IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M02/420/S(3)

CHEMISTRY
STANDARD LEVEL
PAPER 3

Tuesday 21 May 2002 (morning)

1 hour 15 minutes

Name

Number

INSTRUCTIONS TO CANDIDATES

- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from three of the Options in the spaces provided. You may continue your answers in a continuation answer booklet, and indicate the number of booklets used in the box below. Write your name and candidate number on the front cover of the continuation answer booklets, and attach them to this question paper using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the boxes below.

OPTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
		/15	/15	/15
		/15	/15	/15
		/15	/15	/15
NUMBER OF CONTINUATION BOOKLETS USED	. . . . .	TOTAL /45	TOTAL /45	TOTAL /45

Option A – Higher organic chemistry

A1. (a) A primary alcohol **A** (C_3H_8O) was heated with concentrated sulfuric acid. At 180 °C, **B** (C_3H_6) was obtained, whereas at 140 °C, **C** ($C_6H_{14}O$) was obtained.
Write the structural formulas of **A**, **B** and **C** and state the term used to describe the conversion of **A** to **B**. *[4]*

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(b) Treatment of **A** with acidified potassium dichromate(VI) can yield **D** (C_3H_6O) and **E** ($C_3H_6O_2$).

(i) State the name used to describe this reaction **and** give the structural formulas of **D** and **E**. *[3]*

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(ii) Name, or give the formula, of a reagent which can be used to convert **D** to **A**. *[1]*

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(iii) Explain why **E** is more acidic than **A**. *[2]*

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A2. Use Table 9 **and/or** Table 10 in The Data Booklet in answering this question.

(a) Define the term *bond length*. State and explain the trend in bond length between two carbon atoms as the number of bonds increases. *[3]*

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(b) Explain why nitrogen is much **less** reactive than oxygen. *[2]*

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Option B – Higher physical chemistry

B1. Ethanoic acid (CH_3COOH) is a weak acid.

(a) Explain what is meant by the term *weak acid*. *[1]*

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(b) Write a balanced equation to represent the equilibrium reaction of ethanoic acid with water. *[1]*

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(c) State the expression for K_a for ethanoic acid. *[1]*

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(d) The pK_a value of ethanoic acid is 4.76. Calculate K_a, stating its units. *[2]*

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(e) Calculate the pH of a sample containing 0.60 g of ethanoic acid in 1 dm^3 of solution. *[4]*

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B2. (a) Give the equation for the ionisation of water. *[1]*

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(b) The following table shows values of the ionic product constant of water, K_w, at different temperatures.

Temperature / °C	10	20	30
K_w **/ mol^2 dm^{-6}**	0.293×10^{-14}	0.681×10^{-14}	1.471×10^{-14}

(i) Write the expression for K_w. *[1]*

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(ii) Calculate the pH of water at 30 °C. *[2]*

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(iii) State and explain the effect of increasing the temperature on the pH of pure water. *[2]*

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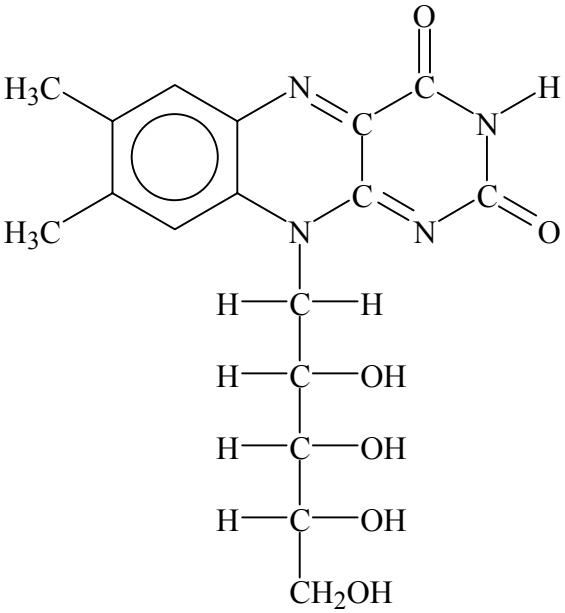
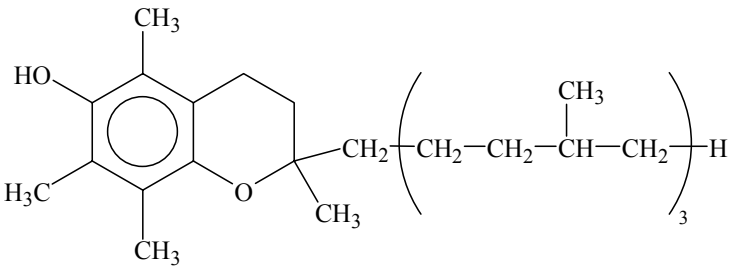
Option C – Human biochemistry

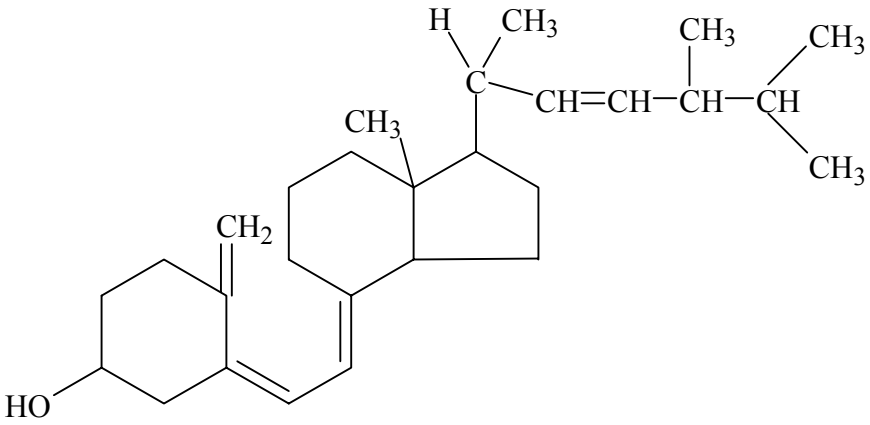
C1. Vitamins may be classified as either *water soluble* or *fat soluble*. The structures of four vitamins, labelled **W**, **X**, **Y** and **Z**, are shown below.



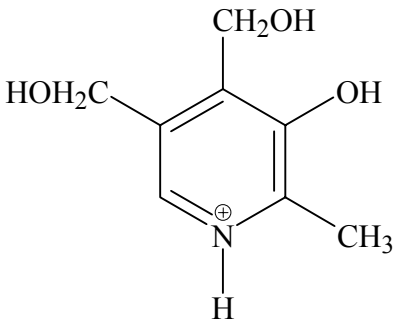
W



X



Y



Z

(This question continues on the following page)

(Question C1 continued)

Identify which **two** structures from **W**, **X**, **Y** and **Z** are **water soluble** vitamins. For **one** of the structures you have chosen, explain what feature(s) lead to its solubility in water. *[4]*

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C2. (a) State **two** reasons why the vitamin C content of vegetables decreases when they are boiled in water. *[2]*

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(b) State **one** important function of vitamin C in the body and state the disease which results from deficiency of this vitamin. *[2]*

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C3. The structure of the *disaccharide* sucrose is shown in the Data Booklet. One of the *monosaccharides* from which sucrose is formed is α-glucose.

(a) Outline what is meant by the term *monosaccharide*. *[2]*

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(b) (i) Give the structural formulas of the two monosaccharides that react to form sucrose. *[2]*

(ii) State the other product of the reaction and name the type of reaction. *[2]*

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(c) Name the other monosaccharide (apart from α-glucose) from which sucrose is formed. *[1]*

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Option D – Environmental chemistry

D1. (a) Explain why rain water is naturally slightly acidic. Give an equation to support your answer. *[2]*

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(b) (i) Identify the two major pollutants that cause acid rain. For each, state the man-made source. *[4]*

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(ii) For **each** of the pollutants mentioned in (b) (i), outline **two** different methods by which their contribution to acid rain could be reduced. *[4]*

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D2. (a) State **two** gases that contribute to the greenhouse effect. *[2]*

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(b) Explain how these gases contribute to this effect. *[3]*

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Option E – Chemical industries

E1. The production of aluminium involves purification and electrolysis.

(a) State the ore from which aluminium is extracted. *[1]*

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(b) Name **one** impurity which is removed at the purification stage. *[1]*

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(c) State why aluminium is not obtained from its oxide by carbon reduction. *[1]*

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(d) Write ionic equations for the reactions that take place during electrolysis at each electrode. *[2]*

Anode: . . . . . .

Cathode: . . . . . .

(e) For **each** of the cases below, state **two** properties of aluminium that make it suitable for use as

(i) cooking pans; *[1]*

. . . . . .

(ii) overhead electric cables. *[1]*

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(f) Aluminium is higher in the reactivity series than iron, yet reacts more slowly with dilute hydrochloric acid at room temperature. Explain this. *[1]*

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E2. The Contact process involves the reversible combination of sulfur dioxide and oxygen, in the presence of a catalyst, according to the equation below:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -192 \text{ kJ mol}^{-1}$$

(a) Sulfur dioxide is produced by burning sulfur in air. Write an equation for this reaction. *[1]*

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(b) State and explain the effect on the yield of sulfur trioxide of

(i) increasing the temperature; *[1]*

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(ii) increasing the pressure. *[1]*

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(c) The Contact process is carried out at 450 °C and at a pressure just above atmospheric. Explain the choice of these conditions. *[2]*

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(d) Sulfur trioxide is used to make sulfuric acid. Give **four** major uses of sulfuric acid. *[2]*

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Option F – Fuels and energy

F1. (a) (i) α, β and γ are three forms of radiation found in nature. In the table below, name these forms of radiation and state their relative charges. *[3]*

Radiation	Name	Relative Charge
α	. . . . .	. . . . .
β	. . . . .	. . . . .
γ	. . . . .	. . . . .

(ii) List the three forms of radiation in order of **increasing** penetrating power (the least penetrating first). *[1]*

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(b) (i) The half-life of ^{90}Sr is 27 years. Calculate the time for the activity of a sample of ^{90}Sr to decay to 12.5 % of its original level. Show your working. *[2]*

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(ii) Give a nuclear equation for the decay of ^{90}Sr in which β-radiation is emitted. *[1]*

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(iii) State why it is meaningless to refer to the half-life of a single atom of ^{90}Sr. *[1]*

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F2. (a) In *active solar heating*, heat is captured and then distributed by pumps and/or fans using a fluid such as air or water.

(i) State **one** advantage of using air. *[1]*

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(ii) State **one** advantage of using water. *[1]*

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(b) State the main difference between *active* and *passive* solar heating. *[1]*

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(c) State **one** advantage of solar heating. *[1]*

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(d) One way of converting solar energy into other forms is by photosynthesis.

(i) Write a balanced equation for the photosynthesis of glucose. *[2]*

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(ii) Identify the substance present in plants needed for photosynthesis. *[1]*

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