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

N02/420/S(3)+

CHEMISTRY
STANDARD LEVEL
PAPER 3

Tuesday 19 November 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. Petrol (gasoline) is a mixture of many hydrocarbons, most of which are alkanes. Alkanes have low chemical reactivity, although they burn easily. They often produce free radicals when they react.

(a) Explain why alkanes have low chemical reactivity. *[2]*

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(b) Explain the term *free radicals* and state the type of bond fission that produces them. *[2]*

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(c) The hydrocarbons used in petrol have different octane numbers. Heptane has an octane number of 0 whereas hexane has an octane number of 25.

(i) 2,2,4-trimethylpentane has an octane number of 100. Give its structural formula. *[2]*

(ii) State **two** structural features of alkanes that have high octane numbers. *[2]*

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(This question continues on the following page)

(Question A1 continued)

(d) Oxygen-containing compounds such as methanol, CH_3OH, and the compound $(CH_3)_3COCH_3$, also known as MTBE, are used to increase the octane rating of petrol.

(i) Deduce the values of the following bond angles in the methanol molecule, explaining your choices by reference to the VSEPR theory: *[5]*

H – C – H

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C – O – H

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(ii) Deduce the number of peaks in the ^1H NMR spectrum of each compound. *[2]*

methanol . . . . . .

MTBE . . . . . .

Option B – Higher physical chemistry

B1. 2-bromo-2-methylpropane and sodium hydroxide react together by the following mechanism:

Step 1 $(CH_3)_3CBr \rightarrow (CH_3)_3C^+ + Br^-$

Step 2 $(CH_3)_3C^+ + OH^- \rightarrow (CH_3)_3COH$

The experimental rate expression for the reaction is $\text{rate} = k[(CH_3)_3CBr]$.

(a) Deduce the overall order of the reaction. *[1]*

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(b) State what is meant by the term *rate-determining step*, and identify this step in the reaction, giving a reason for your choice. *[3]*

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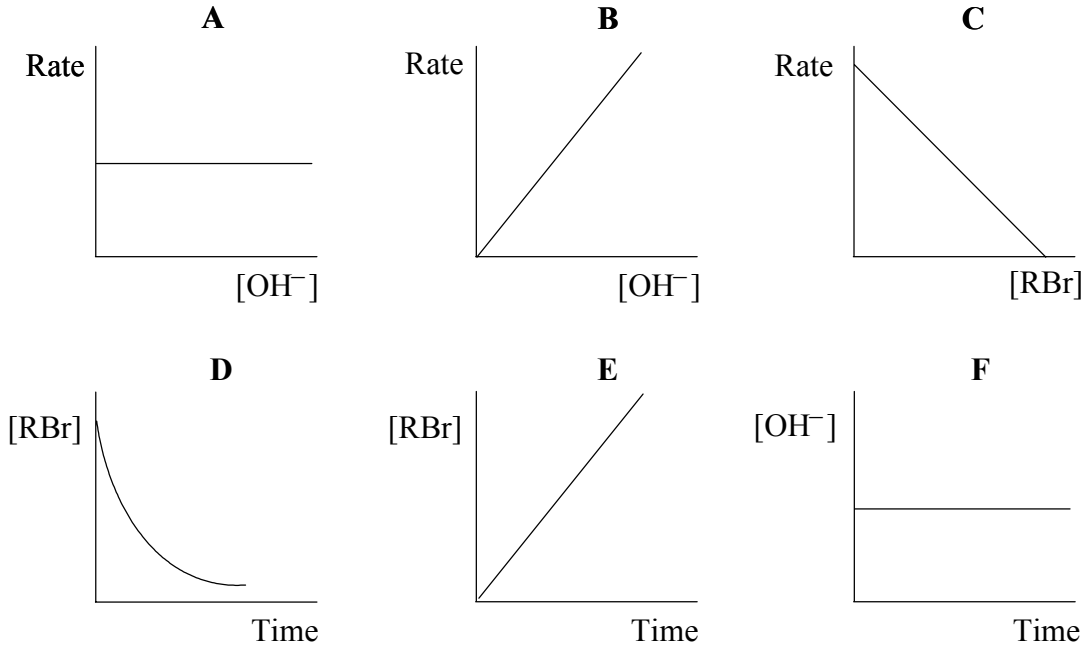
(c) Identify which **two** graphs are correct for this reaction. (Answer by listing your choice from the letters A, B, C, D, E and F.) *[2]*



correct graphs . . . . . .

(d) State the effect of increasing the temperature on the value of k in the rate expression. *[1]*

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B2. (a) A solution of volume 1.00 dm^3 containing 0.200 mol ethanoic acid and 0.100 mol sodium ethanoate can act as a buffer solution.

(i) Explain what is meant by the term *buffer solution*. *[2]*

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(ii) Calculate the pH of the solution, given that for ethanoic acid $K_a = 1.74 \times 10^{-5}$ mol dm^{-3}. *[3]*

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(iii) Explain, with the help of an equation, what happens when a small amount of aqueous sodium hydroxide is added to the buffer solution. *[2]*

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(b) State the name of a substance that could be added to aqueous ammonia to form a buffer solution. *[1]*

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Option C – Human biochemistry

C1. Insulin and thyroxine are hormones produced in the human body.

(a) State which **two** parts of the body control their production. *[2]*

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(b) For each hormone, state where it is produced and outline **one** function in the human body. *[4]*

insulin . . . . . .

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thyroxine . . . . . .

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C2. (a) Fats and oils can be hydrolyzed to fatty acids. Identify the other product of this hydrolysis. *[1]*

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(b) Fatty acids can be saturated or unsaturated. Three examples found in foods are $C_{15}H_{31}COOH$, $C_{17}H_{31}COOH$ and $C_{17}H_{35}COOH$.

(i) Explain the term *unsaturated*. *[1]*

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(ii) List the three fatty acids in **decreasing** order (starting with the highest value) of melting point. *[1]*

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(iii) Identify the type of intermolecular force present in each of the fatty acids. *[1]*

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(iv) By reference to the structure of the following molecules, explain the difference in melting point in each pair. *[2]*

$C_{15}H_{31}COOH$ and $C_{17}H_{35}COOH$

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$C_{15}H_{31}COOH$ and $C_{17}H_{31}COOH$

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(c) 1.00×10^{-3} mol of peanut oil was found to react with 0.254 g of iodine. Calculate the amount of iodine (in mol) that reacted, and state what can be deduced about the structure of the oil. *[3]*

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Option D – Environmental chemistry

D1. The presence of small amounts of ozone in the upper atmosphere is necessary for human health.

(a) Write equations (two in each case) to show the natural formation and depletion of ozone in the upper atmosphere. *[4]*

ozone formation . . . . . .

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ozone depletion . . . . . .

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(b) CFCs are substances that have caused a decrease in atmospheric ozone concentration in recent years.

(i) State what the letters CFC stand for and list **two** sources of CFCs in the atmosphere. *[3]*

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(ii) Outline **two** harmful effects on human health due to the decrease in atmospheric ozone. *[2]*

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(iii) Discuss **two** disadvantages of using C_4H_{10} as an alternative to CFCs. *[2]*

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D2. Many impurities in waste water are removed by secondary treatment. Describe how this is done. *[4]*

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Option E – Chemical industries

E1. The gases in air (mostly nitrogen, oxygen and argon) can be obtained by liquefaction and fractional distillation.

(a) Outline the processes used to liquefy air. *[3]*

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(b) Use information from Table 6 of the Data Booklet to identify the gas given off first when liquid air is warmed. *[1]*

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(c) State **one** use each for nitrogen and oxygen obtained in this way. *[2]*

nitrogen . . . . . .

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oxygen . . . . . .

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E2. Two important processes in the oil industry are cracking and reforming. Each of these processes is carried out in various ways, depending on the product required.

(a) (i) Give an equation to show the thermal cracking of dodecane, $C_{12}H_{26}$, into two molecules, one of which contains eight carbon atoms. *[1]*

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(ii) State the catalyst used in catalytic cracking. *[1]*

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(iii) One type of molecule found in the products of thermal and catalytic cracking is not formed in hydrocracking. Identify this type of molecule and explain why it is not formed. *[3]*

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(b) Hexane, C_6H_{14}, can be reformed by aromatization. State the names of the **two** products of the reaction and write an equation for the reaction. *[2]*

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(c) Deduce the type of reforming taking place when hexane is converted into each of the following: *[2]*

$(CH_3CH_2)_2CHCH_3$ . . . . . .

$(CH_2)_6$ . . . . . .

Option F – Fuels and energy

F1. Two important fossil fuels are coal and oil.

(a) Describe how coal was formed. *[4]*

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(b) Discuss the advantages and disadvantages of coal and oil as fuels by comparing their availability, method and cost of production, and environmental impact. *[5]*

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F2. Ethanol is an example of a biofuel whose production depends indirectly on the sun.

(a) Name the process in which the sun's energy is used to form glucose, $C_6H_{12}O_6$, and write an equation for the process. *[3]*

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(b) Name the process in which glucose is converted to ethanol, and write an equation for the process. *[3]*

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