



22076106

CHEMISTRY
STANDARD LEVEL
PAPER 3

Friday 11 May 2007 (morning)

1 hour

Candidate session number

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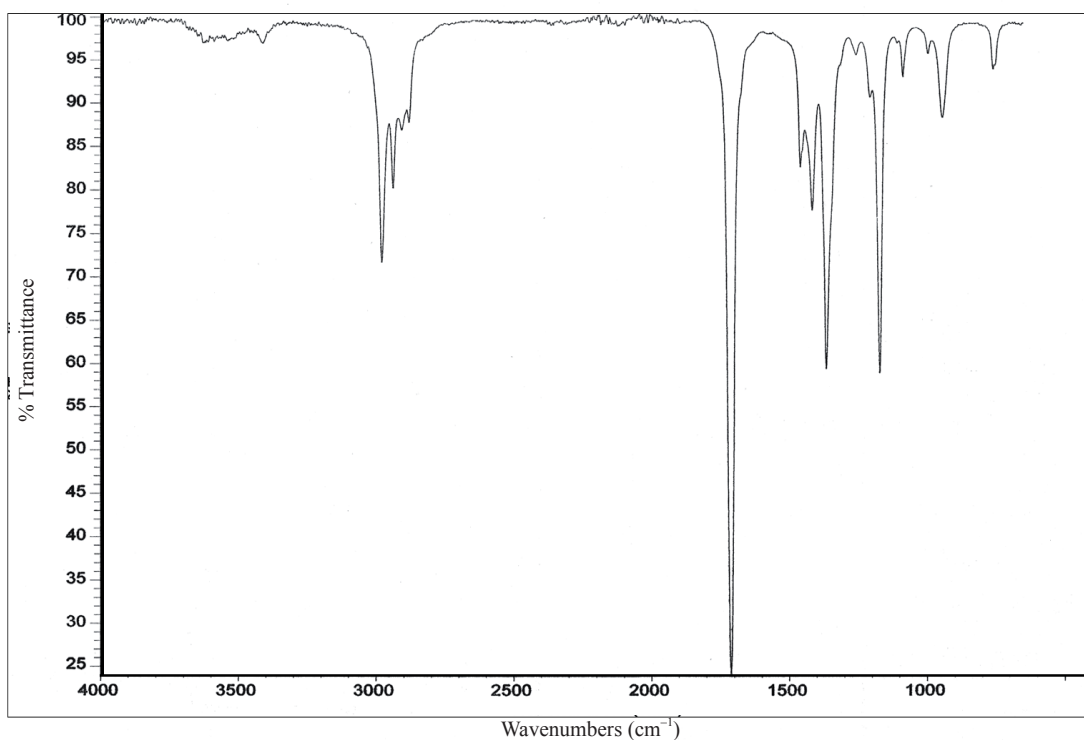
INSTRUCTIONS TO CANDIDATES

- 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.



Option A – Higher physical organic chemistry

A1. Compound A, with the molecular formula C_3H_6O has this infrared spectrum.



- (a) (i) Use Table 18 in the Data Booklet to list **four** classes of compounds that have absorptions near 1700 cm^{-1} . [1]

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- (ii) Identify which of the classes listed in part (a)(i) could **not** have the molecular formula C_3H_6O . [1]

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(Question A1 continued)

(b) The mass spectrum of compound **A** has prominent peaks at $m/z = 15$ and 29 .

(i) Deduce the formula of the species responsible for each peak. [2]

$m/z = 15$

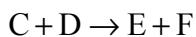
$m/z = 29$

(ii) Deduce the structure of compound **A**. [1]

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A2. (a) The table below shows kinetic data for the following reaction



Experiment	[C] / mol dm ⁻³	[D] / mol dm ⁻³	Initial rate / mol dm ⁻³ min ⁻¹
1	2.0 × 10 ⁻³	3.0 × 10 ⁻³	1.0 × 10 ⁻⁶
2	4.0 × 10 ⁻³	3.0 × 10 ⁻³	2.0 × 10 ⁻⁶
3	6.0 × 10 ⁻³	6.0 × 10 ⁻³	3.0 × 10 ⁻⁶

(i) Deduce the order of reaction with respect to both **C** and **D**, giving a reason in each case. [4]

C

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D

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(ii) Deduce the rate expression for this reaction. [1]

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(iii) Use data from Experiment 1 to calculate a value for the rate constant for this reaction and deduce its units. [3]

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(Question A2 continued)

- (b) Define the term *half-life* and calculate the half-life for a first-order reaction with a rate constant of $3.3 \times 10^{-2} \text{ min}^{-1}$.

[2]

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A3. Benzoic acid, C_6H_5COOH , is a weak acid.

(a) Deduce the equation for the ionization of benzoic acid in water. [1]

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(b) Use information from Table 16 in the Data Booklet to calculate a value for the dissociation constant, K_a for benzoic acid. [1]

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(c) Derive the ionization constant expression for benzoic acid and use it to determine the pH of a 0.20 mol dm^{-3} aqueous solution of benzoic acid. [3]

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Option B – Medicines and drugs

B1. (a) Ethanol in the human body can be detected in several ways.

(i) Explain how the breathalyser works and describe its colour change in a positive result. [2]

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(ii) Explain how alcohol is detected using an intoximeter. [2]

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(b) Using Table 21 of the Data Booklet, identify **three** compounds that are classified as depressants. [2]

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B2. The structures of some stimulants can be found in Table 21 of the Data Booklet.

(a) List **three** physiological effects of stimulants. [2]

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(b) Compare the structures of caffeine and nicotine in terms of functional groups. [2]

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(c) Discuss **two** short-term and **two** long-term effects of smoking tobacco, other than those mentioned in part (a). [4]

short-term

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long-term

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B3. (a) Describe the differences in the ways that bacteria and viruses multiply. [2]

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(b) Outline **two** ways in which antiviral drugs work. [2]

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(c) Explain why effective treatment of AIDS with antiviral drugs is difficult. [2]

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Option C – Human biochemistry

C1. (a) The structures of the amino acids glycine and serine are shown in Table 20 of the Data Booklet.

(i) Draw the structure of one of the dipeptides formed when one molecule of glycine and one molecule of serine react together. Show all the bonds in the link between the two molecules. [2]

(ii) State the type of reaction occurring and identify the other product of the reaction. [1]

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(b) The structure of a protein can be analysed using paper chromatography.

(i) Describe the process that the protein must undergo before chromatography is used and explain why it is necessary. [2]

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(ii) Explain how paper chromatography is used to identify the individual amino acids. [4]

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C2. Fats and oils are formed when fatty acids react with glycerol.

(a) State the name of the functional group formed during this reaction. [1]

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(b) Outline **two** structural differences between saturated and unsaturated fats. [2]

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(c) Explain why saturated fats have higher melting points than unsaturated fats with similar relative molecular masses. [2]

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C3. (a) State the general role of hormones in the body and identify the gland that controls their production. [2]

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(b) The structures of some hormones are shown in Table 22 of the Data Booklet.

(i) Identify **one** hormone with a steroid backbone, state where it is produced and outline its specific role in the body. [2]

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(ii) Identify **one** hormone with a non-steroid backbone, state where it is produced and outline its specific role in the body. [2]

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Option D – Environmental chemistry

D1. The natural greenhouse effect can be summarised in these steps.

- I. About half of the radiation entering the Earth’s atmosphere is absorbed by the Earth’s surface.
- II. This absorbed radiation is re-radiated from the Earth’s surface.
- III. Greenhouse gases in the atmosphere absorb the radiation from the Earth’s surface and re-radiate it back to the Earth’s surface.

(a) (i) Identify the part of the spectrum from which most of the absorbed radiation in step I comes. [1]

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(ii) Identify the part of the spectrum from which most of the radiation in step II comes. [1]

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(iii) Explain on a molecular level, how greenhouse gases absorb the radiation in step III. [1]

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(iv) The term *enhanced greenhouse effect* is sometimes used to describe the increasing effect of human activity on the natural effect. Explain why, with reference to one of the steps above, the greenhouse effect may be increasing. [2]

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(Question D1 continued)

- (b) “Carbon dioxide is the most significant greenhouse gas.”
“Methane is a more important greenhouse gas than carbon dioxide.”

Explain how both these statements can be considered correct.

[2]

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- (c) One predicted consequence of the enhanced greenhouse effect is rising sea levels. Outline **two** different ways in which this could happen.

[2]

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D2. (a) (i) The pH values of five liquids are 1.2, 4.2, 5.2, 6.2 and 7.2. Identify which **two** of these values are most likely to be those of acid rain. [1]

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(ii) Identify an oxide that causes acid rain and write an equation for its reaction with water. [2]

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(iii) State **two** ways in which emissions of the oxide identified in (a)(ii) can be decreased. [2]

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(b) Outline **one** effect of acid rain on

(i) marble statues. [1]

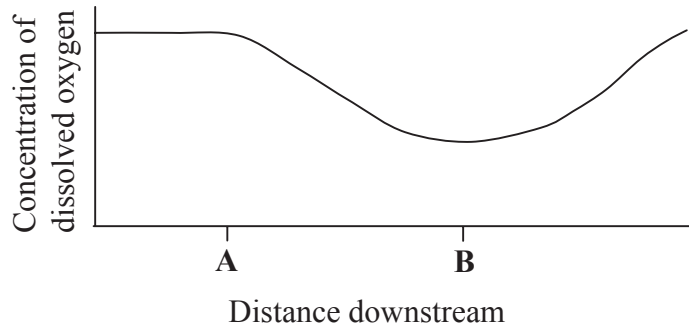
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(ii) lakes. [1]

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D3. The diagram below represents the variation in dissolved oxygen along a river.



(a) Explain the meaning of the term *biological oxygen demand* (BOD). [2]

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(b) (i) Identify, giving a reason, at which of the points **A** or **B** the BOD is greater. [1]

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(ii) Suggest a reason for the change in the amount of dissolved oxygen between **A** and **B**. [1]

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Option E – Chemical industries

E1. (a) List **three** factors to consider when choosing a location for an iron and steel plant. [2]

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(b) Identify **two** raw materials mixed with the iron ore in a blast furnace. In each case, outline its purpose and write an equation to show what happens to it in the blast furnace. [5]

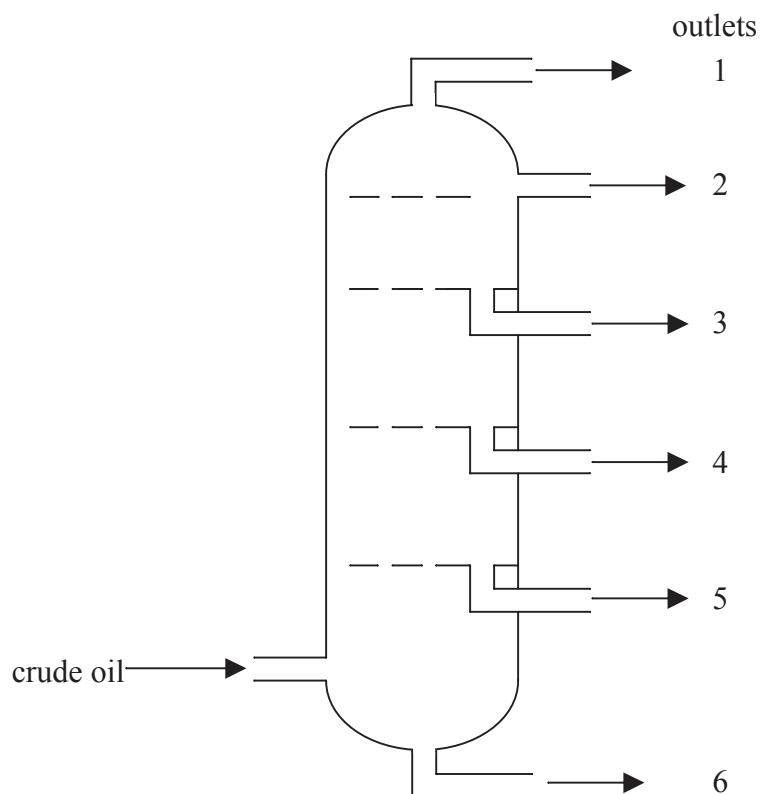
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E2. (a) Approximately 90 % of the refined products from crude oil are used for one main purpose. Identify this purpose and explain why the other 10 % are of great importance. [2]

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(b) The diagram below represents equipment used to refine crude oil.



Predict, stating a reason, which of the compounds C_2H_6 or C_8H_{18} , would be collected at outlet 2. [1]

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(c) Deduce the equation for the cracking of C_8H_{18} in which an alkene and an alkane are formed in the ratio 2 : 1. [1]

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(Question E2 continued)

- (d) Explain why sulfur and its compounds are removed from crude oil, and identify one industry that makes use of this sulfur. [2]

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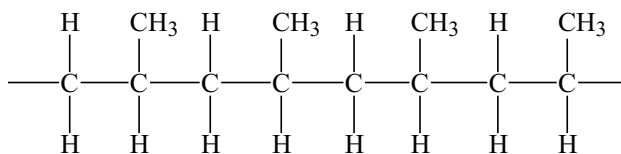
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E3. The diagram below represents a section of a polymer.



(a) (i) Draw the structure of the monomer from which this polymer is manufactured. [1]

(ii) Polymers **A** and **B** both have the structure shown above, but the average chain length is much greater in **A** than in **B**. Suggest **two** physical properties that would be different for **A** and **B**. [2]

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(iii) Polymers **A** and **B** both have isotactic structures. Polymer **C** is manufactured from the same monomer but is not isotactic. State the name used to describe this different structure and outline how the structure differs. [2]

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(b) Polymers have replaced more traditional materials such as metal and wood. Suggest **one** polymer property, different in each case, that makes polymers more suitable than [2]

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wood

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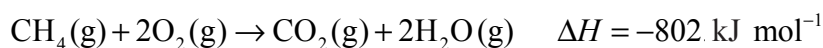


Option F – Fuels and energy

F1. (a) Describe how coal was formed. [3]

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(b) Methane undergoes complete combustion as shown below.



(i) Determine the calorific value of methane in kJ g^{-1} . [1]

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(ii) The amount of heat produced when a 20.0 g sample of one type of coal was completely burned was 610 kJ. Determine the calorific value in kJ g^{-1} . [1]

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(iii) The data above show that the calorific value of methane is higher than that of coal. State **two** other reasons why methane is often described as a better fuel than coal. [2]

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(iv) Explain why coal will continue to be used as a fuel in the future. [1]

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(c) State an equation for the gasification of coal, in which a mixture of two flammable gases is formed. [1]

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F2. Nuclear reactions can be classified as disintegration, fission or fusion reactions.
A typical disintegration reaction involves the loss of an alpha or beta particle from a radioactive isotope.
A typical fission reaction involves the bombardment of an unstable nucleus by neutrons, forming two smaller nuclei and releasing more neutrons.
A typical fusion reaction involves two small nuclei combining to form a larger nucleus.

(a) Deduce a balanced nuclear equation, showing the atomic number and mass number of each species, for the following examples.

(i) The disintegration of radium-226 to form radon-222. [1]

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(ii) The fission of uranium-235 to form lanthanum-145 and bromine-88. [1]

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(iii) The fusion of a nucleus of ordinary hydrogen with ^2H to form a helium nucleus. [1]

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(b) Compare the behaviour of alpha and beta particles in an electric field. [2]

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(c) The half-life of the isotope actinium-225 is 10 days. Determine the amount of this isotope that remains after a 0.40 g sample is left to decay for 40 days. [2]

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F3. Compare the ways in which houses can be heated using solar energy. Include in your answer reference to

- the distinction between active and passive solar heating
- the direct and indirect conversion of solar energy to electricity.

[4]

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