James Ruse Agricultural High School

Theory Exam

Chemistry Assessment
Term 4 2015

General Instructions

- **Reading Time**: 5 minutes
- **Working Time**: 95 minutes
- **Complete both Theory and Data Processing Tasks**

- 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: 35
Take about 35 minutes
to do this section

Data Processing
Total marks: 33
Take about 60 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.

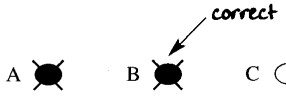
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

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 of the following is an IUPAC name of a commonly existing polymer?

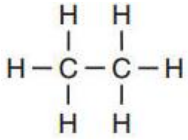
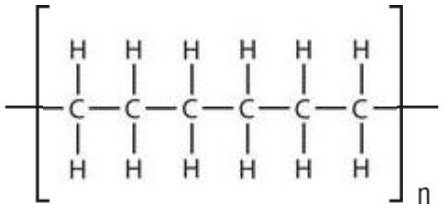
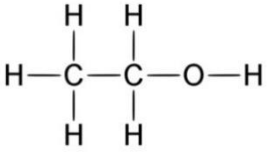
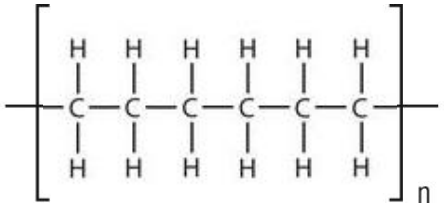
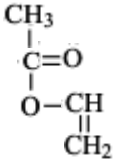
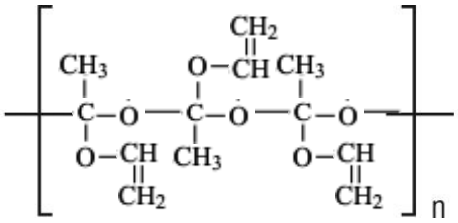
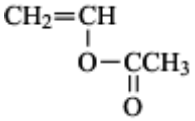
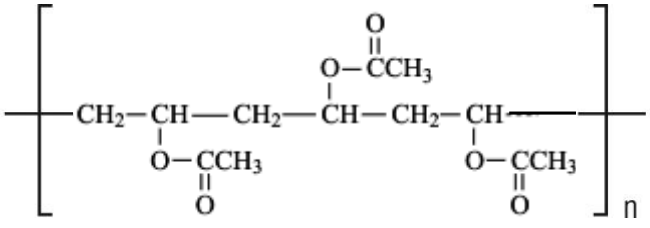
   (A) High density polyethylene

   (B) Polyethenylbenzene

   (C) Polybenzylethene

   (D) Poly(vinyl chloride)

2. Which of the following correctly matches the monomer with its polymer?

	Monomer	*Polymer*
(A)		
(B)		
(C)		
(D)		

3. Which of the following is a correct statement about condensation polymerisation?

(A) It produces only the desired polymer.
(B) Water is always a product.
(C) Molecules with a small molecular weight are always produced as a product.
(D) Always produce simple atoms with a small molecular weight as a product.

4. Which reaction occurs at the anode of a galvanic cell?

(A) oxidation
(B) reduction
(C) corrosion
(D) hydrolysis

5. What is the oxidation state of manganese in $KMnO_4$?

(A) +2
(B) +4
(C) +5
(D) +7

6. What would be the calculated standard cell potential (E^0) for a cell consisting of cobalt and bromine?

(A) +0.28 V
(B) -1.09 V
(C) +1.09 V
(D) +1.37 V

7. Which of the following can have their motion affected by a particle accelerator?

(A) an alpha particle and a beta particle

(B) an alpha particle and a neutron

(C) a gamma ray and a beta particle

(D) a neutron and a gamma ray

8. Which of the following can be blocked by a sheet of paper?

(A) alpha particles

(B) beta particles

(C) gamma rays

(D) electrons

9. Which of the following particles **cannot** be deflected in a magnetic field?

(A) alpha particle

(B) beta particle

(C) neutron

(D) proton

10. Which is the correct molecular formula for pentan-2-ol?

(A) C_5H_9OH

(B) $C_5H_{12}OH$

(C) $C_4H_{10}OH$

(D) $C_5H_{12}O$

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: 25 marks
Attempt questions 11 - 16
Allow about 23 minutes for this part

- *Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response*
- *Show all relevant working in questions involving calculations*

Question 11 (3 marks)

Describe the steps involved in the process of addition polymerisation**.** **3**

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Question 12 (4 marks)

Draw a labelled diagram of a galvanic cell consisting of copper and silver electrodes and their respective ions in solution.

Include the anode, cathode, direction of electron flow and direction of ion flow. **4**

Question 13 (5 marks)

Radioactive isotopes are frequently employed in industry and medicine. Beside the benefits gained by their application, there are risks that must be addressed.

Identify ONE radioisotope used in medicine or industry and analyse the benefits and risks associated with its use. **5**

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Question 14 (3 marks)

Ethanol is widely used as a solvent. Most ethanol required for industrial use is produced using raw materials obtained from the refining of petroleum.

(a) Draw the structural formula for ethanol. **1**

(b) Account for the use of ethanol as a solvent for grease and table salt. **2**

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Question 15 (5 marks)

Spirit burners are to be used in an experiment to compare the molar heat of combustion for two liquid fuels: ethanol and pentanol.

(a) Draw a labelled diagram of the apparatus required to obtain the data required to calculate the heat of combustion of the alkanols. **2**

(b) Some results from the experiment are:
1.5 g of ethanol was burned.
The experiment was conducted at $25^{o}C$ and 100 kPa
The temperature rise for the water in the calorimeter was 53.1 K
The heat of combustion for ethanol is 1364 kJ per mole.
The specific heat capacity for water is 4.18×10^{3} J kg^{-1} K^{-1}.
The mass of the filled spirit burner was 201.5 g.

Calculate the mass of water that was heated in the calorimeter. **3**

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Question 16 (5 marks)

Petrol stations today now sell E-10 petrol. This is a mixture of 90% unleaded petrol and 10% ethanol.

Justify the addition of ethanol to petrol.

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End of Theory Exam……..Continue with Data Processing

Student Number	
Data Processing Mark	

JAMES RUSE AGRICULTURAL HIGH SCHOOL

2015 YEAR 12 CHEMISTRY

TERM 4 ASSESSMENT TASK

DATA PROCESSING

Total: 33 marks

Attempt questions 1 to 4

Allow about 60 minutes for this part

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Question 1 (15 marks)

Analysis of the degree of polymerisation

When synthetic polymers are produced they comprise of many units of different chain lengths. Chain length is often expressed in terms of molecular weight of the polymer chain, related to the relative molecular mass of the monomers and the number of monomers connected in the chain.

The industrial production of polymers requires monitoring. Manufacturers need to know the yield of product and also properties of the product. This is because different polymer lengths can co-exist and grow throughout the duration of the reaction because of random collisions.

The polymers produced could be analysed by finding the "number average molecular weight" (M_n) and "weight average molecular weight" (M_w).

Given that:

Symbol	*Definition*
M_n	number average molecular weight
M_w	weight average molecular weight
$\sum$	sum of all the products of the individual M_n
M_i	molecular weight of chain
n_i	number of chains of that molecular weight
w_i	weight fraction of polymer chain
p	extent of reaction, when p = 0 is the beginning of the reaction and when p = 1 is the completion of the reaction.
MW	molecular weight

$$M_n = \sum \frac{n_i M_i}{\sum n}$$

The number average molecular weight (M_n) is the total weight of all the polymer molecules in a sample divided by the total number of polymer molecules in the sample.

$$M_w = \sum w_i M_i$$

The weight average molecular weight (M_w) is the total weight fraction (w_i) of each polymer length multiplied by its respective molecular weight. The average molecular weight is based on the fact that a bigger molecule contains more of the total mass of the polymer sample than the smaller molecules do.

The relationship between these two values and the extent of reaction (p) is:

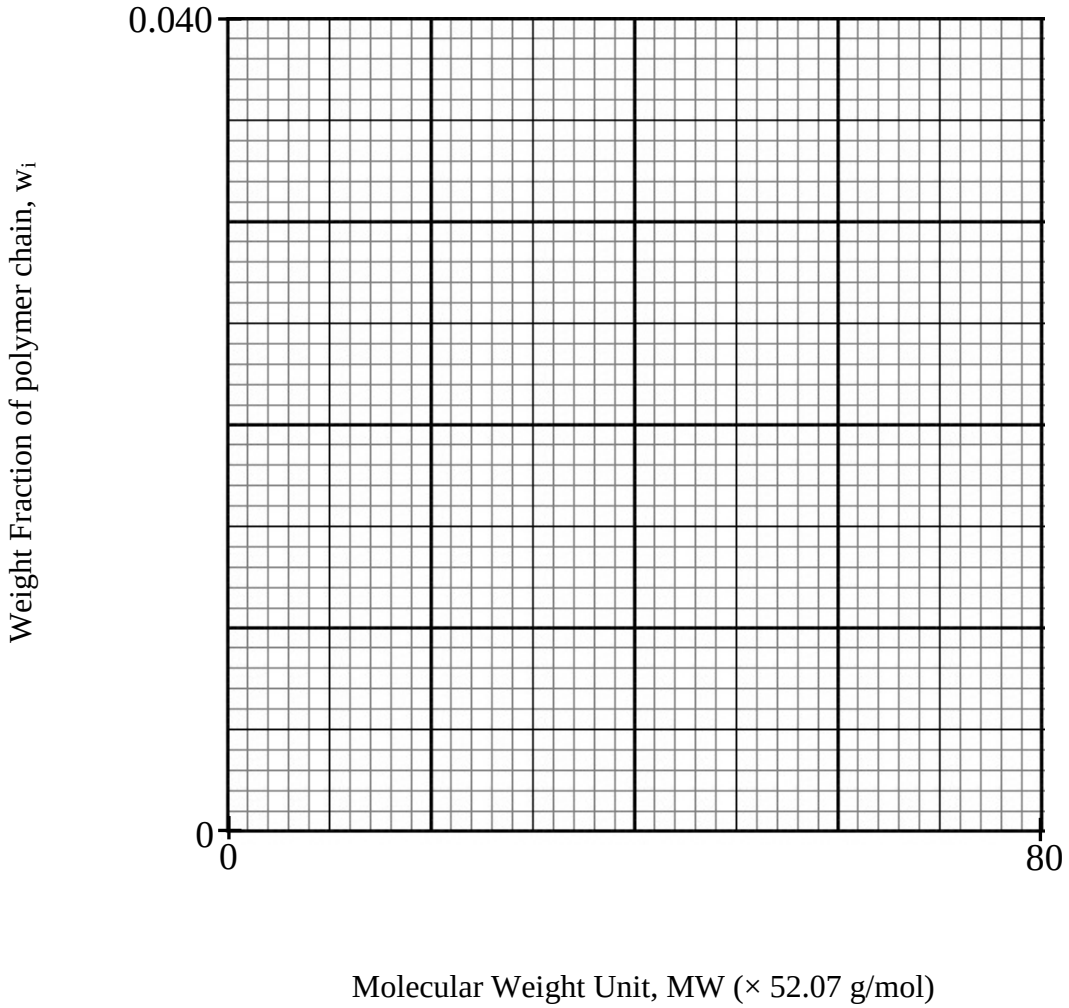
$$\frac{M_w}{M_n} = 1 + p$$

A chemical analyst gathered two data sets (A and B) from the polymerisation of ethylene, where each unit of the polymer (monomer) is 52.07 g/mol.

Table A (p = 0.90) at t_1

Weight fraction of polymer chain (w_i)	*Molecular Weight Unit, MW (× 52.07 g/mol)*
0.008	1
0.015	1.5
0.025	3
0.032	5
0.038	11
0.032	17
0.025	22
0.015	28
0.008	35

(a) Plot the data provided in the Table A (the axes are already given).
Include a curve of best fit. Label this curve **P**. **3**



(b) Use curve P to determine the number average molecular weight (M_n) which could be found by reading the peak of curve P from your graph.
Label this value as **M_nP** on curve P. **2**

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(c) Using your answer in part (b), calculate the weight average molecular weight (M_w).
Label this value as **M_wP** on curve P. **2**

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(d) Plot the data from Table B (given below) on the graph on page 13.
Include a curve of best fit. Label this curve **Q**. **2**

Table B (p = 0.95) at t_2

Weight fraction of polymer chain (w_i)	*Molecular Weight Unit, MW (× 52.07 g/mol)*
0.004	2
0.008	5
0.012	7
0.016	10
0.020	20
0.016	33
0.012	42
0.008	55
0.004	75

(e) Use curve Q to determine the number average molecular weight (M_n) which could be found by reading the peak of the curve Q from your graph.
Label this value as **M_nQ** on curve Q. **1**

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(f) Using your answer in part (e), calculate the weight average molecular weight (M_w). Label this value as $\mathbf{M_wQ}$ on curve Q. **1**

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(g) Compare the two curves as the reaction proceeds to completion. **2**

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2. ……..

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(h) Compare the values M_n and M_w. Propose a reason for this difference. **2**

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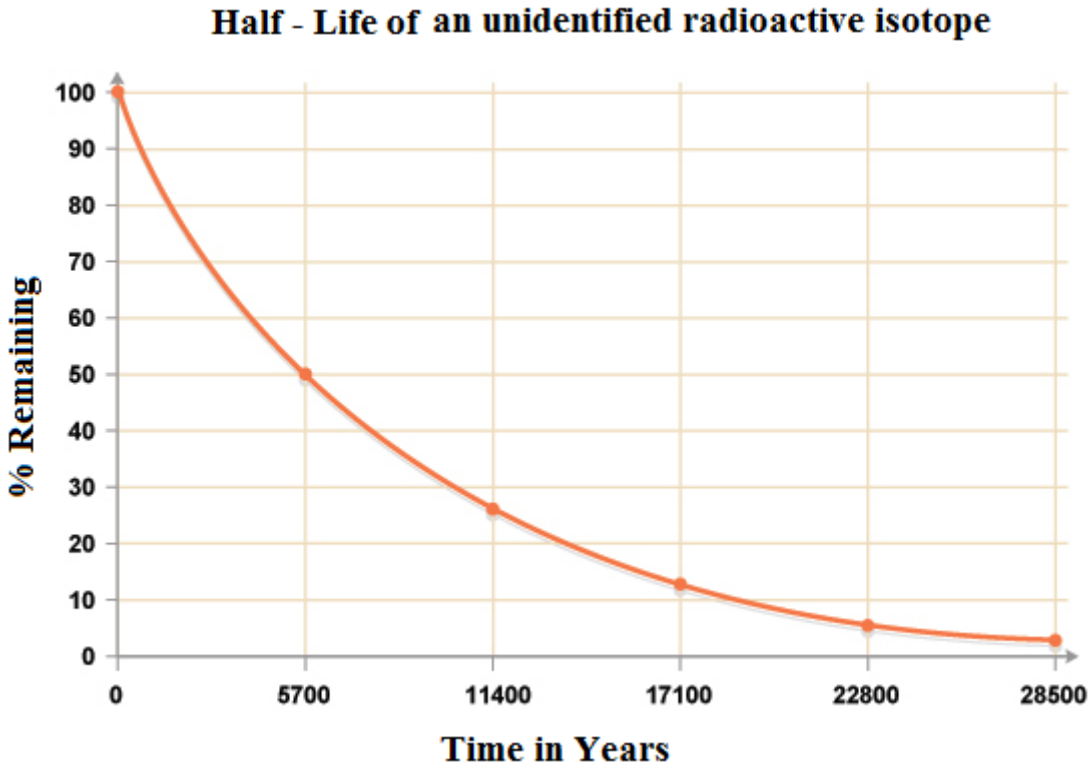
Question 2 (1 mark)

Half Life can be defined as the time required for one half the atoms of a given amount of a radioactive substance to disintegrate. The half-lives of different radioactive elements can vary enormously. The table below shows examples of half-lives of some isotopes.

Isotope	**Half Life**
Uranium - 238	4.5×10^{9} years
Plutonium -239	2.4×10^{9} years
Carbon-14	5570 years
Radium - 226	1622 years
Palladium - 100	4 days
Radon- 220	52 seconds
Lithium- 8	0.84 seconds
Bismuth - 214	1.6×10^{-4} seconds
Lithium - 8	6×10^{-20} seconds



Use the data given in the table to identify the isotope represented in the graph. **1**

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Question 3 (14 marks)

Use the information from the ***Source Material*** on the Vanadium Redox Battery to answer these questions.

(a) Why is the Vanadium Redox Battery (VRB) described as a "flow battery" ? **2**

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(b) Explain why VRB is not used on a large scale and how this problem is being addressed by industry. **4**

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(c) Use the information and graphs on Page 3 and 4 of the Source Material to justify the significance of vanadium as an alloy. **2**

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(d) Use Exhibit 12 to compare the trend in "conventional + battery consumption" vs " conventional consumption". **2**

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(e) Why should there be more investment into the research of VRB technology? **2**

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(f) Assess the reliability of the secondary source of information regarding the vanadium redox battery. **2**

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Question 4 (3 marks)

The following results were measured from a reaction vessel where fermentation was occurring was occurring over a period of time.

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) Why was there a change in mass in the reaction vessel over the 7 days? **2**

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(b) Write a balanced equation showing the fermentation of glucose. **1**

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End of Data Processing Task