INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

N01/420/S(3)

CHEMISTRY
STANDARD LEVEL
PAPER 3

Wednesday 14 November 2001 (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. Several different halogenoalkanes have the molecular formula C_4H_9Cl.

(a) Give the structural formula and name for each of the **four** structural isomers consistent with this formula. *[4]*

(b) One of the isomers undergoes a substitution reaction with aqueous sodium hydroxide by an S_N1 mechanism.

(i) Identify the isomer and define the term S_N1. *[2]*

. . . . . .

. . . . . .

(ii) Give the structural formula of the main organic intermediate formed during this reaction and state whether its formation is faster or slower than its decomposition. *[2]*

(This question continues on the following page)

(Question A1 continued)

(c) Two of the other isomers undergo a substitution reaction with aqueous sodium hydroxide by an S_N2 mechanism. Identify **one** of these isomers and give the structural formula of the transition state for this reaction. *[2]*

(d) The remaining structural isomer can exist in two enantiomeric forms which show different optical activity. Draw representations of these two forms clearly showing the difference between them. *[2]*

A2. Compound **A** is an alkanal and compound **B** is an alkanone. Both have the molecular formula C_3H_6O. The mass spectrum of one of the compounds shows prominent peaks with masses of 15, 43 and 58. Identify the compound which is consistent with the mass spectrum and explain why the other is not consistent with the mass spectrum. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

Option B – Higher physical chemistry

B1. The decomposition of nitrogen(V) oxide, N_2O_5, is a first order reaction:

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

(a) Write the rate law for this reaction. *[1]*

. . . . . .

(b) Given that the rate constant is 8.10×10^{-3} min^{-1} at 35 °C, calculate the initial rate of decomposition of 3.00×10^{-2} $mol\,dm^{-3}$ N_2O_5 at 35 °C. *[2]*

. . . . . .

. . . . . .

. . . . . .

(c) Calculate the half-life for the decomposition of 3.00×10^{-2} $mol\,dm^{-3}$ N_2O_5 at 35 °C. *[2]*

. . . . . .

. . . . . .

. . . . . .

(d) Explain what will happen to the value of the half-life if the concentration of N_2O_5 is doubled to 6.00×10^{-2} $mol\,dm^{-3}$ and the temperature is kept the same. *[1]*

. . . . . .

. . . . . .

B2. Hydrochloric acid and lactic acid (2-hydroxypropanoic acid), $HC_3H_5O_3$, are both monoprotic acids.

(a) (i) Calculate the pH of 0.16 $mol\,dm^{-3}$ hydrochloric acid solution. *[1]*

. . . . . .

(ii) A 0.16 $mol\,dm^{-3}$ solution of lactic acid is 3.1 % ionised at equilibrium at 25 °C. Calculate the pH of this solution. *[2]*

. . . . . .

. . . . . .

. . . . . .

(iii) Explain the difference in pH values of the two acid solutions. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(b) Use the information given above to calculate the acid dissociation constant, K_a, for lactic acid at 25 °C. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Calculate the hydrogen ion concentration of a solution which contains 0.10 mole of sodium lactate and 0.16 mole of lactic acid in 1.00 dm^3. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

Option C – Human biochemistry

C1. Fats and oils are made from a molecule of propane-1,2,3-triol joined to three molecules of alkanoic (fatty) acids.

(a) Give the structural formula of propane-1,2,3-triol. *[1]*

(b) Give the formula of the functional group common to all alkanoic acids and draw the structural formula of an alkanoic acid which contains eight carbon atoms per molecule. *[2]*

. . . . . .

(c) Explain the difference between saturated and unsaturated fats in terms of their molecular structures and explain briefly how the degree of unsaturation can be determined experimentally. *[4]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

C2. The two ends of the primary structure of a myoglobin molecule are shown below:

X-Val-Leu-Ser-Glu-Gly————————————————Gly-Tyr-Gln-Gly-COOH

Val, Leu, Ser *etc.* refer to the different amino acids in the chain.

(a) Identify the functional group represented by **X**. *[1]*

. . . . . .

(b) Name the covalent bond formed between **each** pair of amino acids in the chain. Draw a diagram of this bond to show clearly the atoms present in it and how they are joined to each other. *[2]*

. . . . . .

(c) Describe briefly a technique that might have been used to identify the primary structure of myoglobin. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(d) Explain what is meant by the *secondary* and *tertiary structure* of myoglobin. *[2]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(e) Name the type of bond responsible for the secondary structure of myoglobin. *[1]*

. . . . . .

Option D – Environmental chemistry

D1. (a) CO, NO, SO_2 and hydrocarbons are primary air pollutants.

(i) The levels of CO and NO produced by automobiles can be lowered by a catalytic converter. Write a balanced chemical equation for the reaction that takes place between these two primary pollutants in a catalytic converter. *[2]*

. . . . . .

(ii) SO_2 is produced from the burning of coal. It can be removed from the exhaust gases of coal-burning power plants by alkaline scrubbing. Write a balanced chemical equation for the reaction that takes place in the scrubber. *[2]*

. . . . . .

(b) Write chemical equations to show the formation of acid rain from **one** of the primary pollutants above. *[2]*

. . . . . .

. . . . . .

(c) State **one** adverse health effect of hydrocarbons. *[1]*

. . . . . .

D2. State **two** reasons why the supply of fresh water is inadequate to meet global demands. Explain the principles behind the use of both reverse osmosis and ion exchange to obtain fresh water from sea water. *[8]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

Option E – Chemical industries

E1. In the Haber process nitrogen and hydrogen are passed through a compressor and a converter containing a catalyst. The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) State how the nitrogen and hydrogen are obtained for this process.

(i) Nitrogen: *[1]*

. . . . . .

. . . . . .

(ii) Hydrogen: *[1]*

. . . . . .

. . . . . .

(b) State and explain **two** chemical reasons why the compressor is used. *[4]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

(c) Explain why much of the material which comes through the converter is recycled. *[2]*

. . . . . .

. . . . . .

. . . . . .

E2. (a) One of the important procedures carried out in the petroleum industry is cracking.

(i) State the main advantage of using catalytic cracking rather than thermal cracking. *[1]*

. . . . . .

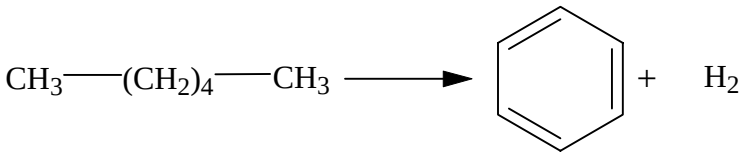
. . . . . .

(ii) Write a balanced equation for the cracking of $C_{12}H_{26}$ and state the major use for **one** of the two products. *[2]*

. . . . . .

. . . . . .

(b) Another important process in the petroleum industry is catalytic reforming. One example of this is:



(i) Balance the equation and name the two organic substances. *[3]*

. . . . . .

. . . . . .

. . . . . .

(ii) State an important use for the organic product. *[1]*

. . . . . .

Option F – Fuels and energy

F1. There are several different types of batteries.

(a) Name the substances used to make the anode (negative electrode), the cathode (positive electrode) and the electrolyte in the Leclanché dry cell. *[3]*

Anode: . . . . . .

Cathode: . . . . . .

Electrolyte: . . . . . .

(b) Write equations to show what happens at each electrode when the cell is in use. *[2]*

Anode: . . . . . .

Cathode: . . . . . .

(c) Alkaline batteries are more expensive than Leclanché cells. State **two** advantages of alkaline batteries. *[1]*

. . . . . .

(d) State and explain the effect of increasing the surface area of the electrodes on the voltage of a battery. *[3]*

. . . . . .

. . . . . .

. . . . . .

. . . . . .

F2. (a) Nuclear reactions produce a wide variety of waste materials.

(i) Why is nuclear waste often stored in pools of water? *[1]*

. . . . . .

(ii) State **one** disadvantage of this method of storing radioactive waste. *[1]*

. . . . . .

. . . . . .

(b) (i) Complete the nuclear equation below: *[2]*

$$^{238}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{239}_{92}\mathrm{U} \rightarrow 2\,{}^{0}_{-1}\mathrm{e} + \_\_\_\_$$

(ii) The radioactive product has a half-life of 24 000 years. How long would it take for its activity to fall to $\frac{1}{16}$ of its initial value? *[2]*

. . . . . .

. . . . . .