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

M06/4/CHEMI/HP3/ENG/TZ0/XX

22066103

CHEMISTRY
HIGHER LEVEL
PAPER 3

Friday 19 May 2006 (morning)

1 hour 15 minutes

Candidate session number

0	0							

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

0129

Option B – Medicines and drugs

B1. (a) Describe the likely effect of a depressant taken in: *[1]*

a moderate dose. . . . . .

a high dose. . . . . .

(b) Ethanol in breath can be detected using a breathalyser containing potassium dichromate(VI) crystals. Describe the colour change that occurs in a positive test and identify the species responsible for the final colour. *[2]*

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B2. (a) State the name of the class of drugs with effects similar to that of adrenaline. Outline **one** effect of these drugs on humans. *[2]*

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(b) (i) Identify the stimulant responsible for addiction to smoking tobacco. *[1]*

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(ii) Describe **two** short-term effects of smoking tobacco. *[2]*

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(iii) Describe **two** long-term effects of smoking tobacco, other than addiction. *[2]*

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B3. (a) State **two** differences between viruses and bacteria. *[2]*

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(b) Suggest how acyclovir acts as an antiviral drug. *[2]*

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(c) Describe **two** ways in which an antiviral drug can prevent the HIV virus from interacting with human cells. *[2]*

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B4. (a) For each of the following anesthetics, state **one** disadvantage, different in each case, of its use. *[3]*

nitrous oxide . . . . . .

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ethoxyethane . . . . . .

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halothane . . . . . .

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(b) An anesthetic mixture of gases is composed of nitrogen, oxygen and nitrous oxide. The gases are mixed in a 40 dm^3 container where their partial pressures are 0.8 atm, 0.3 atm and 0.1 atm respectively, at a temperature of 20ºC.

(i) Calculate the total pressure in the container. *[1]*

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(ii) Calculate the mole fraction of oxygen gas present in the mixture. *[1]*

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B5. The manufacture of some drugs results in the formation of a racemic mixture. Explain why it is often preferable to use a method which does not form a racemic mixture, giving **one** example of such a drug and its effects. *[4]*

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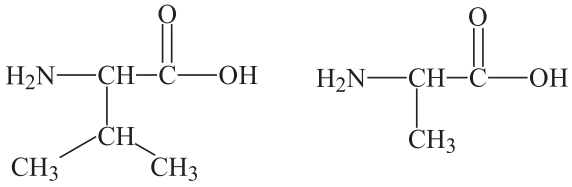
Option C – Human biochemistry

C1. (a) (i) Deduce the structure of **one** of the dipeptides that can be formed when the two aminoacids below react together. *[2]*



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

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(b) Describe how a mixture of aminoacids can be analysed using electrophoresis. *[4]*

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(c) (i) Explain what is meant by the primary structure of proteins. *[1]*

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(ii) Explain, with reference to hydrogen bonding, why the α-helix and β-sheet secondary structures of proteins are different. *[2]*

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C2. (a) The formula of oleic acid is $CH_3(CH_2)_7CH=CH(CH_2)_7COOH$. Using R to represent $CH_3(CH_2)_7CH=CH(CH_2)_7$, show the structure of the triglyceride formed from this acid. *[1]*

(b) Explain why some triglycerides that are liquid at room temperature become solids when they are completely hydrogenated. *[3]*

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C3. (a) Discuss the effect of a competitive inhibitor on an enzyme catalysed reaction. *[4]*

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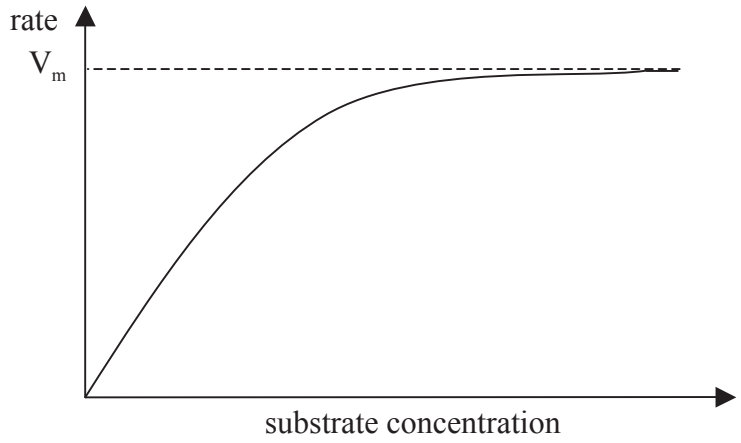
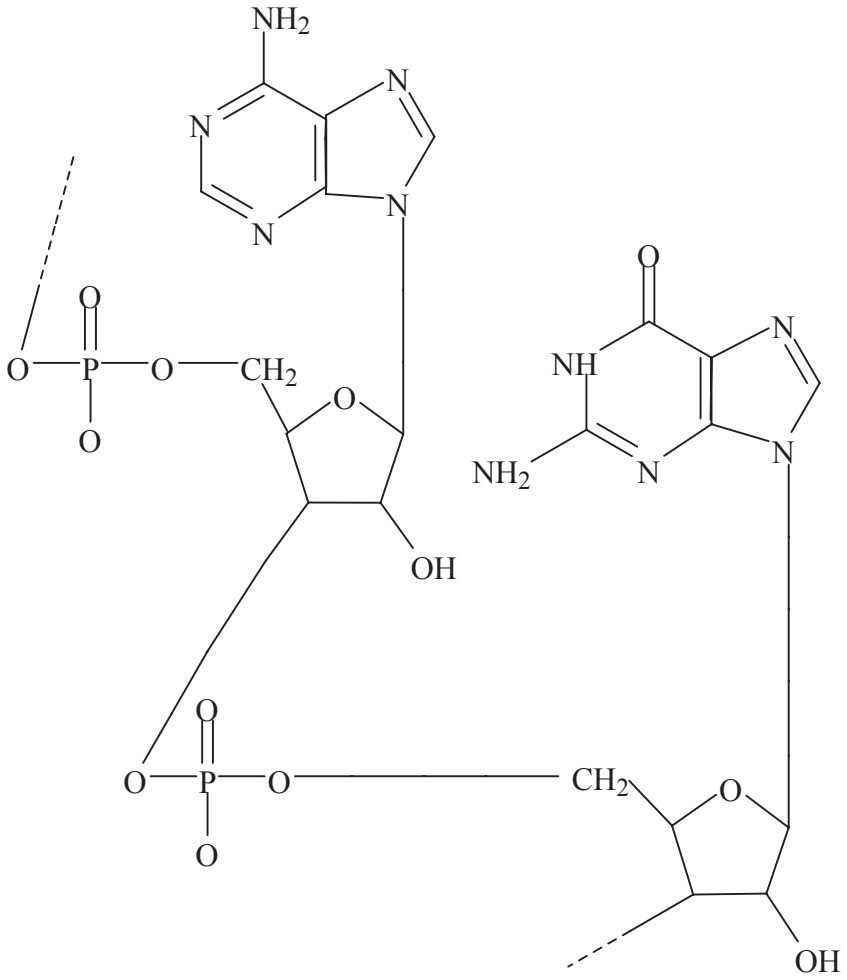
(b) The effect of a competitive inhibitor on an enzyme catalysed reaction can be shown on the graph below.



Annotate the graph to show the position of K_m for the reaction. Draw a line on the graph to represent the effect of competitive inhibition. *[2]*

C4. The following drawing shows a section of a molecule of a nucleic acid.



(a) Identify the part of the nucleic acid that represents one nucleotide, by enclosing it within a ring and labelling it as "nucleotide". *[1]*

(b) For a different nucleotide in the nucleic acid molecule, identify its three parts, by circling each one and labelling it with an appropriate name. *[3]*

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Option D – Environmental chemistry

D1. Global warming is thought to be partly caused by the increasing concentration of carbon dioxide in the atmosphere. Discuss the effects of global warming. *[3]*

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D2. (a) (i) Only a small part of the Earth's supply of fresh water is used for domestic purposes. State the **two** main uses of fresh water. *[1]*

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(ii) Identify the **two** locations that hold most of the Earth's water. *[2]*

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(b) (i) Outline how ion exchange is used to obtain fresh water from sea water. *[4]*

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(This question continues on the following page)

(Question D2 continued)

(ii) Discuss **one** advantage and **one** disadvantage of this method over simple distillation. *[2]*

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(c) Explain what is meant by the term *biological oxygen demand (BOD)*. Compare the values of BOD for water that is pure and water that contains organic waste. *[3]*

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D3. (a) Describe the main source of photochemical smog and of reducing smog. *[2]*

photochemical smog: . . . . . .

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reducing smog: . . . . . .

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(b) Describe the differences in the contents of the types of smog listed in (a). *[2]*

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(c) Explain how the formation of thermal inversions may increase the effect of pollution. *[2]*

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D4. (a) Compounds used in sunscreens contain a specific molecular feature. Identify this feature and describe how the compound interacts with sunlight. *[2]*

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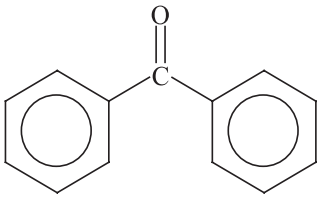
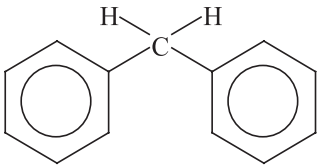
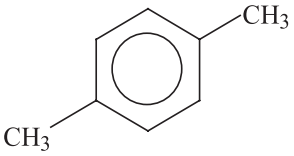
(b) Identify the **two** substances below that are likely to be included in sunscreens. *[2]*



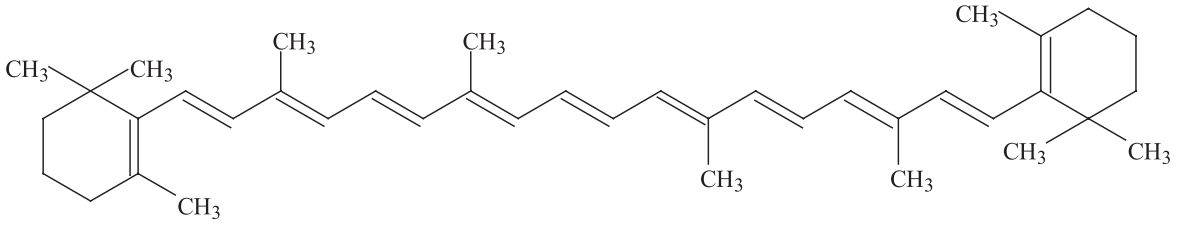
A



B



C



D

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Option E – Chemical industries

E1. List **three** factors that should be taken into account before establishing a chemical industry in a particular location. *[2]*

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E2. (a) State the raw materials needed to produce iron from iron ore in the blast furnace. *[2]*

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(b) (i) Explain why iron from the blast furnace is not as suitable as steel for making many objects. *[2]*

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(ii) Outline how iron from the blast furnace is converted to steel. Include an equation in your answer. *[2]*

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(This question continues on the following page)

(Question E2 continued)

(c) Discuss the environmental impact of aluminium production. *[4]*

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E3. (a) State the most important use of petroleum, other than as a fuel. *[1]*

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(b) (i) Explain why crude oil contains sulfur. *[1]*

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(ii) Explain why sulfur is removed from most petroleum products before use. *[1]*

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E4. Chlorine and hydrogen are produced in a diaphragm cell.

(a) State the raw material used in the diaphragm cell. *[1]*

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(b) Write **one** equation for a reaction occurring at each electrode. *[2]*

negative electrode . . . . . .

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positive electrode . . . . . .

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(c) Identify the other product of the diaphragm cell and outline how it is formed. *[2]*

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E5. Refer to Table 12 in the Data Booklet when answering this question.

(a) Deduce the minimum temperature at which mercury can be obtained by spontaneous decomposition of its oxide, giving a reason for your choice. *[2]*

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(b) Chromium metal can be obtained from its oxide, Cr_2O_3, by heating with a reducing agent.

(i) Deduce the minimum temperature at which carbon can be used as the reducing agent. Deduce the equation for the reaction. *[2]*

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(ii) Explain why carbon monoxide is not used as the reducing agent. *[1]*

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Option F – Fuels and energy

F1. (a) State **two** desirable characteristics of energy sources. *[2]*

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(b) For each of the following energy sources, outline **one** reason why it is not widely used at present. *[2]*

(i) Nuclear fusion

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(ii) Tidal energy

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F2. A company is designing an automobile that is powered by photovoltaic cells instead of by the combustion of gasoline (petrol).
Discuss **three** advantages and **three** disadvantages of using photovoltaic cells in this case. *[6]*

advantages . . . . . .

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disadvantages . . . . . .

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F3. (a) Identify the materials used for the electrodes in a lead-acid battery. *[1]*

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(b) One reaction that occurs in a lead-acid battery involves the conversion of PbO_2 into $PbSO_4$. Write a half-equation for this reaction.
Identify, giving a reason, whether this reaction occurs at the negative or positive electrode. *[2]*

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F4. One method of storing energy is pumped storage. Outline this method and discuss it by referring to **two** advantages and **two** disadvantages. *[6]*

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F5. (a) Describe the characteristics of the high-level radioactive waste produced by a nuclear power plant. *[2]*

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(b) Describe how high-level radioactive waste can be stored. *[2]*

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(c) The radioactive isotope Pu-242 has a half-life of 3.8×10^5 years. Calculate the time for the activity of a sample of this isotope to decrease to 10 % of its orginal value. *[2]*

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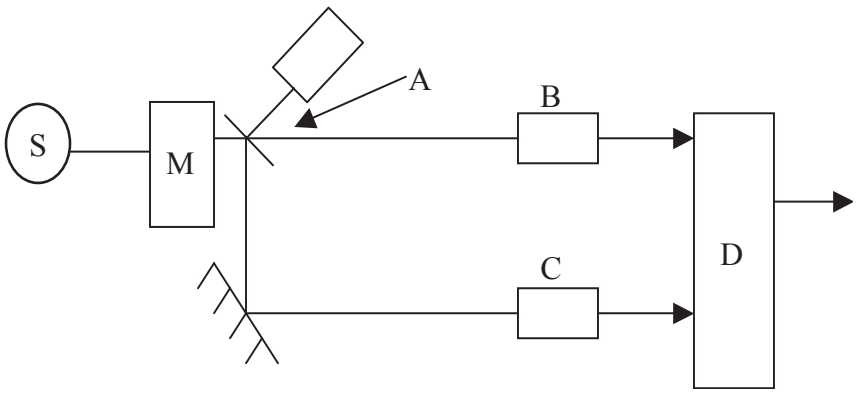
Option G – Modern analytical chemistry

G1. Identify **one** analytical technique, different in each case, that can be used to obtain the following information: *[3]*

Information	Analytical technique
Isotopic composition of an element	
Functional groups present in an organic compound	
Concentration of Fe^{3+} ions in industrial waste waters	

G2. (a) The diagram below represents the principal parts of a double beam infrared spectrometer.



(i) Name the parts labelled A, B, and C. *[2]*

A: . . . . . .

B: . . . . . .

C: . . . . . .

(ii) Describe the function of the monochromator, M. *[1]*

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(This question continues on the following page)

(Question G2 continued)

(iii) Explain how the detector, D, works. *[2]*

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(b) State and explain what happens to a molecule when it absorbs infrared radiation. *[2]*

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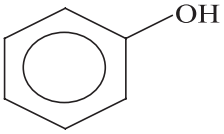
(This question continues on the following page)

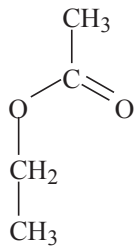
(Question G2 continued)

(c) Each of the infrared absorptions A, B and C is produced by one of the compounds I, II and III. Deduce which compound is responsible for each absorption, and identify the bond causing the absorption. *[5]*

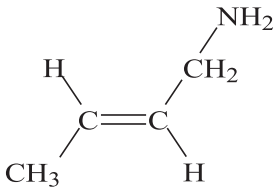
I



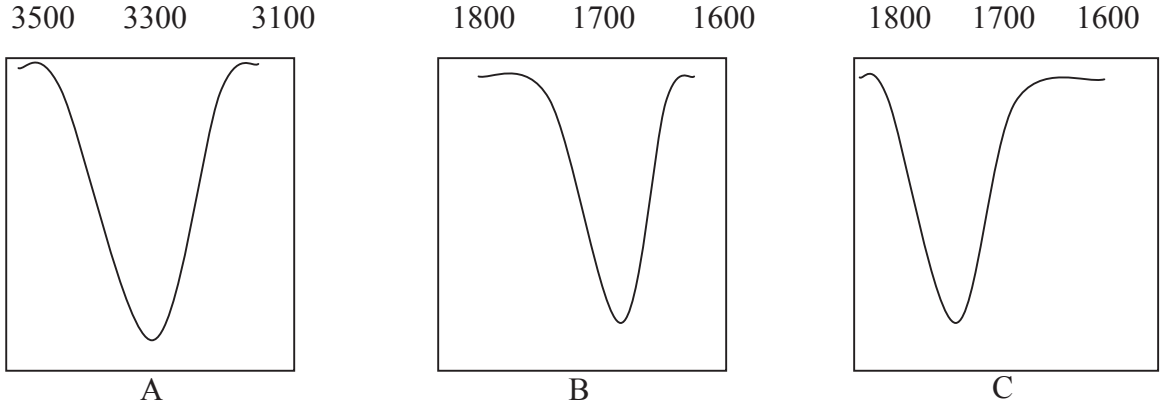
II



III



wavenumbers in cm^{-1}



Absorption	Compound	Bond
A		
B		
C		

(d) Identify which of the absorptions, A, B or C, indicates the greatest amount of energy, giving a reason for you choice. *[2]*

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G3. (a) Chromatography is usually coupled with another analytical technique. Identify the analytical technique that is most commonly coupled with gas-liquid chromatography (GLC). *[1]*

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(b) Chromatographic techniques include the following.

LC (column chromatography)
GLC (gas-liquid chromatography)
HPLC (high performance liquid chromatography)

(i) Explain why LC is used in preference to GLC or HPLC to separate a pharmaceutical drug from its production batch. *[1]*

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(ii) Identify, giving a reason which of the techniques GLC or HPLC is more suitable for determining the composition of a mixture of sugars. *[2]*

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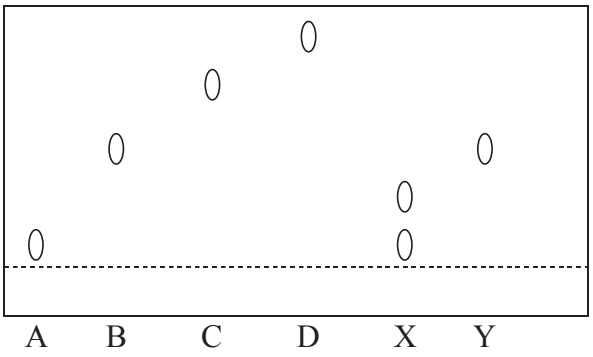
(This question continues on the following page)

(Question G3 continued)

(c) Two samples of unknown alkaloids (X and Y) are analysed using paper chromatography. They are compared against the results obtained with samples of four known alkaloids A, B, C and D. The results are shown in the table below:



Sample	R_f value
A	0.1
B	0.5
C	0.7
D	0.8
X	0.1 and 0.3
Y	0.5

(i) Explain how an R_f value is calculated. *[1]*

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(ii) Use the results above to discuss the composition of samples X and Y. *[3]*

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Option H – Further organic chemistry

H1. Chlorine and ethane react together to form chloroethane.

(a) State the condition needed for the reaction to occur. *[1]*

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(b) Write equations to represent initiation, propagation and termination steps in the reaction. *[4]*

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(c) Discuss how the release of chlorinated alkanes at sea level can affect the levels of ozone in the upper atmosphere. *[3]*

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H2. (a) Identify the reagents used in the nitration of benzene. *[2]*

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(b) Write an equation or equations to show the formation of the species NO_2^+ from these reagents. *[1]*

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(c) Give the mechanism for the nitration of benzene. Use curly arrows to represent the movement of electron pairs. *[2]*

(d) Predict the structures of the products of the (mono) nitration of methylbenzene *[3]*

methylbenzene (two products)

nitrobenzene (one product)

(e) Explain why the nitration of methylbenzene is faster than the nitration of benzene. *[2]*

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(f) Identify the reagent and catalyst used to convert benzene into methylbenzene. *[2]*

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H3. Butan-2-ol can be converted to but-2-ene.

(a) State the reagent used for this conversion and identify the type of reaction. *[2]*

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(b) Give the mechanism for the reaction. Use curly arrows to represent the movement of electron pairs. *[3]*