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Student Name:

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2002

CHEMISTRY

Unit 4 Trial Examination
Total writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of Questions*	*Number of questions to be answered*
A	20	20
B	7	7

Directions to students

Materials
Question and answer book of 16 pages with a detachable Multiple Choice Answer Sheet inside the front cover and a detachable Data Sheet in the centrefold.
You should have at least one pencil and an eraser. An approved calculator may be used.

The task
Please ensure that you write your **name** in the space provided on the cover of this book and in the space provided on the Multiple Choice Answer Sheet.
This paper consists of two sections, Section A and Section B.
Answer **all** questions from Section A. Section A is worth 20 marks.
Section A questions should be answered in pencil on the Multiple Choice Answer Sheet provided.
Answer **all** questions from Section B. Section B is worth 56 marks.
Section B questions should be answered in ink or ball point pen in the spaces provided in this book.
There is a total of 76 marks available.
All written responses should be in English.

At the end of the task
Place the Multiple Choice Answer Sheet inside the front cover of this book.

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CHEMISTRY

Unit 4 Trial Examination

MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	

INSTRUCTIONS: **USE PENCIL ONLY**

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **DO NOT** cross it out.
- Marks will **NOT** be deducted for incorrect answers.
- **NO MARK** will be given if more than **ONE** answer is completed for any question.
- Mark your answer by placing a **CROSS** through the letter of your choice.

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	A	B	C	D
5.	A	B	C	D
6.	A	B	C	D
7.	A	B	C	D
8.	A	B	C	D
9.	A	B	C	D
10.	A	B	C	D

11.	A	B	C	D
12.	A	B	C	D
13.	A	B	C	D
14.	A	B	C	D
15.	A	B	C	D
16.	A	B	C	D
17.	A	B	C	D
18.	A	B	C	D
19.	A	B	C	D
20.	A	B	C	D

SECTION A

Specific instructions for Section A

Section A consists of 20 multiple-choice questions. Section A is worth approximately 26 per cent of the marks available. You should spend approximately 24 minutes on Section A.

Choose the response that is **correct** or **best answers the question**, and mark your choice on the multiple-choice answer sheet according to the instructions on that sheet.

A correct answer is worth 1 mark; an incorrect answer is worth no marks. No mark will be given if more than one answer is shown for any question. Marks will **not** be deducted for incorrect answers. You should attempt every question.

Question 1

In third world countries, farmers can use dung to produce methane. When burnt, the methane can supply sufficient energy for several families.

The combustion reaction is represented by

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g) \qquad \Delta H = -890 \text{ kJ mol}^{-1}$$

If 1.00 kg of methane, at STP, was reacted completely with oxygen, the amount of energy generated is

A. 55.6×10^3 kJ

B. 890 kJ

C. 55.6 kJ

D. 22.4 kJ

Question 2

A student calibrated a solution calorimeter containing 100 mL of water using electrical apparatus. The specific heat capacity of water is 4.18 J $^oC^{-1}$ g^{-1}. Assuming that the student's measurements were reliable, which calibration factor is most likely for a well-insulated calorimeter?

A. 240 J K^{-1}

B. 480 J K^{-1}

C. 960 J K^{-1}

D. 1418 J K^{-1}

Question 3

When the Daniell cell functions under standard conditions, the equation for the reaction occurring is

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

It may be deduced that

A. copper is a stronger reductant than zinc
B. copper(II) ion is a stronger oxidant than zinc ion
C. copper(II) ion is a stronger reductant than zinc ion
D. copper is more likely to react with dilute hydrochloric acid than zinc.

Question 4

The specific heat capacity of a dilute aqueous solution is approximately 4.2 J mL^{-1} $°C^{-1}$.
The equation for the reaction between sodium hydroxide and hydrochloric acid is

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l) \quad \Delta H = -55.0 \text{ kJ mol}^{-1}$$

The temperature change when 50.0 mL of 0.25 M hydrochloric acid is mixed with 25.0 mL of 0.50 M sodium hydroxide would be

A. 2.2°C
B. -2.2°C
C. 3.3°C
D. -3.3°C

Question 5

Secondary cells, such as the lead-acid accumulator, can only be recharged because

A. they can store electrons
B. new chemicals can be added to the cell
C. the products of the discharge reactions are not gaseous
D. the products of the discharge reactions remain in contact with the electrodes.

Question 6

Sodium hydroxide is produced by electrolysis of hot, concentrated NaCl solution (brine). If 1.0 mol of electrons is used in the process

A. 2.0 mol of NaOH is formed
B. 1.0 mol of chlorine gas is produced
C. 1.0 mol of gas is produced
D. 36 g of water reacts.

Question 7

The pair of species that would be expected to react spontaneously under standard conditions is

A. Ni^{2+} with Zn^{2+}
B. Ni with Zn^{2+}
C. Ni^{2+} with H^{+}
D. Ni^{2+} with Zn

Question 8

Aluminium is produced using the Hall-Heroult cell. A purpose of the cryolite in this cell is to

A. lower the melting temperature of the alumina
B. react with the alumina to produce aluminium
C. reduce the waste gases produced by the process
D. increase the rate of the electrode reactions.

Question 9

Which of the following is **least** likely to act as a ligand in a transition metal complex?

A. OH^{-}

B. NH_4^{+}

C. Cl^{-}

D. $NH_2CH_2CH_2NH_2$

Question 10

The oxidation numbers of manganese in $MnCl_2$, MnO_2 $KMnO_4$ respectively are

A. +2, +2 and +4
B. +2, +2 and +7
C. +2, +4 and +7
D. +4, +4 and +9.

Question 11

A sample of gallium consists of 60.4% of ^{69}Ga and 39.6% of ^{71}Ga. If the relative isotopic mass of ^{69}Ga is 68.9, the relative isotopic mass of ^{71}Ga is

A. 69.2
B. 69.4
C. 70.2
D. 70.9

Question 12

The labelling on a tub of ice cream indicated that an emulsifier was present.
The purpose of the emulsifier in the ice cream was to

A. provide flavour
B. act as a preservative
C. prevent oxidation of fats
D. stabilise the water and cream mixture.

Question 13

When triglyceride molecules are formed in a living organism

A. unsaturated fatty acids are always involved
B. the process is termed a hydrolysis reaction
C. the substrates combine in a 1 : 1 ratio
D. hydroxyl and carboxyl functional groups are involved.

Question 14

Nitrogen fixation could involve the

A. oxidation of nitrite to nitrate ions
B. oxidation of ammonium ions to nitrate ions
C. reduction of nitrate ions to atmospheric nitrogen
D. reduction of atmospheric nitrogen to ammonium ions.

Question 15

In the process of cellular respiration, molecules such as glucose, $C_6H_{12}O_6$, are broken down into water and carbon dioxide. Respiration is an example of a reaction that is

A. exothermic, with oxygen acting as the oxidant
B. endothermic, with oxygen acting as the reductant
C. exothermic, with oxygen acting as the reductant
D. endothermic, with oxygen acting as the oxidant.

Question 16

The secondary structure of proteins generally refers to

A. the amino acid sequence of the protein
B. hydrogen bonding between peptide bonds within the protein molecule
C. hydrogen bonding between peptide bonds of adjacent protein molecules
D. all forms of bonding between sections of the same protein molecule.

Question 17

In the period consisting of the elements from sodium to chlorine, there is an increase in the core charge of the nucleus, leading to the outer shell electrons being more firmly held by the nucleus. Which **one** of the following trends does this explain?

A. A decrease in ionisation energy.
B. A decrease in the acidity of the oxides.
C. An increase in electronegativity.
D. An increase in atomic mass.

Question 18

James Chadwick's contribution to atomic theory was that he

A. demonstrated the existence of the neutron
B. demonstrated the existence of the electron
C. proposed that electrons orbited the nucleus in fixed energy levels, called shells
D. demonstrated that the atom contained a dense, positively charged nucleus at its centre.

Question 19

Which of the following lists only basic oxides?

A. Na_2O, MgO, Al_2O_3
B. Na_2O, MgO, SO_2,
C. Na_2O, K_2O, and CaO
D. Al_2O_3, SO_2, SO_3

Question 20

Which of the following nuclear reactions is a fusion reaction that is endothermic

A. $^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n$

B. $^{253}_{99}Es + {}^{4}_{2}He \rightarrow {}^{256}_{101}Md + {}^{1}_{0}n$

C. $^{3}_{2}He + {}^{1}_{0}n \rightarrow {}^{2}_{1}H + {}^{2}_{1}H$

D. $^{256}_{101}Md + {}^{1}_{0}n \rightarrow {}^{253}_{99}Es + {}^{4}_{2}He$

END OF SECTION A

SECTION B

Specific instructions for Section B

Section B consists of seven short-answer questions numbered 1 to 7; you must answer all of these questions. This section is worth 56 marks or approximately 74 per cent of the total. You should spend approximately 66 minutes on this section.

The marks allotted to each question are shown & suggested times are shown at the end of each question.

Questions must be answered in the spaces provided in this book.

To obtain full marks for your response you should

- give simplified answers with an appropriate number of significant figures for 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 all chemical equations are balanced and that the formulas for individual substances include an indication of state (for example, $H_2(g)$; NaCl(s)).

Question 1

A well-insulated calorimeter containing 100 mL of water was calibrated by dissolving a known amount of potassium chloride in the calorimeter. The dissolution of potassium chloride in water can be represented by the equation

$$KCl(s) \xrightarrow{\text{water}} K^+(aq) + Cl^-(aq) \quad \Delta H = +17.0 \text{ kJ mol}^{-1}$$

The temperature of the calorimeter was initially 14.56 ^oC. A sample of 5.1592 g of potassium chloride was dissolved in the 100 mL of water and the temperature was recorded as 12.08 ^oC.

(a) Draw an energy profile diagram and explain why the temperature of the calorimeter and its contents decreased.

Question 1 continues on the next page

(b) Calculate the change in energy, in kJ, that occurred when the 5.1592 g of potassium chloride was dissolved.

(c) Determine the calibration factor for the calorimeter and its contents.
Be careful to use the appropriate number of significant figures in your answer.

3 + 2 + 2 = 7 marks
Suggested time: 8 minutes

Question 2

An experimental fuel cell is based on methanol, oxygen and a simple acidic electrolyte. The overall reaction occurring is

$$2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$$

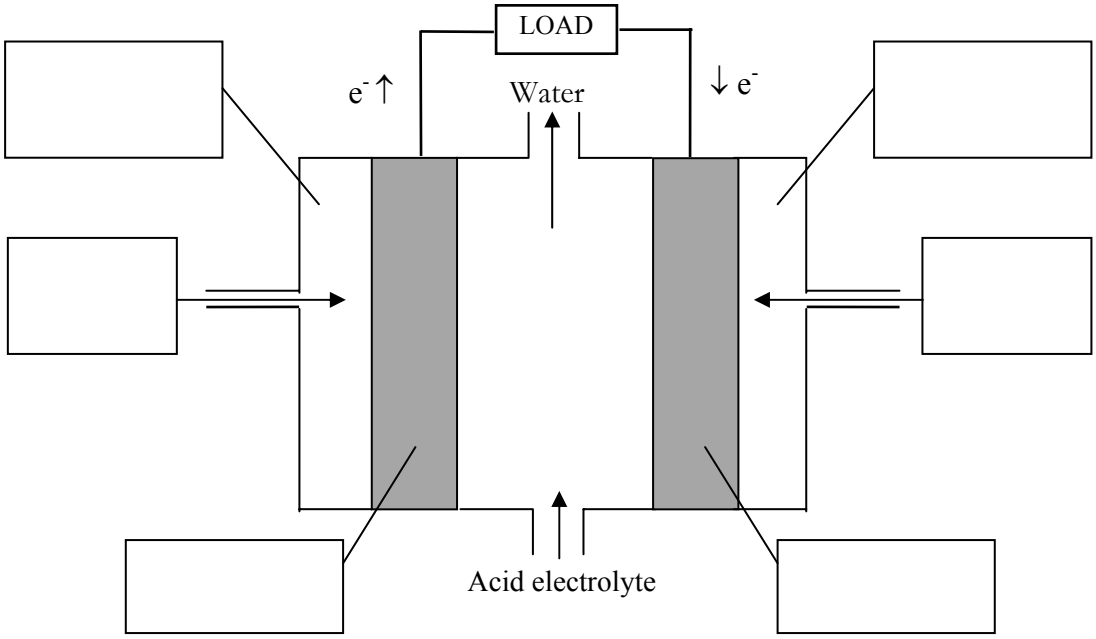
(a) Write balanced half equations for the reaction occurring at the

(i) anode _____

(ii) cathode _____

Question 2 continues on the next page

(b) Label the diagram of the fuel cell to indicate the
(i) **anodic** and **cathodic** chambers
(ii) **polarity** of the electrodes
(iii) input connections for the **fuel** and **oxidant**



(c) What two features of the electrodes (in addition to being a solid electrical conductor) would be needed?

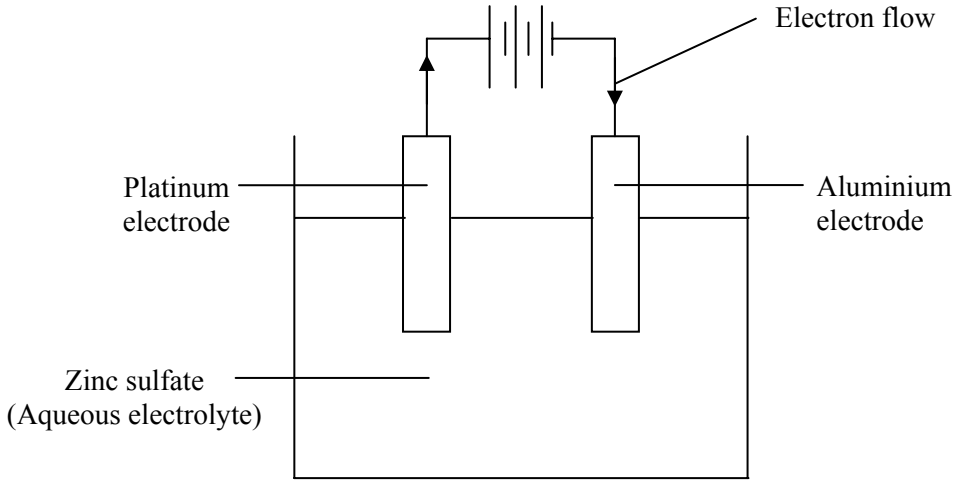
(d) When the cell starts producing energy the pH of the electrolyte near the anode decreases but eventually reaches a constant value. Explain these observations.

(e) State one major advantage fuel cells have over the current use of conventional fuels such as coal and petroleum?

2 + 3 + 2 + 1 + 1 = 9 marks
Suggested time: 11 minutes

Question 3

A simple representation of an electrolytic cell is shown in the diagram.



(a) Which of the electrodes in the representation is the cathode?

_____

(b) Write the half equations for the reactions expected at the

(i) Aluminium electrode

_____

(ii) Platinum electrode

_____

(c) If the zinc sulfate electrolyte was replaced by a solution of manganese(II) sulfate, write the half equation for the reaction expected at the cathode.

_____

Question 3 continues on the next page

(d) The Electrolytic Zinc Company in Australia uses an electrolytic cell similar to that in the diagram. The cell produces 5.5 kg of zinc every 24 hours using a voltage of 4.1 volt.

(i) Calculate the amount, in mol, of zinc produced per hour by the Electrolytic Zinc Company.

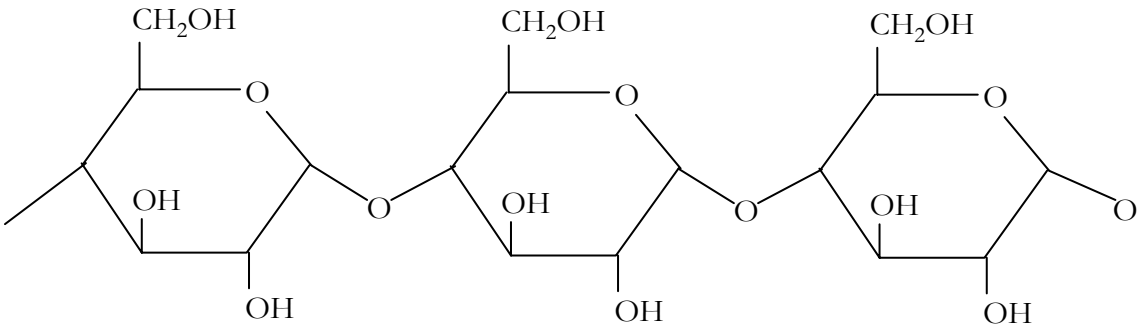
(ii) Calculate the energy, in megajoules, that must be supplied to produce this amount of zinc per hour.

1 + 2 + 1 + 4 = 8 marks
Suggested time: 9 minutes

Question 4

Starch is a major carbohydrate store in many plants, such as potatoes. It is a polymer of glucose. A simplified diagram of a section of a starch molecule is shown.

(a) On the diagram, circle one example of a glycosidic (ether) link.



Question 5 continues on the next page

(b) In the intestine, starch undergoes enzyme-catalysed hydrolysis.

(i) What molecule, other than the starch and the enzyme, is required for this hydrolysis reaction?

_____

(ii) Draw the structure of the monomer that is formed by the enzyme-catalysed hydrolysis of starch.

(c) Cellulose is also a polymer of glucose, yet the enzymes that are able to hydrolyse starch are unable to hydrolyse cellulose. Explain why this is so.

_____

_____

(d) Briefly explain why an athlete would not eat a food high in starch as a means of providing an immediate source of energy.

_____

_____

(e) (i) Write a balanced chemical equation for the complete oxidation of glucose in the body.

_____

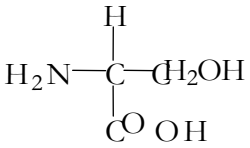
(ii) The heat energy liberated for this reaction is 2800 kJ mol^{-1}.
Express this as kJ g^{-1}.

1 + 2 + 1 + 1 + 3 = 8 marks
Suggested time: 9 minutes

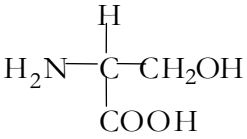
Question 5

The following diagrams **A** and **B** represent the structure of the amino acid serine.

A



B



(a) Circle the side chain in the serine molecule shown in diagram **A**.

(b) Clearly identify and name all the functional groups present in serine on the second diagram **B**.

(c) Would you expect serine to be soluble in water? Explain your answer in chemical terms.

_____

_____

(d) Some serine is placed in a solution of sodium hydroxide. Draw the structure of the serine as it would exist in this solution.

(e) Serine molecules are able to join together to form a polymer chain.
Name the type of reaction that occurs when molecules of serine join together.

_____

(f) (i) Draw the structure of the dipeptide formed when two molecules of serine combine and circle the peptide link.

(ii) Name the process by which this dipeptide can be reverted back to serine molecules.

_____

1 + 3 + 1 + 1 + 1 + 3 = 10 marks
Suggested time: 12 minutes

Question 6

a) Cobalt is a transition element; its compounds exhibit many oxidation states and they are typically coloured.

(i) Write the ground state subshell configuration for cobalt, Co.

(ii) Write the ground state subshell configuration for the cobalt(II) ion.

(iii) Why is cobalt classified as a transition element?

b) Consider the following data for the elements, Q, X, Y and Z.

Element	Conductivity (High or Low)	Melting Point (°C)	Density (g cm^{-3})
Q	High	98	0.97
X	High	1495	8.90
Y	High	651	1.74
Z	Low	3547	3.51

(i) Write the letter that is most likely to correspond to the element cobalt.

(ii) Explain your selection.

3 + 2 = 5 marks
Suggested time: 6 minutes

Question 7

Energy can be produced by nuclear reactions. One example is the nuclear reaction involving uranium-235 shown below.

$$^{235}U + {}^{1}n \rightarrow {}^{90}Sr + 3\ {}^{1}n + R$$

(a) Identify the particle R by giving the

(i) atomic number _____

(ii) mass number _____

(iii) name of the element _____

(b) Name the type of nuclear reaction given. Briefly explain your answer.

_____

(c) State the **Group** and **Period** in which strontium is found on the Periodic Table.

_____

(d) State the charge that would most likely be present on the ion formed by strontium.

_____

(e) Write the formula for strontium oxide.

_____

(f) Would strontium oxide be a solid, liquid or gas at room temperature. Briefly explain your answer.

_____

_____

_____

_____

1 + 3 + 2 + 1 + 1 + 1 = 9 marks

Suggested time: 11 minutes

END OF EXAMINATION