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Student name

BIOLOGY
Unit 4
Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Structure of book

Section	Number of questions	Number of marks
A	25	25
B	6	50
	Total	**75**

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is allowed in this examination.

Materials supplied

- Question and answer book of 20 pages with a detachable answer sheet for multiple-choice questions inside the front cover.

Instructions

- Detach the answer sheet for multiple-choice questions during reading time.
- Write your **name** in the space provided above on this page and on the answer sheet for multiple-choice questions.
- All written responses should be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

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STAV Publishing
2004

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 27 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

The least efficient process for a coal fired power station involving the conversion of energy would occur

A. during the combustion of coal to produce thermal energy.

B. when thermal energy is used to produce steam.

C. when movement energy in the steam is converted to mechanical energy.

D. as mechanical energy is converted to electrical energy.

Question 2

When 5.00 g of phosphorus is burned at 1.00 atmosphere pressure in gaseous chlorine, according to the given equation, 98.7 kJ of heat energy is released to the surroundings.

$$2P(s) + 3Cl_2(g) \rightarrow 2PCl_3(g)$$

The enthalpy change, ΔH, for this reaction is

A. $-98.7\ kJ\ mol^{-1}$

B. $-6.12 \times 10^2\ kJ\ mol^{-1}$

C. $+6.12 \times 10^2\ kJ\ mol^{-1}$

D. $-1.22 \times 10^3\ kJ\ mol^{-1}$

Question 3

When a direct current of electricity is conducted by an aqueous solution of an electrolyte in an electrolytic cell

A. the movement of electrons accounts for the current flow through the solution.

B. the solution remains electrically neutral.

C. electrons always flow towards the positive electrode.

D. the number of positive ions moving toward one electrode is always equal to the number of negative ions moving toward the other electrode.

Question 4

A galvanic cell can be constructed by linking a standard hydrogen half-cell to a standard Ni^{2+}/Ni half-cell. In this galvanic cell

A. the concentration of nickel(II) ions would decrease.

B. reduction would occur at the platinum electrode.

C. the pH of the solution in the standard hydrogen half-cell would decrease.

D. hydrogen gas would be consumed at the anode.

Questions 5 and 6 refer to the following information.
A solution containing a mixture of 1.0 M KNO_3, 1.0 M $Zn(NO_3)_2$ and 1.0 M $Cu(NO_3)_2$ is electrolysed using platinum electrodes. A potential of 3.0 volts is applied and the cell is run until gaseous products are observed from both electrodes.

Question 5

The electrolytic process was stopped and the coating on the cathode examined. The materials coated onto the electrode from the platinum core outwards will be

A. copper followed by zinc.

B. copper, zinc and then potassium.

C. copper only.

D. potassium only.

Question 6

A gaseous product was

A. hydrogen, H_2, produced at the anode.

B. oxygen, O_2, produced at the anode.

C. nitrogen, N_2, produced at the cathode.

D. ozone, O_3, produced at the cathode.

Question 7

The elements aluminium, magnesium, sodium and chlorine can be produced by the electrolysis of molten compounds. The **greatest** quantity of electricity will be required to produce 1.0 g of the element

A. Al

B. Mg

C. Na

D. Cl_2

Question 8

Under certain conditions an electron shifts from one energy level in an atom to another. The electronic transition that would release the most energy occurs when an electron moves from the

A. second shell to the third.

B. first shell to the second.

C. third shell to the second.

D. second shell to the first.

Question 9

When polyunsaturated triglycerides are hydrolysed the products will be

A. saturated triglycerides.

B. fatty acids and water.

C. carbon dioxide and water.

D. glycerol and fatty acids.

Question 10

A molecule of the naturally occurring triglyceride made solely from stearic acid ($C_{18}H_{36}O_2$) and glycerol, has the molecular formula

A. $C_{57}H_{116}O_9$

B. $C_{57}H_{110}O_6$

C. $C_{21}H_{44}O_5$

D. $C_{21}H_{42}O_4$

Question 11

The percentage by mass of oxygen in β-glucose is 53.5%. When several thousand β-glucose molecules combine to form cellulose the percentage by mass of oxygen in the polymer formed is

A. 53.5%

B. more than 53.5%

C. less than 53.5%

D. unable to be determined without further information.

Question 12

Linoleic acid is a fatty acid with formula $C_{18}H_{32}O_2$. From this information, linoleic acid is likely to be

A. a polyunsaturated fatty acid.

B. a monounsaturated fatty acid.

C. a saturated fatty acid.

D. a solid at room temperature

Question 13

It is ***incorrect*** to state that glucose reacts

A. with oxygen exothermically to produce carbon dioxide and water.

B. endothermically to produce cellulose and water.

C. exothermically to produce carbon dioxide and ethanol.

D. exothermically to produce starch and water.

Question 14

Which of the following could not be readily determined by using a mass spectrometer?

A. the atomic number of an element

B. the relative atomic mass of an element

C. the mass number of an isotope

D. the number of isotopes in an element

Question 15

Which of the following nuclear reactions correctly identifies the production of energy in our sun?

A. ${}^{4}_{2}\mathrm{He} \rightarrow 4\,{}^{1}_{1}\mathrm{H} + 2\,{}^{0}_{+1}\mathrm{e}$

B. ${}^{4}_{2}\mathrm{He} \rightarrow 4\,{}^{1}_{1}\mathrm{H} + 2\,{}^{0}_{-1}\mathrm{e}$

C. $4\,{}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + 2\,{}^{0}_{+1}\mathrm{e}$

D. $4\,{}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + 2\,{}^{0}_{-1}\mathrm{e}$

Question 16

Under certain conditions, a proton within an atom may be converted to a neutron and a positron. The positron is ejected from the nucleus and the resulting atom will have the same

A. atomic number but a greater mass number.

B. atomic number but a smaller mass number.

C. mass number but a greater atomic number.

D. mass number but a smaller atomic number.

Question 17

The melting points of the Period 3 elements are given in the table.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Melting point (K)	371	922	933	1683	317	392	172	84

These melting points of the elements are best explained in terms of

A. electronegativity

B. atomic radius

C. structure and bonding

D. ionization energy

Questions 18 to 20 refer to the following information.

The electron configurations of the elements I, II, III and IV are shown.

I $1s^2 2s^2 2p^4$

II $1s^2 2s^2 2p^6 3s^2$

III $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$

IV $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$

Question 18

Selecting from the elements I to IV, identify any Period 3 elements.

A. I

B. II

C. II, III and IV

D. III and IV

Question 19

Selecting from the elements I to IV, identify any elements likely to form a 2+ ion.

A. I

B. II

C. II, III and IV

D. III and IV

Question 20

Selecting from the elements I to IV, identify any non-metal elements.

A. I

B. II

C. II, III and IV

D. III and IV

END OF SECTION A

SECTION B

Specific instructions for Section B

Section B consists of six short-answer questions numbered 1 to 6; you must answer all of these questions. This section is worth 55 marks or approximately 73 per cent of the total. You should spend approximately 66 minutes on this section.

The marks allotted to each question are shown and 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

Write concise explanations for the following observations.

a. When writing electronic configuration it is incorrect to place electrons in a ***2d*** subshell.

b. Earlier chemists published versions of the periodic table with nickel placed before cobalt. Modern versions correctly place nickel after cobalt.

c. The negative ion, O^-, has a greater ionic radius than the positive ion, O^+.

Question 1 continued

d. Stores of energy in the body are predominantly triglycerides stored as adipose tissue.

e. Vitamin C is an antioxidant but it is not used in commercial table margarines to decrease the oxidation of unsaturated fats. Vitamin C, also known as ascorbic acid, has a structure that includes four hydroxyl groups and has a molecular formula of $C_6H_{10}O_6$.

f. A cleaned lead strip is placed in 1 M HCl at 25 ^oC. No reaction is observed after several minutes.

g. A student rejects their calibration factor of 380 J $^oC^{-1}$ for a solution calorimeter containing 100 mL of water and uses one provided by the teacher for experimental calculations.

1 + 1 + 1 + 1 + 1 + 1 + 1 = 7 marks
Suggested time: 9 minutes

Question 2

Ethanol, C_2H_5OH, is produced from α-glucose, $C_6H_{12}O_6$, by fermentation. Carbon dioxide is the only other product formed.

a. Write a balanced equation for the fermentation of α-glucose.

_____

b. Write the half equations for the

(i) Oxidation process

_____

(ii) Reduction process

_____

c. A large-scale trial fermentation was carried out in a well-insulated stainless steel vat. Suitable yeast, 11.5 kg of glucose and water was added to the vat to make the volume up to 100 L of solution. The temperature rose from 20.0 ^oC to 30.5 ^oC.

(i) Calculate the minimum heat energy, in MJ, released by the fermentation process. Assume that the density of the reaction mixture is 1.0 g mL^{-1} and the specific heat capacity is 4.18 kJ kg^{-1} $^oC^{-1}$.

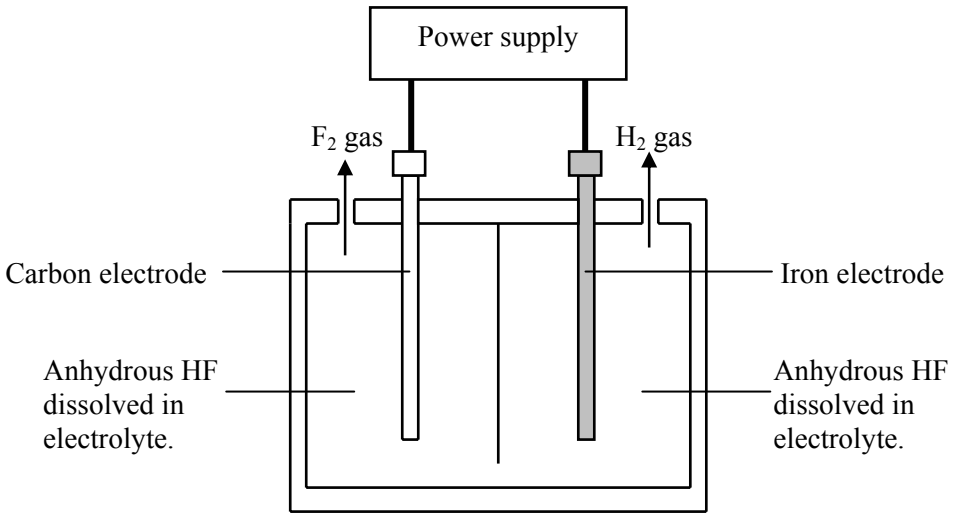
(ii) Use your value calculated in part (i) to determine the heat of reaction for the fermentation of glucose, in kJ mol^{-1}.

[1 + 1 + 1] + [2 + 3] = 8 marks
Suggested time: 10 minutes

Question 3

Many industrial processes result in the build-up of deposits in reaction chambers. To clean these chambers a powerful oxidant, such as fluorine gas, F_2, is required. A safe and cheap method of generating F_2 on-site uses anhydrous hydrogen fluoride, HF.

The diagram below shows an electrolytic cell used for the on-site production of F_2.



a. Indicate which of the electrodes is the cathode. _____

b. Write the half equations for the reactions expected at the

Iron Electrode:

_____

Carbon Electrode:

_____

c. Anhydrous hydrogen fluoride is used rather than an aqueous solution of HF. Suggest a reason for this ***and*** include a relevant chemical equation to assist in your response.

_____

_____

_____

d. Iron electrodes are cheaper and better electrical conductors than carbon electrodes. However, carbon rather than iron is used as the electrode in the chamber where fluorine gas is produced. Explain why?

_____

_____

Question 3 continued

e. In a pilot plant a current of 10.5 A was passed through a cell for 10 minutes with an efficiency of 90 percent.

(i) Calculate the amount, in mol, of fluorine gas produced in this time.

(ii) Determine the volume this amount of fluorine gas would occupy at SLC.

f. Fluorine is described as the most powerful elemental oxidant known. Explain why fluorine is such a powerful oxidant.

_____

_____

_____

_____

1 + 2 + 2 + 1 + [4 + 1] + 2 = 13 marks

Suggested time: 15 minutes

Question 4

Many of the molecules A to E shown below are biologically important.

A. $C_{12}H_{22}O_{11}$

B. $C_{18}H_{34}O_2$

C. $C_3H_8O_3$

D. $C_6H_{12}O_6$

E. $C_{16}H_{32}O_2$

Identify the molecule or molecules that could have been formed from

i) the hydrolysis of starch

ii) the hydrolysis of a disaccharide

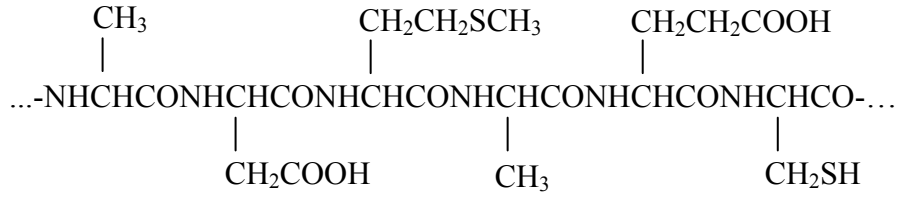
iii) the hydrolysis of saturated fat

5 marks

Suggested time: 5 minutes

Question 5

A segment of a protein chain found in serine dehydratase is shown.



a. How many **different** amino acid residues are shown in this segment?

_____

b. Protein chains can be converted into amino acids in acidic solutions.

(i) Name the type of reaction involved in this process.

_____

(ii) Draw ***zwitterion structures*** representing **two** of the amino acids formed from the protein chain shown **and** name **one** of these amino acids. Clearly indicate the structure you have named.

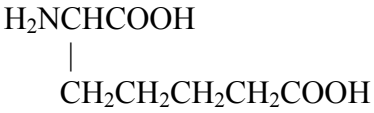
(iii) The structure of amino acids alters at different pH values. Selecting one of the amino acid structures you have shown in part (ii) draw the structure of this amino acid in solution at high pH.

Structure at high pH

Question 5 ***continued***

c. Proteins can be analysed by electrophoresis. In this procedure a mixture of amino acids is placed in a suitable solvent medium and a potential difference is applied to cause charged particles to migrate.

In neutral pH Lysine has the structure:



If lycine in a solution of pH 2 was analysed by electrophoresis, would you expect the amino acid to migrate towards the cathode or anode? Explain your response.

_____

_____

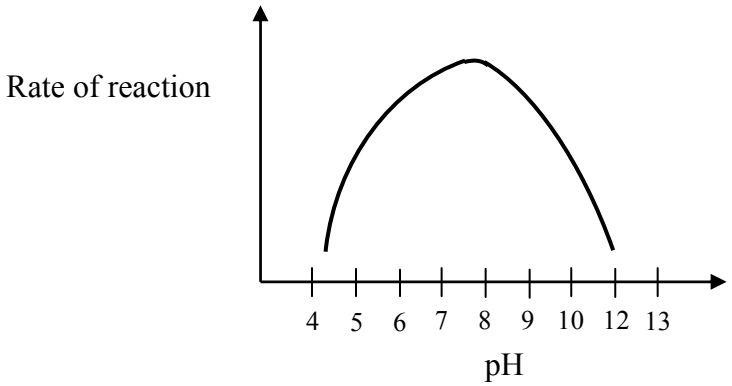
_____

_____

d. Excess amino acids cannot be stored in the human body. The excess amino acids undergo deamination reactions.

(i) The ammonium ion is rapidly converted to another product before being excreted. Name this product. Draw the structural formula of the product.

(ii) An example of the deamination of an amino acid is the reaction catalysed by serine dehydratase. The graph shows the rate of reaction of this reaction against pH.



Above pH 12 no deamination occurs. Explain why?

_____

What **other** change could be used to bring about this change in enzyme activity?

_____

1 + [1 + 3 + 1] + 2 + [2 + 2] = 12 marks

Suggested time: 15 minutes

Question 6

Lithium and titanium are both metallic elements whose atoms have approximately the same atomic radius.

a. Write the electronic configuration, using *s*, *p*, *d* notation, for

(i) lithium _____

(ii) titanium _____

b. Explain why the melting temperature of titanium (1943 K) is much greater that that of lithium (453 K).

_____

_____

_____

_____

_____

c. Transition elements form numerous complex ions, for example, titanium forms $[Ti(OH)_2(H_2O)_4]^{2+}(aq)$.

(i) Explain the term 'complex ion'.

_____

_____

_____

(ii) What is the charge on titanium in $[Ti(OH)_2(H_2O)_4]^{2+}(aq)$?

_____

(iii) Draw a diagram to represent the structure of this complex ion. Clearly label **all** bond types on your diagram.

2 + 2 + [1 + 1 + 4] = 10 marks
Suggested time: 12 minutes

END OF EXAMINATION