INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
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M01/420/S(3)

CHEMISTRY
STANDARD LEVEL
PAPER 3

Friday 11 May 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

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Option A – Higher organic chemistry

A1. Consider the following reaction sequence:

$$CH_3CH_3 \xrightarrow[\text{sunlight}]{Cl_2(g)} CH_3CH_2Cl \xrightarrow{OH^-(aq)} CH_3CH_2OH$$

reaction A **reaction B**

(a) With reference to **reaction A**:

(i) explain the term *free radical* and give the formula of a free radical involved in this reaction. *[2]*

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(ii) explain the term *homolytic fission*. *[1]*

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(b) With reference to **reaction B**:

(i) what type of reaction is this? *[1]*

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(ii) show the reaction mechanism involved. *[2]*

(iii) what is the value of the *molecularity* of this reaction? Explain your answer. *[2]*

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(This question continues on the following page)

(Question A1 continued)

(c) (i) The product of **reaction B**, CH_3CH_2OH, is reacted with acidified dichromate(VI) solution. Give the structural formula of the product formed. *[1]*

(ii) State and explain the difference in acidity between CH_3CH_2OH and the product formed in (c) (i). *[3]*

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(d) (i) Describe, giving a brief explanation, the ^1H NMR spectrum of CH_3CH_2OH. *[2]*

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(ii) Comment on the relative sizes of the peaks in the spectrum. *[1]*

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Option B – Higher physical chemistry

B1. Two chemicals, **X** and **Y**, react together to form compound **Z**, according to the equation:

$$\mathbf{X} + \mathbf{Y} \rightarrow \mathbf{Z}$$

Experiments were carried out to determine the order and the rate expression for this reaction.

Experiment	[X] / mol dm^{-3}	[Y] / mol dm^{-3}	Initial Rate / mol dm^{-3} s^{-1}
1	0.02	0.02	0.10
2	0.02	0.05	0.10
3	0.08	0.07	1.60
4	0.06	0.09	0.90

(a) What is the order with respect to reactant **Y**? Explain how you arrive at your answer. *[2]*

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(b) What is the order with respect to reactant **X**? Explain how you arrive at your answer. *[2]*

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(c) What is the overall order of the reaction? *[1]*

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(d) Write the rate expression for this reaction. *[1]*

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(e) What is meant by the *rate-determining step* in a reaction mechanism? *[1]*

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B2. (a) (i) What is meant by the term *entropy*, *S*? *[1]*

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(ii) Predict whether there will be an increase or decrease in the entropy as the following reaction proceeds. Explain your answer.

$$H_2(g) + Br_2(l) \rightarrow 2HBr(g)$$ *[3]*

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(b) The spontaneity of a reaction can be predicted using the sign of ΔG, the change in Gibbs free energy.

(i) What would be the sign of ΔG for a reaction to be spontaneous? *[1]*

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(ii) Using the equation $\Delta G^{\ominus} = \Delta H^{\ominus} - T\Delta S^{\ominus}$, state whether a reaction would be spontaneous or non-spontaneous under the following conditions: *[1]*

$\Delta H^{\ominus}$ negative and $\Delta S^{\ominus}$ positive: . . . . . .

(iii) In the case of $\Delta H^{\ominus}$ negative and $\Delta S^{\ominus}$ negative, a spontaneous reaction will only occur under certain conditions. State these conditions and explain your answer. *[2]*

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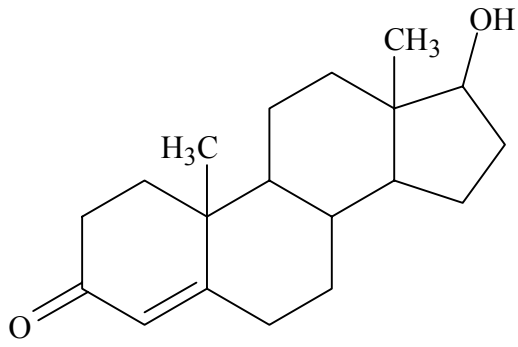
Option C – Human biochemistry

C1. The hormone testosterone has the structure:



(a) State what is meant by the term *hormone*. *[1]*

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(b) (i) Name the gland which is the **major** source of testosterone in humans. *[1]*

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(ii) Testosterone is a member of a group of compounds called *steroids*. Certain steroids have useful medical applications. However, in recent years steroid abuse amongst athletes has become more common. Describe briefly the use and abuse of steroids. *[3]*

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(c) Circle **two** functional groups in the structure of testosterone above, labelling them **A** and **B**. Name both functional groups. *[2]*

Functional group **A**: . . . . . .

Functional group **B**: . . . . . .

(d) By referring to the structure of cholesterol in Table 21 of the Data Booklet, give **one** structural difference between testosterone and cholesterol. *[1]*

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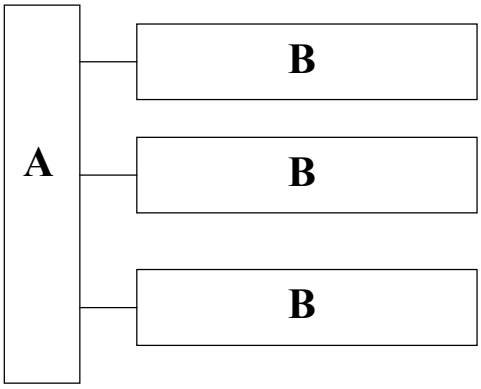
C2. The diagram below represents a molecule of a fat.



(a) If the molecule is hydrolysed, what product would be formed from **A**? *[1]*

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(b) What general name is given to the products formed from **B**? *[1]*

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(c) State the conditions needed to carry out the hydrolysis of a fat. *[1]*

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(d) An experiment was carried out using a calorimeter to determine the calorific value of a 'low fat' chocolate bar with a mass of 50.0 g. The complete oxidation (combustion) of a 10 g sample of the chocolate bar raised the temperature of 500 g of water to 86.5 °C. The initial temperature of the water was 19.0 °C. Calculate the calorific value (in kJ) of the chocolate bar. *[4]*

(The specific heat capacity of water = 4.18 $J g^{-1} K^{-1}$.)

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Option D – Environmental chemistry

D1. Two of the greenhouse gases which contribute to global warming are carbon dioxide, CO_2, and methane, CH_4.

(a) Name **one** other greenhouse gas. *[1]*

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(b) (i) Name **one** natural and **one** man-made source of carbon dioxide. *[2]*

Natural: . . . . . .

Man-made: . . . . . .

(ii) Name **one** natural and **one** man-made source of methane. *[2]*

Natural: . . . . . .

Man-made: . . . . . .

(c) Explain how greenhouse gases are thought to cause global warming. *[3]*

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D2. (a) Two processes used to treat sewage are *filtration* and *chemical precipitation*.

(i) Name the type of substance removed by *filtration* and the equipment used to do this. *[2]*

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(ii) Name the type of substance removed by *chemical precipitation* and a chemical used to do this. *[2]*

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(b) (i) State **two** advantages of treating drinking water with ozone rather than chlorine. *[2]*

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(ii) Other than cost, name **one** disadvantage of treating drinking water with ozone rather than chlorine. *[1]*

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Option E – Chemical industries

E1. (a) State **two** functions of the coke fed into the blast furnace during the extraction of iron from iron ore. *[2]*

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(b) The cast iron produced in the furnace contains the impurities carbon and silica. Describe how these impurities are removed to produce pure steel.

(i) Carbon: *[2]*

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(ii) Silica: *[2]*

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E2. (a) Write an equation for the thermal cracking of hexane. Give **one** use for **each** of the products of your reaction. *[3]*

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(b) (i) Name a catalyst used in catalytic cracking. *[1]*

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(ii) What other condition is needed for catalytic cracking? *[1]*

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(c) How do the products of catalytic cracking and hydrocracking differ? *[2]*

Catalytic cracking: . . . . . .

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Hydrocracking: . . . . . .

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E3. Most chemical processes have associated environmental hazards. State **one** potential problem linked to oil refining and iron production.

Oil refining: . . . . . *[1]*

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Iron production: . . . . . *[1]*

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Option F – Fuels and energy

F1. In a given location, the earth's surface receives 1.26×10^{6} units of solar energy. Green plants (*e.g.* algae) absorb 1.26×10^{4} units of this energy.

(a) (i) What percentage of the sun's energy is absorbed by the green plants? *[1]*

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(ii) Suggest **two** reasons why the remainder of the sun's energy is not absorbed by green plants. *[2]*

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(b) (i) Name the process by which green plants use the sun's energy to convert water and carbon dioxide into glucose (biomass). *[1]*

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(ii) Give a balanced chemical equation for the reaction. *[1]*

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(c) (i) State **two** methods in which biomass can be converted into energy: *[2]*

1 . . . . . .

2 . . . . . .

(ii) For **one** of the above methods, state **one** advantage and **one** disadvantage of the process. *[2]*

Advantage: . . . . . .

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Disadvantage: . . . . . .

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(This question continues on the following page)

(Question F1 continued)

(d) (i) Outline how the algae and plankton in ancient oceans were converted into crude oil. *[3]*

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(ii) State **three** disadvantages of using oil as an energy source. *[3]*

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