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PYMBLE LADIES' COLLEGE

SEMESTER 2, 2007

YEAR 12 CHEMISTRY

MULTIPLE CHOICE QUESTION BOOK

Tuesday 31st July

General Instructions
• Reading time – 5 minutes
• Working time – 3 hours
• Write using black or blue pen
• Draw diagrams using pencil
• Board-approved calculators may be used
• A data sheet and a Periodic Table are provided at the back of this paper
• Write your Student Number where indicated and on each page of the writing paper for the Option.

Total marks – 100
SECTION I 84 marks
This section has two parts, Part A and Part B

Part A – 15 marks
• Attempt Questions 1–15
• Allow about 30 minutes for this part

Part B – 69 marks
• Attempt Questions 16–27
• Allow about 1 hour and 55 minutes for this part

SECTION II 16 marks
• Allow about 35 minutes
• Attempt ONE question from Questions 28 - 30.

PART A
Total Marks – 15 marks
Attempt ALL questions

Select the alternative that best answers the question.
Mark your answers on the Multiple Choice Answer Sheet provided.

1. Carbon-14 is an unstable isotope because:

    (A) It has a half life of about 6000 years.
    (B) Its nucleus has an atomic number greater than 83.
    (C) The neutron to proton ratio is too great.
    (D) It has more neutrons than protons.

2. Which of the following is a major component of biomass?

    (A) Cellulose
    (B) Ethanol
    (C) Natural gas
    (D) Oil

3. Which instrument is used to detect radiation from radioactive isotopes?

    (A) pH meter
    (B) Geiger counter
    (C) Ion selective electrode
    (D) Atomic absorption spectrophotometer

4. Why is research into synthetic biopolymers attracting great interest?

    (A) They decompose more readily than traditional synthetic polymers.
    (B) They can be produced more cheaply than traditional synthetic polymers.
    (C) They have superior physical properties compared to traditional synthetic polymers.
    (D) They have superior chemical properties compared to traditional synthetic polymers.

5. Terylene (polyester) is a condensation polymer.
   Part of the structure of the polymer is shown.
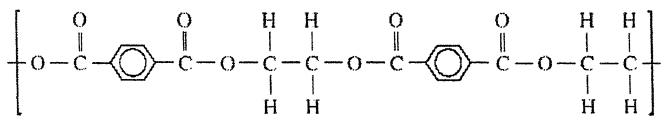
What are the two monomers of this polymer?

	Monomer 1	Monomer 2
(A)		
(B)		
(C)		
(D)		

6. 100 mL of an 0.0100 $mol.L^{-1}$ aqueous solution of calcium hydroxide will absorb carbon dioxide according to the equation

$$Ca(OH)_2(aq) + 2CO_2(g) \longrightarrow Ca(HCO_3)_2(aq)$$
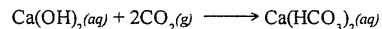
The maximum volume, in mL, at STP (0°C, 100kPa) of CO_2 that could be absorbed by the solution is closest to

(A) 22.7
(B) 45.4
(C) 227
(D) 454

7. The ionization of a weak acid is shown by the following equation.

$$HNO_2(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + NO_2^-(aq)$$
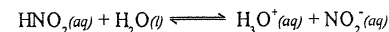
Which of the following correctly lists conjugate acid base pairs for this reaction?

	ACID	BASE
(A)	HNO_2	H_3O^+
(B)	HNO_2	NO_2^-
(C)	H_2O	H_3O^+
(D)	H_2O	NO_2^-

8. 1 g of each of the following substances is dissolved in 1 L of water.
   In which one would the pH of the resultant solution be closest to 7?

(A) H_2SO_4
(B) NH_3
(C) $NaHSO_4$
(D) $NaCl$

The following information is referred to in Questions 9 and 10.

Consider a solution in which the following equilibrium is established.
$$Br_2(aq) + 2OH^-(aq) \rightleftharpoons OBr^-(aq) + Br^-(aq) + H_2O(l); \quad \Delta H = +15 \text{ kJ/mol}$$
The molecular bromine (Br_2) gives the aqueous solution a reddish brown colour.
All the other species present are colourless.
The following tests are carried out on separate samples of the solution.
Test 1 A few mL of a concentrated HCl solution are mixed into the solution.
Test 2 The solution is heated from room temperature to 40°C.
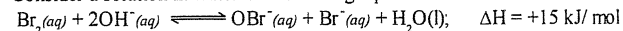
9. As a result of **Test 1**

(A) The solution becomes darker.
(B) The [OBr⁻] in the solution increases.
(C) The [Br_2] in the solution decreases.
(D) The solution becomes lighter.

10. As a result of **Test 2**

(A) The position of equilibrium shifts to the left
(B) The [OBr⁻] in the solution increases.
(C) The [Br_2] in the solution increases.
(D) Since there are three molecules on each side of the equilibrium the position does not change.

11. Which reagent would be most useful in distinguishing between solutions of lead (Pb^{2+}) and iron (Fe^{2+})?

    (A) sodium hydroxide
    (B) sodium sulfate
    (C) hydrochloric acid
    (D) silver nitrate

12. Which diagram correctly represents the bonding in Ozone?

(A)

(B)

(C)

(D)
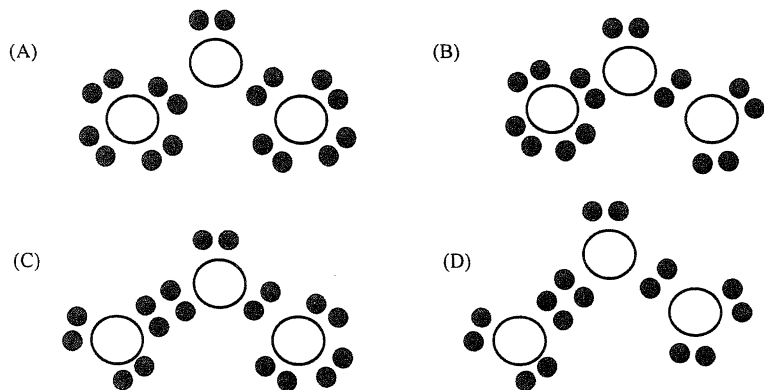
13. What is the correct name for this structure?

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    Cl    H    H
    |     |    |
F — C  —  C  — C — F
    |     |    |
    Cl    Cl   H
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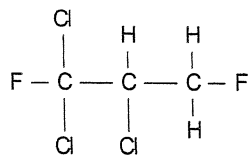
    (A) 1,3-trichloro-1, 1,2-difluoropropane
    (B) 1,3-trichloro-1,1,2-difluorobutane
    (C) 1,1,2-trichloro-1,3-difluoropropane
    (D) 1,1,2-trichloro-1,3-difluorobutane

14. What products would you expect to form if hexane is combusted in a plentiful supply of oxygen?

    (A) carbon dioxide and carbon monoxide
    (B) water and carbon monoxide
    (C) carbon dioxide and water
    (D) water, carbon monoxide and carbon

15. A sample of river water was analysed using AAS to determine the level of lead. A calibration curve is shown below.
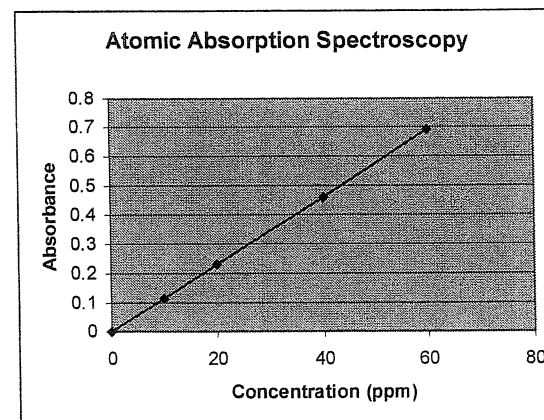
The sample gave an absorbance reading of 0.30 .
Which of the statements is correct?

    (A) This water is contaminated with a lead concentration of 50 ppm.
    (B) The sample contains less than 30 ppm of lead.
    (C) The sample contains 35 ppm of lead.
    (D) Lead cannot be detected using AAS.

SECTION I continued

Part B - 69 marks
Question and Answer Book

Attempt Questions 16 - 27
Allow about 1 hour and 55 minutes for this part.
Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.   **Marks**

Question 16.   [6 marks]

A student placed 25 g of glucose into a conical flask containing 80 mL water. She added about 2 g of yeast and then mixed the contents by shaking.
She stood the apparatus in a warm place at about 30°C for 2–3 days. The evolution of bubbles in the gas trap indicated that a reaction had occurred.
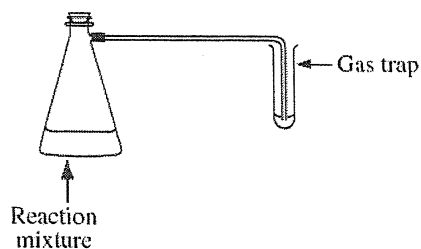
a) Name this process.   1

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b) Write a balanced chemical equation for the reaction that occurred.   1

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b) The flowchart shows how the reaction mixture can then be used to produce ethylene.
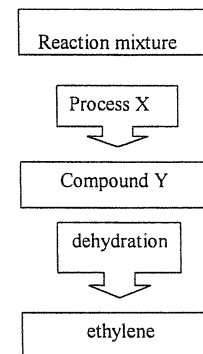
c) Identify the process X and compound Y   2

Process X ....

Compound Y ....

d) Explain, using two (2) examples, why ethylene is considered a very important chemical.   2

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Question 17   [4 marks]

You performed a first hand investigation that determined the heat of combustion of an alkanol.

    a)   Outline the procedure you used   **3**

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    b)   The accepted value for the heat of combustion, 1364 kJmol^{-1}, is higher than the value
         obtained experimentally. Account for the difference between the two values.   **1**

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Question 18   [7 marks]

Describe and explain how a named isotope is used in medicine in terms of its chemical properties and analyse the benefits and problems associated with its use.   **7**

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Question 19 [6 marks]

An electrochemical cell was set up using two half-cells. One of the half-cells consisted of aluminium metal and aluminium sulfate solution. The other half-cell consisted of zinc metal and zinc sulfate solution.

(a) Draw a labelled diagram of the complete electrochemical cell including the direction of electron flow. **3**

(b) Write a balanced ionic equation for the reaction that occurs in the electrochemical cell. Show relevant half-equations. **2**

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(c) Calculate the theoretical cell voltage for the electrochemical cell using the data provided. **1**

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Question 20 [7 marks]

Ethanoic acid (CH_3COOH) is a weak acid in water.

(a) Write an equation showing the ionisation of ethanoic acid in water. **1**

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(b) 100ml of 0.100 $mol.L^{-1}$ solution of ethanoic acid in water at 25°C has a pH of 2.88.

   i) Calculate the hydrogen ion concentration in the 100ml of 0.100 $mol.L^{-1}$ solution of ethanoic acid. **1**

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   ii) **If** ethanoic acid behaved as a strong acid **state** the hydrogen ion concentration of the 0.1 $mol.L^{-1}$ ethanoic acid solution. **1**

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   iii) Use the information from i) and ii) to calculate the percentage decomposition of ethanoic acid. **1**

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(c) At 25°C, methanoic acid (HCOOH) is approximately a ten times stronger acid than the ethanoic acid.
   i) Comparing two 0.10 $mol.L^{-1}$ solutions of methanoic and ethanoic acids, which solution would have the higher pH? Give a simple **qualitative** explanation for your answer. **1**

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   ii) Equal volumes of both solutions were titrated against a 0.10 $mol.L^{-1}$ solution of NaOH. Which of the solutions, if either, would require the greater volume of the NaOH solution for complete neutralisation? Explain your conclusion. **2**

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Question 21 [6 marks]

Some students were set the task of determining the concentration of acetic acid in a particular brand of vinegar. An outline of the method they used is given below.

1. A **burette** is filled with a standard solution of sodium hydroxide.
2. The vinegar is diluted by a factor of 10 in a **volumetric flask**. A **pipette** is used to transfer 20.00 mL of diluted vinegar to a **conical flask** and a few drops of phenolphthalein indicator is added.
3. The diluted vinegar is titrated with the base. Titrations are repeated until three concordant (similar) results are obtained.

The equation for the reaction is

$$NaOH_{(aq)} + CH_3COOH_{(aq)} \longrightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$$

a) The volumetric flask, the burette, the pipette and the conical flask are all rinsed before they are used. Indicate which solution should be used to finally rinse each of these pieces of glassware by ticking your choices in the appropriate boxes below. **2**

glassware used	rinse with water	rinse with diluted vinegar solution	rinse with NaOH solution
volumetric flask			
burette			
20.00 mL pipette			
conical flask			

b) One student's results are given below:

concentration of NaOH(aq) = 0.11 mol.L^{-1}
volume of undiluted vinegar = 10.00 mL
total volume of diluted vinegar = 100.00 mL
volume of diluted vinegar used in each titration = 20.00 mL
average titre (volume from burette) of NaOH = 15.35 mL

Using these results, calculate the concentration, in mol.L^{-1}, of acetic acid in the **undiluted** vinegar solution. Be careful to use the correct number of significant figures in your answer. **4**

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Question 22 [4 marks]

Esters are the basis of many naturally occurring odours and are therefore widely used in the creation of artificial flavours. Methyl butanoate is a component of the smell of pineapple.

a) Draw the structure of the ester methyl butanoate. **1**

b) Write a balanced chemical equation to show the preparation of methyl butanoate. Give the name of any catalyst used. **3**

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Question 23   [6 marks]

Compare and contrast the ideas about acids of Lavoisier and Arrhenius with the Bronsted-Lowry theory of acids and bases.

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Question 24   [6 marks]

In the early 20th century Fritz Haber developed an industrial process to produce ammonia.

a) Write a balanced equation for the Haber process.   1

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b) Is the Haber process reaction exothermic or endothermic?   1

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c) A yield of 98% ammonia can be obtained in the Haber process at temperatures of 200^{0}C and 10000 kPa pressure using a catalyst.
    Explain why the reaction is usually carried out at 500^{0}C and 3500 kPa even though the yield under these conditions is only about 30%.   4

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Question 25   [4 marks]

a) In which layer of the atmosphere is ozone beneficial to life on earth?   **1**

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b) Explain in detail the benefits of ozone in the upper atmosphere including equations where possible.   **3**

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Question 26   [8 marks]

Locals were concerned when several dead fish were discovered at a popular fishing spot in a nearby creek. The Community fishing Club sampled the water and sent it to be tested.

a) Identify TWO factors which determine the water quality and which should be considered to determine the cause of the fish deaths.   **2**

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b) Describe ONE quantitative test which can be carried out to compare the quality of the water sample.   **3**

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c) A tap water sample in a country town known for its hard water contains 3×10^{-5} mol L^{-1} of calcium carbonate. Calculate the mass of calcium carbonate in 250 mL of tap water.   **3**

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Question 27 [5 marks]

Below is a diagram of an Atomic Absorption Spectrometer.
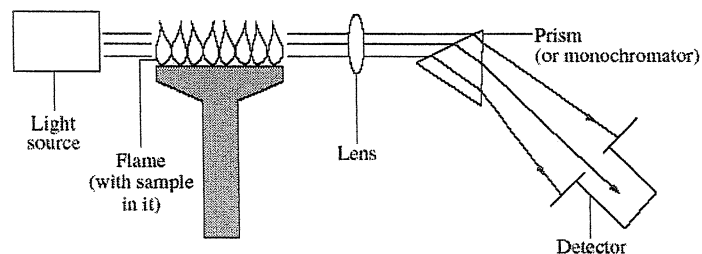
Roland Smith, 2000, Conquering Chemistry, 3rd edition (C) McGraw - Hill Australia Pty Ltd.

a) A sample is known to contain lead and copper. AAS allows us to determine the concentration of each metal ion using the same solution. What has to be changed to analyse for different metals? **1**

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b) AAS allows the detection of trace elements. Assess the impact of AAS on scientific understanding of the effects of trace elements. **4**

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Section II
16 marks

Attempt ONE question from Questions 28, 29 and 30
Allow about 35 minutes for this section.

Answer the question on the writing paper provided. Extra paper is available.

Show all relevant working in questions involving calculations.

Question 28 – Industrial Chemistry [16 marks]

a) Dinitrogen tetroxide (N_2O_4) is a colourless gas. It exists in equilibrium with nitrogen dioxide (NO_2), a brown gas. The concentration of NO_2 in a gas mixture can be determined using a spectrophotometer. The equation for the reaction is

$$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)} \; ; \quad K = 5.5 \times 10^3 \text{ M at } 25°C$$
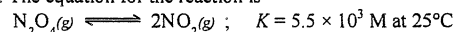
    i. Write the expression for the equilibrium constant for this reaction.   1

    ii. Calculate the concentration of N_2O_4 in a sample if the equilibrium concentration of NO_2 is 5.5×10^2 M.   2

b) Some pure NO_2 is placed in a gas syringe at 25°C and allowed to reach equilibrium.

    i. Keeping the volume constant the temperature is then raised to 35°C. The brown colour then becomes more intense. Is the above reaction (1) exothermic or endothermic? Explain your answer.   3

    ii. Keeping the temperature at 35°C the plunger of the syringe is then pushed in so as to halve the volume. Equilibrium is then re-established. Is the intensity of the brown colour greater or less than before the system was disturbed?   1

c) Sulfuric acid can be produced from mined sulfur via the Contact Process.
The first two stages in the industrial production of sulfuric acid by this process are represented below.
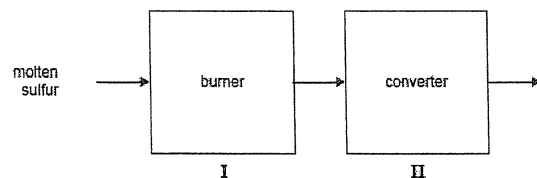
A conflict is involved in choosing the best temperature to be used in stage II, where the reaction is

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$
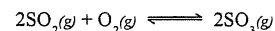
    i. Describe the nature of the conflict and explain how the conflict is resolved.   4

    ii. Would increasing the pressure of the reacting mixture in the converter affect the amount of SO_3 produced in stage II? Explain your answer.   2

d) Sulfuric acid is a diprotic acid. The first ionisation reaction of sulfuric acid is complete while its second ionisation is that of a weak acid. Give chemical equations for both the first and second ionisation reactions of sulfuric acid.   2

e) Give one major industrial use of sulfuric acid.   1

Question 29 – The Chemistry of Art [16 marks]

a)   i. Define the Pauli Exclusion Principle.   1

    ii. Draw an orbital box diagram for silicon.   2

b)   i. Successive ionisation energies provide information about the number of electrons in the outermost shell. Explain this statement?   2

    ii. Four elements with atomic numbers 17, 18, 19 and 20 have first ionisation energies of 1500, 600, 400 and 1300 kJ/mol. The elements are not listed in the same order as the ionisation energies. Which ionisation energy belongs to which element?   1

    iii. Explain why the first ionisation energy of beryllium is lower than that of lithium.   2

c)   i. Identify a metal ion that will produce a red colour in a flame test.   1

    ii. Explain why metal ions produce a characteristic colour in a flame.   3

    iii. Explain how the Bohr model of the atom was developed and outline its limitations.   4

Question 30 – Forensic Chemistry [16 marks]

a)   i. Define the term *organic compounds*.   1

    ii. From the investigations carried out during the course, how could you distinguish organic compounds from inorganic ones?   2

    iii. Draw a general structure for an amino acid.   1

    iv. Demonstrate the meaning of the terms peptide bond and dipeptide   2

b) Carbohydrates are a general class of compounds that includes the monosaccharide, glucose and polysaccharides such as glycogen and cellulose.

    i. What is the general formula of carbohydrates?   1

    ii. Compare the composition of glycogen and cellulose, and where they occur in nature   2

    iii. Explain the differences in structure between glycogen and cellulose.   3

c) An analytical chemist had three bottles whose labels had fallen off onto the tray they were standing in. One label was cyclohexene, the second propanol and the third methanoic acid. Describe two tests that could be used to distinguish between the three bottles so they can be relabeled.   4