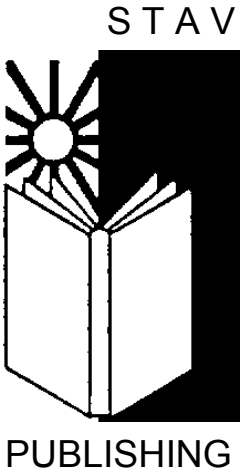

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CHEMISTRY
UNIT 4 Trial Examination

Name:……..

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2000
CHEMISTRY
UNIT 4 Trial Examination
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.

1.	A	B	C	D	11.	A	B	C	D
2.	A	B	C	D	12.	A	B	C	D
3.	A	B	C	D	13.	A	B	C	D
4.	A	B	C	D	14.	A	B	C	D
5.	A	B	C	D	15.	A	B	C	D
6.	A	B	C	D	16.	A	B	C	D
7.	A	B	C	D	17.	A	B	C	D
8.	A	B	C	D	18.	A	B	C	D
9.	A	B	C	D	19.	A	B	C	D
10.	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 29 per cent of the marks available. You should spend approximately 26 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. Nor 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
A sample of 9.00 g of glucose is combusted with excess oxygen in a bomb calorimeter according to the equation:

$$C_6H_{12}O_{6(s)} + 6O_{2(g)} \rightarrow 6H_2O_{(g)} + 6CO_{2(g)}$$

The initial temperature of the gaseous mixture was 290 K and the final temperature was 3000 K.
The change in heat energy for the process was determined to be 141 kJ.
The enthalpy change, ΔH, for the reaction represented by the equation is:

A $+2.82 \times 10^3$ kJ mol^{-1}
B -2.82×10^3 kJ mol^{-1}
C $+2.82 \times 10^4$ kJ mol^{-1}
D -2.82×10^4 kJ mol^{-1}

Question 2
Water and the iron(II) ion are both able to act as either an oxidant or a reductant during a chemical reaction. Select the equation representing a reaction that would be expected to proceed substantially to the right spontaneously.

A $Fe_{(s)} + 2Fe^{3+}_{(aq)} \rightarrow 3Fe^{2+}_{(aq)}$
B $2H_2O_{(l)} \rightarrow O_{2(g)} + 2H_{2(g)}$
C $2H_2O_{(l)} + 2Fe^{2+}_{(aq)} \rightarrow O_{2(g)} + 4H^{+}_{(aq)} + 2Fe_{(s)}$
D $2H_2O_{(l)} + 4Fe^{3+}_{(aq)} \rightarrow O_{2(g)} + 4H^{+}_{(aq)} + 4Fe^{2+}_{(s)}$

Question 3
In a fuel cell, the:

A fuel is oxidised at the cathode.
B reductant is oxidised at the cathode.
C fuel is reduced at the cathode.
D oxidant is reduced at the cathode.

Question 4
Which one of the following half-cells would give the largest cell potential when paired with the $Ni^{2+}_{(aq)}/Ni_{(s)}$ half-cell under standard conditions?

A $Fe^{3+}_{(aq)}/ Fe^{2+}_{(aq)}$
B $Ag^{+}_{(aq)}/Ag_{(s)}$
C $Cu^{2+}_{(aq)}/Cu_{(s)}$
D $Co^{2+}_{(aq)}/Co_{(s)}$

Question 5
Which of the following is a product formed at the cathode in the electrolysis of a 1.0 M aqueous solution of sodium sulfate, Na_2SO_4, using inert electrodes?

A Sodium metal.
B Hydrogen ions.
C Hydrogen gas.
D Oxygen gas.

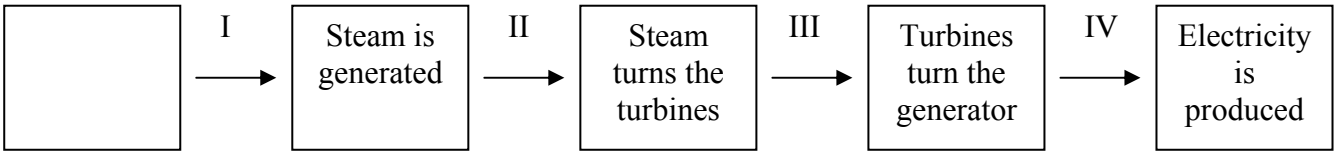
Question 6
Nickel-cadmium, NiCad, batteries are commonly used as rechargeable batteries. Each cell generates a potential of 1.30 V. The overall cell reaction for discharging can be written as:

$$Ni_2O_{3(s)} + 3H_2O_{(l)} + Cd_{(s)} \rightarrow Cd(OH)_{2(s)} + 2Ni(OH)_{2(s)}$$

In recharging the cell it would be necessary to apply a potential of:

A more than 1.30 V across the cell with the Cd electrode connected to the positive terminal of the power source.
B more than 1.30 V across the cell with the Cd electrode connected to the negative terminal of the power source.
C 1.30 V across the cell with the Cd electrode connected to the positive terminal of the power source.
D 1.30 V across the cell with the Cd electrode connected to the negative terminal of the power source.

Question 7
The processes occurring in a coal-fired power station in a Latrobe Valley power station are shown in the following flowchart:



The process which involves the transformation of heat energy to mechanical energy is:

A I
B II
C III
D IV

Question 8
In the nitrogen cycle, oxidising bacteria convert:

A NH_3 into NO_3^-
B N_2 into NH_3
C NO_3^- into N_2
D NO_3^- into NH_4^+

Question 9
Which one of the following represents an α-amino acid species in 0.1 M sodium hydroxide solution?

A $^+NH_3CH_2CH_2COOH$
B $^+NH_3CH_2COOH$
C $NH_2CH_2CH_2COO^-$
D $NH_2CH_2COO^-$

Question 10
The carbohydrates found in plants are:

A sucrose and glycogen.
B cellulose and glycogen.
C starch and cellulose.
D starch and glycogen.

Question 11
Which one of the following only includes molecules that are typical waste products of human cellular chemical processes?

A $C_6H_{12}O_6$, $(NH_2)_2CO$, H_2O
B NH_3, NH_2CH_2COOH, $NH_2CH.CH_3.COOH$
C CO_2, NH_3NO_3, $C_6H_{12}O_6$
D $(NH_2)_2CO$, H_2O, CO_2

Question 12
An example of a saturated fatty acid is:

A CH_3COOH
B $C_6H_{12}O_6$
C $C_{16}H_{31}COOH$
D $C_{16}H_{33}COOH$

Question 13
One mole of each of the following fuels was combusted. Which one would contribute the most carbon dioxide to the atmosphere?

A methanol, CH_3OH
B methane, CH_4
C octane, C_8H_{18}
D toluene, $C_6H_5CH_3$

Question 14
Marie and Pierre Curie discovered the element radium in 1898. The radium isotope with the longest half-life undergoes alpha decay. This process can be represented by:

$$^{228}_{88}\text{Ra} \rightarrow {}^{4}_{2}\text{He} + X$$

The particle, *X*, represents:

A $^{232}_{88}\text{Ra}$
B $^{232}_{54}\text{Xe}$
C $^{224}_{86}\text{Rn}$
D $^{224}_{90}\text{Th}$

Question 15
All except **one** of the electronic configurations below represent atoms in their ground states. Which is the exception?

A $1s^2 2s^2 2p^6$
B $1s^2 2s^2 2p^6 3s^1$
C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1$
D $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

Question 16
The first ionisation energy is the minimum amount of energy required to:

A remove an electron from an atom in the gaseous state to form a positive ion.
B promote an electron to a higher energy level within an atom.
C add an electron to an atom in the gaseous state to form a negative ion.
D form a more positively charged ion from a cation.

Question 17
Which one of the following substances is most likely to produce a highly coloured solution?

A $AgNO_3$
B $ZnSO_4$
C $Cu(OH)_2$
D $Ni(NO_3)_2$

Question 18
Which one 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, CaO
D Al_2O_3, SO_2, SO_3

Question 19
Atomic radius:

A decreases across a period, right to left, and increases down a group.
B decreases across a period, right to left, and decreases down a group.
C increases across a period, right to left, and increases down a group.
D increases across a period, right to left, and decreases down a group

Question 20
The neutron was discovered by:

A Aston.
B Chadwick.
C Rutherford.
D Thompson.

SHORT ANSWER QUESTIONS

Specific Instructions for Section B

Section B consists of seven short answer questions, numbered 1 to 7.

You must answer **all** questions. This section is worth 50 marks or approximately 71 percent of the total. You should spend approximately 64 minutes on this section.

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

Questions should 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 to all numerical questions; unsimplified answers will not be given full credit.
* show all working in your answers to numerical questions. No credit can be given for an incorrect answer unless it is accompanied by details of the working.
* make sure chemical questions are balanced and that the formulae for individual substances include an indication of state, eg. $H_{2(g)}$; $NaCl_{(s)}$.

Question 1

The lead-acid accumulator is used in cars as the source of the electrical energy needed to start the engine. The reaction occurring in the cell during discharge can be written as:

$$Pb_{(s)} + PbO_{2(s)} + 4H^{+}_{(aq)} + 2SO_4^{2-}{}_{(aq)} \rightarrow 2PbSO_{4(s)} + 2H_2O_{(l)}$$

(a) Write the half-equations for the reactions occurring during discharge at the

(i) anode _____

(ii) cathode _____

(b) Explain how pH can be used to indicate the state of charge of the battery over a period of time.

_____

_____

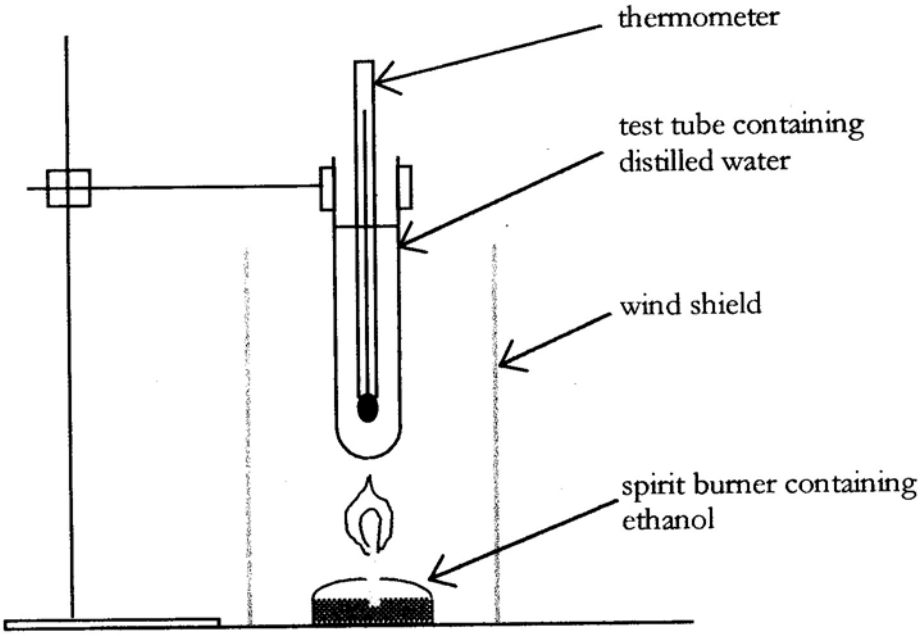
_____

_____

(2 + 2 = 4 marks)
(*Suggested time: 5 minutes*)

Question 2

A student wishes to determine the heat of combustion of ethanol, using the apparatus shown below:



The following data was collected by the student:

Mass of test tube	=	33.121 g
Mass of ethanol burnt	=	0.414 g
Mass of water heated	=	49.80 g
Initial temperature of water	=	16.60°C
Final temperature of water	=	75.60°C

4.180 J of energy are required to raise the temperature of 1.00 g of water by 1.00°C.

(a) Write a balanced chemical equation for the complete combustion of ethanol.

_____

(b) Calculate the heat of combustion for 1 mole of ethanol.

(c) The heat of combustion of propanol, C_3H_7OH, is 2016 kJ mol^{-1}. Use calculations to show which of ethanol or propanol is the better fuel on a per gram basis.

(d) What factor would give ethanol an advantage over propanol as a fuel?

_____

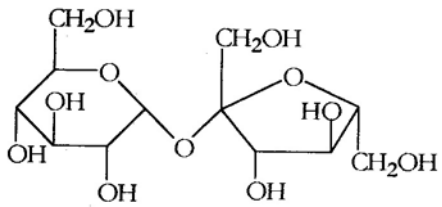
_____

_____

_____

(1 + 3 + 2 + 1 = 7 marks)
(*Suggested time: 9 minutes*)

Question 3
A representation of the biochemical molecule sucrose is shown below:



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

(b) In a living organism, the sucrose molecule is broken down into two smaller molecules.

(i) What is the general name given to the two molecules formed?

_____

(ii) Both the product molecules have the same molecular formula. What is this molecular formula?

_____

(iii) What chemical substance(s) must be present for sucrose to be broken down in a living organism?

_____

(iv) The break down of sucrose occurs during digestion. State the name of the type of chemical reaction that occurs during this biochemical process.

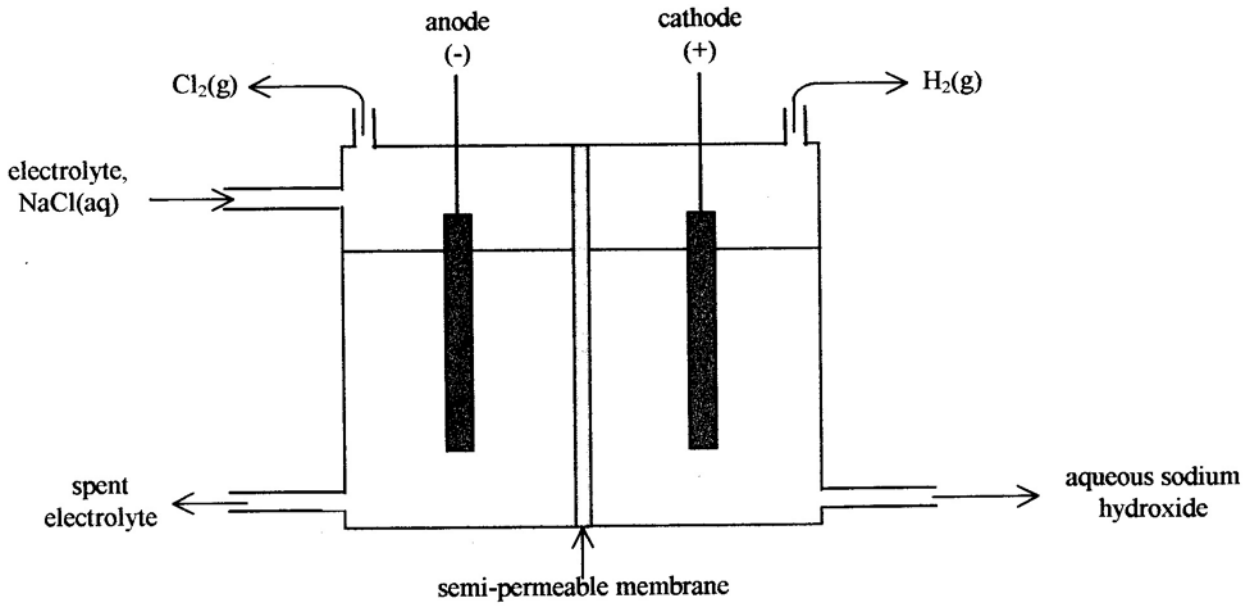
_____

(v) State the main biochemical role of the products of the digestion of sucrose in humans.

_____

(1 + 6 = 7 marks)
(*Suggested time: 9 mintues*)

Question 4
Industrially chlorine is produced by the electrolysis of brine, a solution of sodium chloride. A simplified diagram of the electrolytic cell used is shown below:



(a) Write the half-equations for the reactions excepted, **under standard conditions**, at the:

anode _____

cathode _____

(b) (i) Explain why chlorine is produced in the industrial electrolytic cell shown.

_____

_____

_____

_____

(ii) Write a half-equation for the production of chlorine.

_____

(c) What is the function of the semi-permeable membrane in the operation of this electrolytic cell?

_____

_____

_____

_____

_____

(d) (i) Calculate the volume of chlorine gas, measured at SLC, produced by one electrolytic cell in 24 hours if the current flowing through the cell is 1.50×10^5 A.

(ii) Explain why the actual volume produced is likely to be less than the volume calculated in part (d)(i).

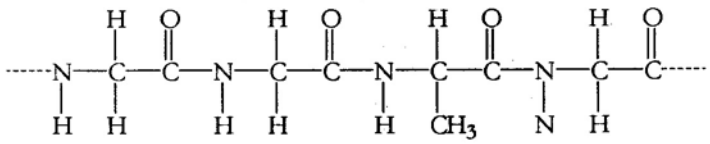
_____

_____

_____

(2 + 3 + 3 + 5 = 13 marks)
(*Suggested time: 17 minutes*)

Question 5
A segment of a protein molecule is shown below:



(a) Draw a peptide link.

(b) The action of enzymes on the protein molecule produces amino acids.
(i) Name the amino acids formed from this section of the protein molecule.

_____

(ii) Name the type of chemical reaction that results in the formation of the amino acids.

_____

(c) In the human body, amino acids are usually found in the form of zwitterions. Draw the amino acid, methionine, in the zwitterion form. Methionine has the chemical formula

$H_2N—CH(CH_2CH_2SCH_3)—COOH$

(1 + 3 + 1 = 5 marks)
(*Suggested time: 6 minutes*)

Question 6

(a) Write the ground state electronic configuration of an atom of chromium.

_____

(b) Chromium is able to form compounds such as $Cr(OH)_2$ and $Na_2Cr_2O_7$.

(i) Identify the oxidation number of chromium in each of these compounds

$Cr(OH)_2$ _____

$Na_2Cr_2O_7$ _____

(ii) Write the electronic configuration for chromium in $Cr(OH)_2$.

_____

(c) Chromium is able to form complex ions, such as $[Cr(H_2O)_5Cl]^{2+}$ in aqueous solution.

(i) Identify the ligand(s) in this complex ion.

_____

(ii) Explain what is meant by the term 'ligand'.

_____

_____

_____

(iii) Sketch the shape of this ion.

(iv) Explain why transition elements, such as chromium, are more likely to form complex ions than main group elements.

_____

_____

_____

_____

(1 + 3 + 5 = 9 marks)

(*Suggested time: 12 minutes*)

Question 7
It has been experimentally determined that Red Giant stars have mean temperatures of around 2×10^8 K. In such stars, helium nuclei combine to form carbon nuclei, as shown by the equation:

$$3\,{}^{4}_{2}\mathrm{He} \rightarrow {}^{12}_{6}\mathrm{C}$$

(a) Explain why such high temperatures are required to initiate this nuclear reaction.

_____

_____

_____

_____

(b) Given that the relative masses of ${}^{12}_{6}\mathrm{C}$ and ${}^{4}_{2}\mathrm{He}$ nuclei are 11.9965 and 4.0015 respectively, calculate the total mass loss during the formation of one mole of ${}^{12}_{6}\mathrm{C}$ nuclei.

(c) Explain the 'fate' of the mass lost in the formation of carbon nuclei in Red Giant stars.

_____

_____

_____

(2 + 2 + 1 = 5 marks)
(*Suggested time: 6 minutes*)

END OF PAPER