

Student Name: \_\_\_\_\_

# CHEMISTRY

## Unit 4 – Written examination 2



### 2007 Trial Examination

Reading Time: 15 minutes  
Writing Time: 1 hour 30 minutes

## QUESTION AND ANSWER BOOK

### Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	20	20	20
B	8	8	57
			Total 77

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, and a scientific calculator.
- Students are NOT permitted to bring into the room: blank sheets of paper and/or white out liquid/tape.

### Materials supplied

- Question and answer book of 18 pages.

### Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

**Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.**

**SECTION A – Multiple-choice questions****Instructions for Section A**

Answer **all** questions.

Choose the response that is **correct** or **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

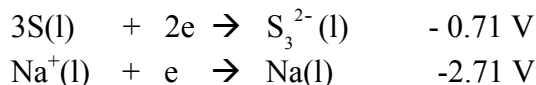
**Question 1**

Pick the correct statement on solar energy from the list below;

- A. Solar cells are very efficient but very expensive.
- B. The efficiency of a solar cell is quite low.
- C. Solar cells are only feasible in tropical regions.
- D. The energy collected by a solar cell is used to turn water into steam to drive a turbine.

*Questions 2 and 3 refer to the following information.*

A galvanic cell being trialed in electric vehicles is the sodium- sulfur cell. This cell uses inexpensive materials and it delivers high currents. Its operating temperature is around 350 °C, the sulfur being a liquid at these temperatures. The half equations for this cell, as they appear on an extensive electrochemical series are

**Question 2**

For the above cell, the anode and cathode will be

	anode and polarity		cathode and polarity	
A.	sodium	negative	Sulfur	positive
B.	sulfur	negative	sodium ions	positive
C.	sulfur ions	positive	Sodium	negative
D.	sodium	positive	Sulfur	negative

**Question 3**

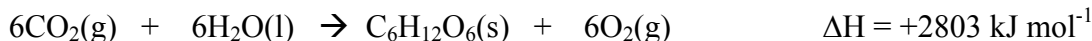
The balanced overall equation for this cell will be

- A.  $\text{Na}_2\text{S}_3(\text{s}) \rightarrow 2\text{Na(l)} + 3\text{S(l)}$
- B.  $2\text{Na(l)} + 3\text{S(l)} \rightarrow \text{Na}_2\text{S}_3(\text{s})$
- C.  $3\text{S(l)} + 2\text{Na(l)} \rightarrow \text{Na}_2\text{S}_3(\text{l})$
- D.  $\text{Na}_2\text{S}_3(\text{s}) \rightarrow 2\text{Na}^+(\text{l}) + 3\text{S}^{2-}$

**SECTION A-** continued

**Question 4**

Photosynthesis can be represented by the equation



The energy change when 360 g of glucose is burnt in a calorimeter will be

- A. the absorption of 2803 kJ of energy.
- B. the release of 5606 kJ of energy.
- C. the absorption of 5606 kJ of energy.
- D. the release of 5606 J of energy.

**Question 5**

In a redox reaction,

- A. electrons always flow from the anode to the cathode.
- B. the anode is always the positive electrode.
- C. the oxidation reaction always occurs at the positive electrode.
- D. chemical potential energy is always converted very efficiently to electrical energy.

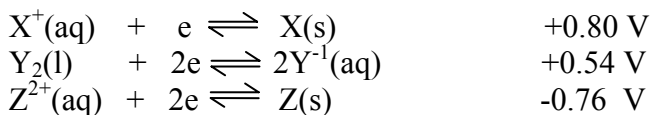
**Question 6**

When methane is oxidised in an alkaline fuel cell, the half equation will be

- A.  $\text{CH}_4(\text{g}) \longrightarrow \text{C}(\text{s}) + 4\text{H}^+(\text{aq}) + 4\text{e}$
- B.  $\text{CH}_4(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \longrightarrow \text{CO}_2(\text{g}) + 8\text{H}^+(\text{aq}) + 8\text{e}$
- C.  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
- D.  $\text{CH}_4(\text{g}) + 8\text{OH}^-(\text{aq}) \longrightarrow \text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l}) + 8\text{e}$

**Question 7**

X, Y and Z represent three elements found on the electrochemical series



- A. A galvanic cell could be formed between Z(s) and X<sup>+</sup>(aq).
- B. The strongest oxidant is X(s).
- C. The table contains two oxidants and one reductant.
- D. X<sup>+</sup>(aq) and Z(s) could react if attached to a power supply.

**Question 8**

Bile acids are

- A. used to hydrolyse fatty acids to carbon dioxide and water.
- B. produced in the liver. They help bond glycerol to fatty acids.
- C. formed in the liver and they act as emulsifiers.
- D. formed in the stomach and used to help transport lipid molecules through the body.

**SECTION A- continued**  
**TURN OVER**

**Question 9**

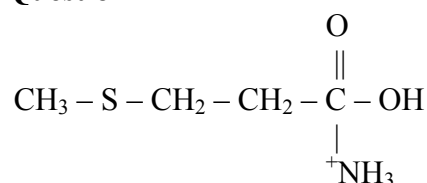
Glucose, fructose and galactose are all monosaccharides.

- A. Each one can be polymerized to form either glycogen, starch or cellulose.
- B. They are structural isomers.
- C. Each one has a different molecular mass.
- D. They are all formed through photosynthesis.

**Question 10**

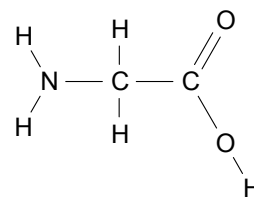
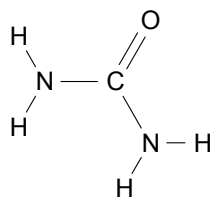
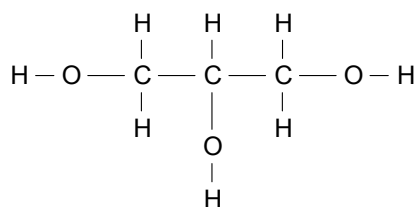
Which of the following sequences correctly represents the return of nitrogen to the atmosphere by bacteria.

- A.  $N_2 \rightarrow NH_4^+ \rightarrow NO_3^-$
- B.  $NO_3^- \rightarrow NH_4^+ \rightarrow N_2$
- C.  $NH_3 \rightarrow NO_2 \rightarrow NO_3^- \rightarrow N_2$
- D.  $NH_4^+ \rightarrow NO_2^- \rightarrow NO_3^- \rightarrow N_2$

**Question 11**

The molecule sketched is

- A. an amino acid in a solution of pH 2.
- B. a dipeptide molecule.
- C. an amino acid in a solution of pH 12.
- D. a protein molecule.

**Question 12**

The molecules above are, respectively

- A. glycerol, urea and glycine
- B. glucose, alanine and glycine
- C. ethanol, glycine and alanine
- D. glycerol, glycine and alanine

**SECTION A-** continued

**Question 13**

The molecule  $C_{17}H_{35}COOH$  is a typical saturated fatty acid. What is the general formula for a typical monounsaturated fat?

- A.  $C_nH_{2n+1}COOH$
- B.  $C_nH_{2n-1}COOH$
- C.  $C_nH_{n-1}COH$
- D.  $C_nH_{2n-3}COOH$

**Question 14**

Which one of the following alternatives lists the atoms of oxygen, sulfur, sodium and magnesium in order of increasing atomic radius?

- A. (smallest) O, S, Mg, Na (largest)
- B. (smallest) O, S, Na, Mg (largest)
- C. (smallest) Na, Mg, O, S (largest)
- D. (smallest) O, Na, Mg, S (largest)

**Question 15**

Which one of the following lists the atoms of nitrogen, fluorine, magnesium and lithium in order of increasing electronegativity?

- A. (lowest) Mg, Li, N, F (highest)
- B. (lowest) Li, Mg, N, F (highest)
- C. (lowest) F, N, Mg, Li (highest)
- D. (lowest) Li, Mg, F, N (highest)

**Question 16**

English physicist J. J. Thomson and his research team used a cathode tube to study a new particle that he called an electron. Which alternative below correctly sums up the properties of electrons?

- A. They have a negative charge but no mass.
- B. They have a negative charge that is much smaller than the charge on a proton.
- C. They have a negative charge, a much lower mass than hydrogen and they are common to all elements.
- D. They have a negative charge, a mass similar to that of a proton and they are found in most elements.

**Question 17**

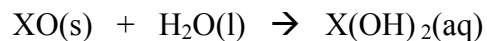
Which of the following statements about the Periodic Table is **incorrect**?

- A. The atomic size of elements decreases as you move across the Periodic Table.
- B. All the elements in Period 4 are progressively filling the fourth electron shell.
- C. The Lanthanides and Actinides are both progressively filling f subshells.
- D. There are more than ten transition elements.

**SECTION A- continued  
TURN OVER**

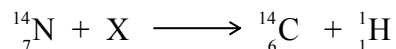
**Question 18**

The molecule XO reacts with water in the equation shown;



The element, X is most likely to be

- A. S
- B. Li
- C. Cl
- D. Ca

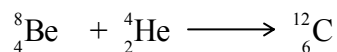
**Question 19**

The likely identity of particle X in this nuclear equation is a

- A. helium nucleus
- B. proton
- C. neutron
- D. positron

**Question 20**

In the reaction,



- A. there will be no mass change because mass is always conserved.
- B. mass will be lost as energy as this is a nuclear fission reaction.
- C. there will be an increase in mass.
- D. nuclear fusion has occurred to make a larger nucleus.

**END OF SECTION A**

**SECTION B – Short-answer questions****Instructions for Section B**

Answer **all** questions.

To obtain full marks for your responses you should

- Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- Show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example,  $\text{H}_2(\text{g})$ ;  $\text{NaCl}(\text{s})$

**Question 1**

Sir Humphry Davy was the first scientist to successfully isolate potassium metal. He extracted potassium from potash, potassium hydroxide. He wrote in his journal;

‘The potash began to fuse at both its points of electrolyzation. There was a violent effervescence at the upper surface, at the lower, or negative surface, there was no liberation of elastic fluid, but small globules having a high metallic lustre, and being precisely similar in visible characters to quicksilver, appeared, some of which burnt with explosion and bright flame, as soon as they were formed, and others remained, and were merely tarnished, and finally covered with a white film which formed at their surfaces’

a. Name the process that Davy used.

\_\_\_\_\_ 1 mark

b. Write a balanced half equation for the formation of potassium as described above.

\_\_\_\_\_ 1 mark

c. Is this process exothermic or endothermic?

\_\_\_\_\_ 1 mark

d. Did Davy use an aqueous solution? Explain your answer.

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ 2 marks

**SECTION B-Question 1-continued**  
**TURN OVER**

- e. Davy describes the violent reaction of some of the potassium formed.
- Write a balanced equation for this reaction.

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- Will the main product of this violent reaction be acidic, basic or neutral when added to water?

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1 + 1 = 2 marks

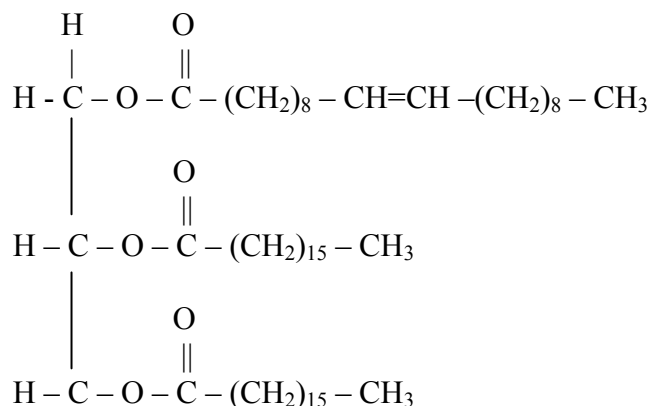
Total 7 marks

**SECTION B-continued**



**Question 2**

The structure of a lipid molecule is shown in the diagram below



- a. What category of lipid does this molecule belong to?

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1 mark

b.

- i. Name the main functional group present in this molecule.

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- ii. Circle all instances of this functional group.

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1 + 1 = 2 marks

- c. The lipid molecule is now hydrolysed in sodium hydroxide solution.

- i. How many different fatty acids are formed?

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- ii. What functional groups are present now?

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- iii. What is the molecular formula of the unsaturated fatty acid?

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**SECTION B-Question 2-continued**  
**TURN OVER**

- iv. Write a balanced equation for the complete combustion in air of this unsaturated acid.

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1 + 1 + 1 + 2 = 5 marks

- d. The gross energy produced when a fat molecule is burnt is  $39 \text{ kJ g}^{-1}$ . If 0.388 g of fat is burnt under a 200 mL beaker of water, what is the maximum possible temperature change? The specific heat capacity of water is  $4.18 \text{ JK}^{-1}\text{g}^{-1}$  and its density is  $1 \text{ g mL}^{-1}$

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2 marks

Total 10 marks

**SECTION B**-continued

**Question 3**

Give concise explanations in each of the following.

- a. Vitamin C and Vitamin E are both used as antioxidants. They are however, used in different types of foods. Why is this?

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1 mark

- b. The addition of ammonia,  $\text{NH}_3$  to copper sulfate solution causes an obvious chemical reaction. Ammonia does not react with sodium sulfate solution. Give one reason why ammonia reacts differently in these two solutions.

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1 mark

- c. The Victorian electricity industry is researching ways of reducing the pollution involved in generating electricity from brown coal. Give one example of a line of research being trialled and explain how it might help with the reduction of pollution.

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1 mark

- d. An element of a higher atomic number can sometimes be formed when a nucleus emits radiation. Explain how this is possible.

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1 mark

Total 4 marks

**SECTION B-Question 3-continued**  
**TURN OVER**

**Question 4**

The following table refers to the properties of the three elements fluorine, neon and sodium.

Element	Electron configuration	Atomic size	Electronegativity	First ionisation energy	Ion configuration
fluorine					
neon					
sodium					

- a. Write the electron configuration for each element in the appropriate box. 1 mark
- b. Use the next column of the table to rank the elements in order of atomic size, number 1 being the largest. 1 mark
- c. Use the appropriate column to rank the elements in order of electronegativity, 1 being the most electronegative. 1 mark
- d. Use the appropriate column to rank the elements in order of first ionisation energy, number 1 having the highest first ionisation energy. 1 mark
- e. Write the electron configuration of the likely ion of each of the elements in the final column. 1 mark
- f.
- i. Neon is considered chemically inert. It is also colourless. Explain how it might be possible to prove that a sample of gas is in fact neon.

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- ii. Explain the science behind this test.

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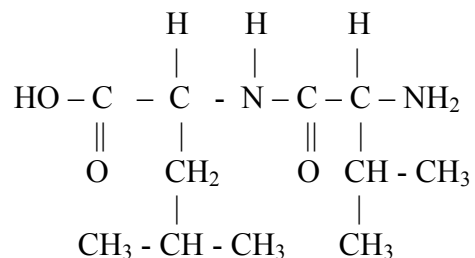
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1 + 2 = 3 marks  
Total 8 marks

**SECTION B-continued**

**Question 5**

- a. A dipeptide formed from the amino acids leucine and valine is shown below (leucine is on the left)



- i. Draw the structural formula of valine.

- ii. What is the molecular mass of leucine?

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- iii. Are the side chains in valine and leucine hydrophilic or hydrophobic?

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1 + 1 + 1 = 3 marks

- b. Papain is an enzyme that is used by butchers to soften meat. It partially hydrolyses the protein in meat, allowing the meat to pull away from the bones. Papain is produced in the tropical fruit, paw-paw.

- i. Explain how an enzyme works.

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- ii. Explain what is happening when a protein is hydrolysed.

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**SECTION B-Question 5-continued**  
**TURN OVER**

- iii. Will papain still be an active enzyme when humans eat the meat it has been used on?  
Explain your answer.

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2 + 1 + 1 = 4 marks

- c. Ammonium nitrate,  $\text{NH}_4\text{NO}_3$  is a popular fertilizer. What are the respective oxidation states of the two nitrogen atoms in this compound?

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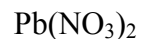
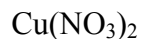
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2 marks

Total 9 marks

**SECTION B-continued**

**Question 6**



- a. Refer to the list of ionic compounds above to answer the following questions.
- i. Aqueous 1.0 M solutions are prepared from each of the above compounds. Each solution is placed in a separate electrolytic cell. Which of these cells will produce a metal as a product?

\_\_\_\_\_

- ii. Which gas is formed at the anode when a current is passed through each of these aqueous solutions?

\_\_\_\_\_

- iii. 72375 coulombs of charge is passed through a molten solution of each of these compounds. Which cell will produce 0.25 mole of metal?

\_\_\_\_\_

\_\_\_\_\_ 1 + 1 + 2 = 4 marks

- b. The charge on one mole of electrons is known as a Faraday.

- i. Calculate the charge on a single electron.

\_\_\_\_\_

\_\_\_\_\_

- ii. Six Faradays of charge is passed through a range of molten solutions. Discuss the likely amount of metal that might form in each cell.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ 1 + 2 = 3 marks

**SECTION B-Question 6-continued**  
**TURN OVER**

- c. Aluminium is produced in the Hall cell. For this cell, write a half equation for the reaction occurring at the
- anode.

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- cathode.

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1 + 1 = 2 marks

Total 9 marks

**SECTION B-continued**



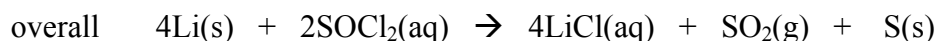
**Question 7**

Lithium has emerged as the basis for a range of innovative, new galvanic cells. One such example is the lithium - thionyl chloride (SOCl<sub>2</sub>) cell. This cell is of interest because its operating voltage is a very high 3.4 V and it can function well at relatively high temperatures.

- a. The overall equation for this cell is provided below. Use this equation, and the electrochemical series, to deduce both half equations for this cell. Write the half equations in the space provided.

anode

cathode



2 marks

- b. The sulfur dioxide, SO<sub>2</sub> produced in the cell dissolves in the electrolyte. Give one reason why this might be important.

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1 mark

- c. A mobile phone uses one of these cells. If a typical AA battery has a voltage of 1.5 volts, how many AA batteries would be required to produce a greater voltage than the three lithium – thionyl chloride cells?

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1 mark

- d. If this cell delivers a current of 0.2 amps for 55 minutes, what mass of lithium is converted to lithium ions?

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3 marks

- e. Write a balanced equation for the reaction of sulfur dioxide and water.

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1 mark

**SECTION B-Question 7-continued**

f. Which is bigger, sulfur atom or sulfur ion,  $S^{2-}$ ? Explain your answer.

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2 marks  
Total 10 marks

**END OF QUESTION AND ANSWER BOOK**