	${}^{18}_{8}X$
(C)	${}^{6}_{16}L$	${}^{8}_{18}X$
(D)	${}^{6}_{10}L$	${}^{8}_{10}X$

10. Which choice gives the correct stability and mode of decay of the elements, *L* and *X*?

		Stable/Unstable	*Mode of decay*
(A)	*L*	stable	none
(B)	*L*	unstable	β - decay
(C)	*X*	unstable	β - decay
(D)	*X*	stable	none

Student Number .....

Theory Mark …….

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
6.	A O	B O	C O	D O
7.	A O	B O	C O	D O
8.	A O	B O	C O	D O
9.	A O	B O	C O	D O
10.	A O	B O	C O	D O

Part B : Answer Questions 11-15 in the spaces provided (26 Marks)

Question 11 (6 marks)

(a) Describe the structure of cellulose. (2 marks)

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(b) Discuss the significance of cellulose as a major component of biomass. (4 marks)

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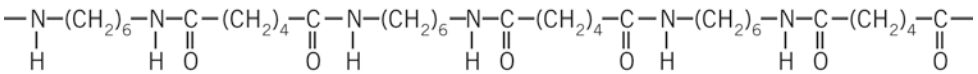
Question 12 (2 marks)

Draw the structures of the two monomers that were used to form the segment of the condensation polymer shown below.



Monomer 1

Monomer 2

Question 13 (5 marks)

A galvanic cell consists of an iron electrode in a 1.0 mol L^{-1} solution of iron (II) sulfate and a tin electrode in a 1.0 mol L^{-1} solution of tin (II) sulfate.

(a) Draw a neat, labelled diagram of the working galvanic cell.
In your diagram, label

(i) the anode
(ii) the positive electrode
(ii) the path of electron flow
(iii) the path of anion flow

(4 marks)

(b) Calculate the cell potential. (1 mark)

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Question 14 (8 marks)

Identify a radioisotope used in medicine.

Assess its use in relation to its production, properties and other relevant issues.

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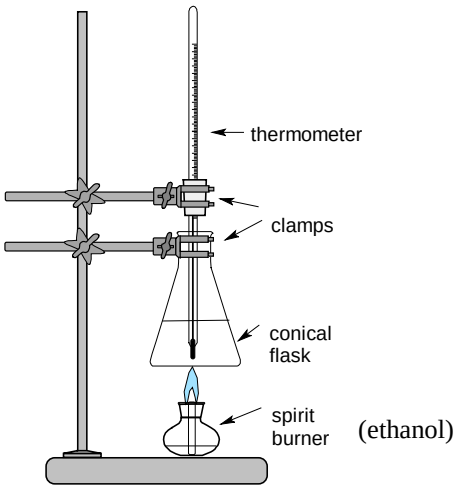
Question 15 (5 marks)

A pair of year 12 students performed an experiment to determine the heat of combustion of ethanol. The ethanol was burned in a spirit burner and the heat released was used to heat 100.0 mL of water, as shown in the diagram below.



The results they obtained were:

Initial temperature of the 100.0 mL of water	=	20.6 ^{0}C
Final temperature of the 100.0 mL of water	=	32.9 ^{0}C
Initial mass of the spirit burner + ethanol	=	251.24 g
Final mass of the spirit burner + ethanol	=	249.97 g

(a) Use these results to determine the molar heat of combustion of ethanol. (4 marks)

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(b) The experimental molar heat of combustion was much lower than the text book value. With reference to the set up shown, outline ONE reason for the difference in values. (1 mark)

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End of theory, continue with Data processing...

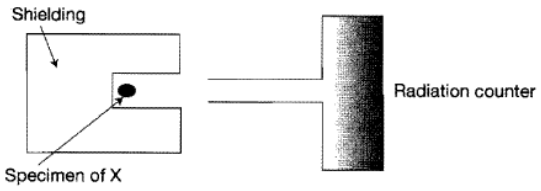
Data Processing

Student Number .....

Data Processing Mark ……....

Question 1 (10 marks)

A student was set the task of designing and doing an experiment to determine the half-life of a radioactive isotope, X. She set up the following apparatus:



Before introducing the sample of X into the apparatus, she measured the background radiation each minute and recorded the following results:

Trial	Radiation counts
1	25
2	29
3	36
4	22
5	28

She then placed X in the shielding and recorded the following results over a period of 24 days.

Time (days)	Radiation (counts/minute)	Corrected Radiation Count (counts/minute)
0	988	
6	568	
12	328	
18	193	
24	119	

(a) Calculate the average background radiation count.. (1 mark)

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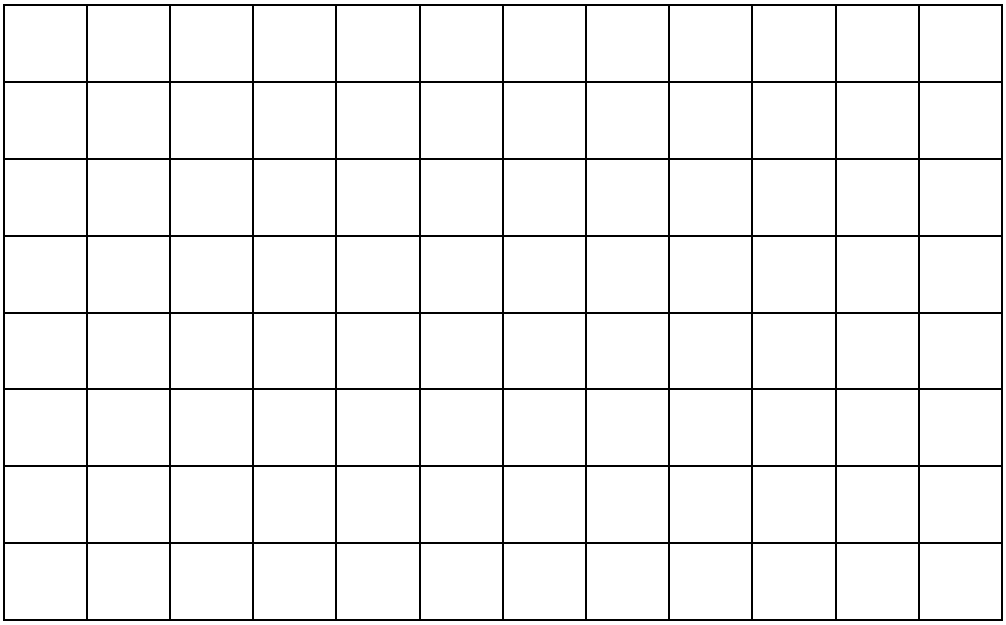
(b) Complete the table above by recording the corrected radiation count for each day measurements were made. Show working. (1 mark)

(c) On the grid provided, plot the corrected radiation count against time and draw the curve of best fit.. Put time on the x- axis. (5 Marks)



(e) The half-life of a radioisotope is the time it takes for half of the mass to decay. Use your graph to determine the half-life of isotope X. (1 mark)

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(f) From your graph, predict the radiation count from the sample of X on: (2 marks)

Day 9 = ……

Day 38 = ……..

Question 2 (6 marks)

Modern jet aircraft, particularly those transporting large numbers of people or with large cargoes, use substantial amounts of atmospheric oxygen to burn the necessary fuel for their flights. As a result, they produce substantial amounts of carbon dioxide and heat energy.

Data:

- Air is 20% oxygen
- Oxygen is put into the air by the process of photosynthesis in green plants according to the equation : $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
- When a hydrocarbon burns completely, it produces water and carbon dioxide.
- The composition of aviation fuel varies considerably, but it always a mixture of hydrocarbons, mostly alkanes. These vary in carbon chain length from C_5 to C_{15}. The hydrocarbon decane ($C_{10}H_{22}$) is and average of these.
- The density of decane is $0.73 gmL^{-1}$ at 20^0C and its melting point is -27^0C and its boiling point is 174^0C.
- A laden Boeing 767 uses 4.7 litres of fuel every second while in flight.
- A 767 flight from Sydney to Los Angeles takes 13.5 hours.
- The balanced equation for the complete combustion of decane is:

  $C_{10}H_{22}\,(l) + O_2\,(g) \rightarrow CO_2\,(g) + H_2O\,(l)$

(a) Determine the mass of one litre of decane. (1 mark)

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(b) What is the molar mass of decane? (1 mark)

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(c) How many moles of decane are present in a litre of decane at 25^0C and 100 kPa? (1 mark)

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(d) Calculate the number of litres of decane burned on a Sydney to Los Angeles flight. (2 marks)

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(e) What mass, in grams, does the volume in (e) represent? (1 mark)

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Question 3 (16 marks)

Straight chain hydrocarbons with halogens on the chains e.g. chlorine and fluorine, have appeared in the natural environment in steadily increasing amounts over several decades as a consequence of their growing use, chiefly as refrigerants, foam blowing agents and solvents, prompted by their unique properties and low cost. These compounds are referred to as CFCs. It is recognised that human applications of the above compounds, which are classified as ozone – depleting substances (ODSs), are partly responsible for the depletion of stratospheric ozone and may contribute to global warming and the greenhouse effect. Stratospheric ozone is essential as a barrier for UV radiation from the sun.

The photodecomposition of these compounds in the stratosphere produces significant amounts of chlorine atoms, which cause the destruction of stratospheric ozone, which allows increased levels of biologically damaging UV radiation to reach the Earth's surface.

Use the text and the loose data sheet to answer the following questions.

Figure 1 and Figure 2

(a) Within what altitude range were the ozone concentrations measured? (1 mark)

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(b) Estimate the altitude that recorded the highest level of ozone. (1 mark)

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(c) Which layer of the atmosphere corresponds with this highest level? (1 mark)

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(d) Which halogen in the text causes the destruction of stratospheric ozone? (1 mark)

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Table 1 and Table 2

(e) Which compound can be used as both a solvent and a cleaning agent? (1 mark)

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(f) What does ODP stand for? (1 mark)

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(g) Which compound has the greatest ODP? (1 mark)

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(h) Which of the compounds has the greatest halocarbon global warming potential (HGWP)? (1 mark)

…….

(i) Compare the HGWP of ozone depleting substances (CFCs) with their replacement compounds (HCFCs and HFCs) (2 marks)

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(j) Which 3 compounds have the greatest residence time in the atmosphere? (1 mark)

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(k) Assess the possibility of solving the two problems of ozone depletion and global warming in the next ten years. (5 marks)

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End of Data Processing