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Student Name/Number:...

2003
HIGHER SCHOOL CERTIFICATE
Sample Examination Paper

CHEMISTRY

Reading time - 5 minutes

Working time - Three (3) hours

Direction to Candidates

° Board approved calculators may be used.

A Data Sheet and Periodic Table are to be provided with this paper

Section I – Core
Attempt ALL questions.

Part A 15 multiple-choice questions, each worth 1 mark.
Mark your answers in pencil on the Answer Sheet provided with this book.

Part B Other questions with a total mark value of 60.
Answer this part in the spaces provided in Part B of the Answer Book.

Section II – Electives
Attempt ONE question only.
Each question is worth 25 marks.
Answer the question in a separate Elective Answer Book.

Directions to School or College

PART A – 15 marks

Attempt all questions (1-15).   Each question is worth 1 mark.
Allow about 30 minutes for this part.

Select the alternatives A, B, C or D that best answers the question.
Mark your answers in pencil on the Multiple Choice Answer Sheet provided.

1. Which of the following describes an atom that is reduced
A. loses electrons and becomes more positively charged
B. loses electrons and becomes more negatively charged
C. gains electrons and becomes more positively charged
D. gains electrons and becomes more negatively charged

2. Ethanol can be prepared by the addition of water to
A. ethene
B. acetic acid
C. methane
D. 2-chloropropane

3. Polyvinyl chloride (PVC) is an addition polymer. The monomer from which it is made is
A. chloroethane
B. chloroethene
C. tetrafluoroethene
D. ethene

4. In the half equation for a substance acting as a reductant
A. the oxidation number increases
B. the oxidation number does not change
C. the oxidation number decreases
D. the oxidation number is negative

5. Transuranic elements
A. do not occur naturally
B. are not radioactive
C. are formed from uranium isotopes
D. emit neutrons

6. A conical flask to be used in titration should be finally rinsed with
A. the solution in the burette
B. the solution to be added by the pipette
C. distilled water, with the flask being dried before use in a drying oven
D. distilled water and left wet

7. Given 0.10 M aqueous solutions of each of the following listed compounds, which would be the most basic
A. NH_3
B. $NaOH$
C. $Ca(OH)_2$
D. $NaCH_3COO$

8. The common laboratory peparation of an ester (with a byproduct of water) involves the reaction of
A. an alcohol and a carboxylic acid
B. an alkane and an alkene
C. two amino acids
D. an alcohol oxidized with acidified potassium dichromate

9. The conjugate acid of HS^- is
A. H^+
B. S^{2-}
C. H_2S
D. $HS(OH)^{2-}$

10. The major human activity that releases the pollutant sulfur dioxide in large amounts into the atmosphere is
A. clearing of old growth forests
B. use of motor vehicles
C. use of chlorofluorocarbons
D. burning of fossil fuels

11. Which of the following will increase the rate at which a state of equilibrium is reached without affecting the position of equilibrium
A. increasing the temperature
B. increasing the pressure
C. decreasing the concentration of products
D. adding a catalyst

12. In the conversion of nitrogen to ammonia using the Haber process, the main reason why the temperature is limited to about 400°C is because
A. a higher temperature would cause the catalyst to break down
B. a higher temperature would slow the reaction
C. a higher temperature would decrease the amount of ammonia product at equilibrium
D. a higher temperature would make the reaction process too costly

13. The molecule that contains a coordinate covalent bond is
A. carbon monoxide
B. water
C. nitrogen
D. sodium chloride

14. Water hardness can be caused by the presence of high levels of one of the ions listed
A. magnesium ions
B. chloride ions
C. sodium ions
D. manganese ions

15. An increase in organic waste material in a body of water will usually result in an increase in
A. dissolved oxygen
B. biochemical oxygen demand
C. N:P ratio
D. acidity

PART B – 60 marks

Allow about 1 hour and 45 minutes for this part.

Answer all questions in the spaces provided.
Show working for all questions requiring calculations.

Marks

16. For alcoholic beverages, ethanol is prepared by fermentation of sugars such as glucose
    a. Write an equation for the fermentation of glucose, $C_6H_{12}O_6$, to ethanol. **1**

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    b. What other factor is required for this fermentation to occur. **1**

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    c. What apparatus would you use to obtain a sample of pure ethanol from the reaction mixture. **1**

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17. a. In order to determine the relative strengths of several metals as reducing agents, a group of students performed the following experiment. Pieces of each of the four metals, Cu, Pb, Ag, Zn were placed in aqueous solutions of nitrates of each of the other metals on the list. Results after a period of time are recorded below. A + means the metal in the left-hand column of that row reacted with the metal ion in the top row of that column; a x means that there was no reaction. A dash means that no test was performed.

	Cu^{2+}	Pb^{2+}	Ag^{+}	Zn^{2+}
Cu	-	x	+	x
Pb	+	-	+	x
Ag	x	x	-	x
Zn	+	+	+	-

i. Use the results in the Table to arrange the metals in order of decreasing strength as reducing agents; i.e. strongest reductant first, weakest last.   1

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ii. Explain carefully how you used the results in the Table to deduce the order you wrote above.   2

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iii. Write equations for the reactions between Cu and Ag^{+} and Zn and Cu^{2+}.   2

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18. a Draw a galvanic cell which uses a copper and a lead electrode in solutions of their salts

    i. In the diagram label.

        the direction of electron flow
        the direction of flow of positive ions
        the beaker in which oxidation is taking place
        the anode   **5**

    ii. For the above cell show the equations for the half reactions which occur in each beaker and the overall cell reaction.   **3**

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b. i. For each of the following compounds, state the oxidation state of the metal.
                FeS, Cr_2O_3, $FeCl_3$ **2**

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    ii. Does each of the following represent oxidation or reduction of the metal, or neither. Explain.
        $MnCl_3 \longrightarrow MnO_2$ $NiO_2 \longrightarrow Ni(OH)_2$ **4**
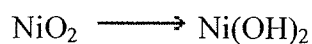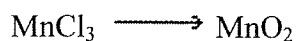
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19. a. Explain what is meant by a 'condensation polymer'.   **2**

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   b. Name a synthetic condensation polymer.   **1**

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   c. Describe the formation of cellulose, including the monomer(s) and functional
groups involved.   **2**

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   d. How can cellulose be used as a biofuel.   **2**

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20. Below is the structural formula for an ester.
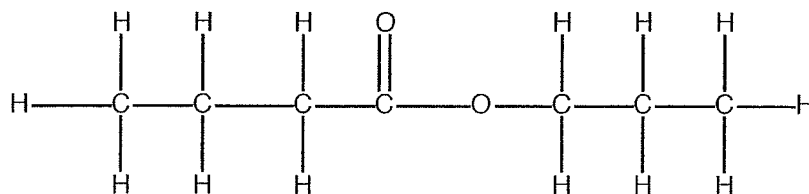
a. Name the ester using the rules of IUPAC nomenclature.   1

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b. Write the structural formula and the names of the reactants for the preparation of this ester.   3

c. What are the conditions necessary for the reaction in b.   2

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d. Describe one common use of esters in industry.   1

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21. a. A chemist has 0.10M solution of four acids, A, B, C and D, and measures the pH of each. The values are 4.2, 6.1, 2.0 and 2.7 respectively. Arrange these acids in order of increasing strength (weakest first).   **3**

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b. Are any of these acids completely ionized. Explain.   **2**

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22. In order to standardize an approximately 0.2M solution of hydrochloric acid, an analyst first prepared an accurately known solution of sodium carbonate. To do this 5.404 g of pure anhydrous sodium carbonate was weighed out, dissolved in water and made up to 500mL in a volumetric flask. What is the molar concentration of this standard solution.   **2**

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23. a. An acid X has a empirical formula of C_2H_4O and a molar weight of 88g/mol. What is the molecular formula of the compound.   **1**

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   b. Draw structural formula for two possible isomers of X that have properties consistent with the data given.   **2**

   c. Draw a structural formula for an isomer of X that belongs to a different homologous series. Name this isomer.   **3**

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   d. Predict whether the molecule you have shown in c. is likely to have a lower or higher boiling point than the isomers of X. Explain.   **2**

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24. a. Explain why ethanol is called a renewable resource.   **1**

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b. Discuss a disadvantage of the use of ethanol as a fuel.   **1**

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25. Water can be purified by the use of microscopic membrane filters
a. What materials can be used in such filters.   **1**

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b. What contaminants are removed from water by the use of membrane filters.   **1**

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c. What contaminants are not removed by the use of membrane filters and what methods can be used to remove these contaminants.   **1**

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26. Industrial production of ammonia from nitrogen is carried out using the Haber process

    a. Write the equation for the Haber process.   **1**

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    b. In the Haber process the following conditions are selected. Comment on the significance of each of the selected conditions.   **3**

        i. high pressures.

        ii. intermediate temperatures, about 500-600°C.

        iii. a catalyst.

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SECTION II – OPTIONS

25 marks

Attempt ONE question from questions 27 – 31.
Allow about 45 minutes for this section.

Answer the questions in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Question 27 – INDUSTRIAL CHEMISTRY (25 marks)

a. The contact process is used to manufacture sulfuric acid
   i. Outline the three main stages in the manufacture of sulfuric acid.   **3**

   ii. Sulfur is burnt in dry air to produce sulfur dioxide. Explain why the air must be dry for this step.   **1**

   iii. A catalyst is used in the process. Why is a catalyst used rather than a simply raising the temperature.   **2**

   iv. The process typically produces sulfuric acid of 98.5% w/w concentration. Given that the density of this acid is 1.8 gcm^{-3}, calculate the molarity of the acid.   **3**

   v. Discuss the conditions used for the Contact process. Include the significance of temperature, pressure and catalyst.   **3**

   vi. Why is sulfuric acid regarded as the most important industrial acid.   **2**

b. Chlorine and sodium hydroxide are produced by the electrolysis of saturated sodium chloride. Briefly outline the two different commercial methods that are used and write the anode and cathode reactions for each method.   **6**

c. i. Define the term saponification.   **1**

   ii. What is the chemical process involved in saponification.   **2**

   iii. Briefly describe the experimental method.   **2**
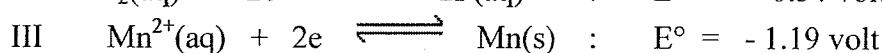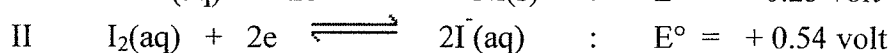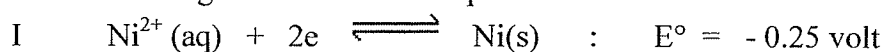
Question 28 – SHIPWRECKS, CORROSION and CONSERVATION
(25 marks)

a. i. Draw a diagram showing the electrolysis of NaCl. Label in your diagram the external voltage source, the anode and the cathode and indicate the site of oxidation and the site of reduction. Indicate also in your diagram the direction of movement of ions.   **4**

   ii. Write equations showing the reactions at the electrodes.   **2**

   iii. What is the electrolyte in this electrolysis cell and in what is the state of matter of this electrolyte.   **2**

b. You are given the following standard reduction potentials:

$$\text{I} \qquad Ni^{2+}(aq) + 2e \rightleftharpoons Ni(s) \quad : \quad E° = -0.25 \text{ volt}$$
$$\text{II} \qquad I_2(aq) + 2e \rightleftharpoons 2I^-(aq) \quad : \quad E° = +0.54 \text{ volt}$$
$$\text{III} \qquad Mn^{2+}(aq) + 2e \rightleftharpoons Mn(s) \quad : \quad E° = -1.19 \text{ volt}$$

   i. Write a balanced equation for the overall reaction which will occur spontaneously when electrodes I and II are combined.   **2**

   ii. Calculate E^0_{cell} for an electrochemical cell formed using electrodes II and III. **1**

   iii. If the I_2 concentration in the cell in part ii. is increased relative to the concentration of I^-, what will be the effect on E^0_{cell}? Explain your answer.   **2**

c. i. Outline the mechanism for the rusting/corrosion of iron.   **3**

   ii. How can galvanizing protect iron from rusting.   **3**

   iii. What three factors are important in their effect on the rate of corrosion of submerged shipwrecks.   **1**

   iv. How do these factors influence the process of corrosion.   **3**

   v. Compare the rate of corrosion by the factors noted in iii. in shallow versus deep ocean water.   **2**