



**CHEMISTRY  
STANDARD LEVEL  
PAPER 3**

Thursday 5 May 2005 (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 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.** (a) The reaction of warm aqueous KOH with 1-bromobutane occurs by an  $S_N2$  mechanism. Draw the mechanism for this reaction, including the structural formulas of 1-bromobutane, the transition state and the organic product. [4]

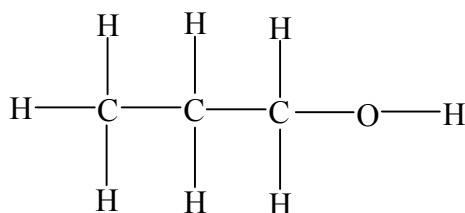
(b) State and explain how the rate of the above reaction is affected when the concentration of the KOH is doubled. [2]

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**A2.** State and explain how the rate of reaction of 1-chlorobutane in the above  $S_N2$  reaction compares with that of 1-bromobutane. [2]

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A3. Propan-1-ol has the following structural formula.



- (a) Use Table 18 in the *Data Booklet* to identify **two** characteristic infrared absorption ranges for propan-1-ol and state the bonds responsible. [2]

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- (b) Deduce the number of peaks and the ratio of the areas of the peaks in the  $^1\text{H}$  NMR spectrum of propan-1-ol. [2]

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- (c) Propan-2-ol is an isomer of propan-1-ol. Draw the structure of propan-2-ol and explain why  $^1\text{H}$  NMR spectroscopy would be more useful than infrared spectroscopy in distinguishing between the two isomers. Explain your answer with reference to both techniques. [4]

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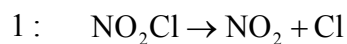
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A4. Consider the following steps in the reaction mechanism for the decomposition of nitryl chloride,  $\text{NO}_2\text{Cl}$ , into nitrogen dioxide,  $\text{NO}_2$  and chlorine,  $\text{Cl}_2$ .



(a) Write the equation for the overall reaction. [1]

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(b) Define the term *activated complex*. [1]

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(c) (i) Step 1 is the rate determining step in the above reaction mechanism. State what is meant by the term *rate-determining step*. [1]

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(ii) Deduce the molecularity of the rate-determining step. [1]

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**Option B – Medicines and drugs**

**B1.** (a) State the purpose of using an antacid. *[1]*

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(b) State and explain which would be more effective as an antacid, 1.0 mol of magnesium hydroxide or 1.0 mol of aluminium hydroxide. Support your answer with balanced equations. *[3]*

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**B2.** Analgesics can be classified as mild or strong.

(a) State and explain how each type of analgesic prevents pain. [4]

*mild analgesic*

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*strong analgesic*

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(b) Aspirin is a common mild analgesic.

(i) Outline **one** advantage and **one** disadvantage of using aspirin. [2]

*advantage*

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*disadvantage*

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(ii) State **one** synergistic effect of using aspirin and ethanol together. [1]

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(iii) Acetaminophen (paracetamol) is often used as a substitute for aspirin. State **one** disadvantage of using acetaminophen. [1]

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**B3.** (a) Compare broad-spectrum and narrow-spectrum antibiotics. [1]

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(b) State how penicillins prevent the growth of bacteria and explain why scientists continue to develop new penicillins. [2]

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(c) Explain the specific effects of modifying the side chain in penicillin. [1]

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(d) (i) Discuss the possible effects of over prescribing penicillin to humans. [3]

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(ii) Suggest another practice that may lead to these results. [1]

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**Option C – Human biochemistry**

**C1.** (a) A brand of vegetable fat consists of 88 % unsaturated fats and 12 % saturated fats. State the major structural difference between unsaturated and saturated fats. [1]

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(b) Linoleic acid,  $\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$ , and palmitic acid,  $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$ , are components of vegetable fat. Explain why palmitic acid has the higher melting point. [3]

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(c) The energy content of a vegetable oil was determined using a calorimeter. A 5.00 g sample of the oil was completely combusted in a calorimeter containing 1 000 g of water at an initial temperature of 18.0 °C. On complete combustion of the oil, the temperature of the water rose to 65.3 °C.

Calculate the calorific value of the oil in  $\text{kJ g}^{-1}$ . [4]

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(d) List **two** functions of fats in the human body. [2]

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- C2. (a) By referring to Table 22 of the *Data Booklet*, identify **one** vitamin that is water soluble and **one** vitamin that is fat soluble. Explain the differences in solubility in terms of their structures and intermolecular forces.

[4]

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- (b) Vitamins C and D are vital in a balanced diet. State **one** major function of each of these vitamins and state a disease that results from the deficiency of each one.

[4]

vitamin C

*function*

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*disease*

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vitamin D

*function*

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*disease*

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**C3.** Discuss **two** benefits of using genetically modified foods.

[2]

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**Option D – Environmental chemistry**

**D1.** (a) List **two** gases which contribute to the greenhouse effect. *[1]*

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(b) Explain how greenhouse gases cause global warming. *[3]*

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(c) State **one** man-made source of particulates and outline the effect of particulates on the Earth's surface temperature. *[2]*

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**D2.** (a) Use equations to show how ozone undergoes natural depletion in the atmosphere. [2]

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(b) Identify **one** pollutant that contributes to the lowering of the ozone concentration in the upper atmosphere. State a source of the pollutant identified. [2]

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(c) Fluorocarbons and hydrofluorocarbons are now considered as alternatives to some ozone-depleting pollutants. Outline **one** advantage and **one** disadvantage of the use of these alternatives. [2]

*advantage*

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*disadvantage*

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- D3.** (a) The initial stages of waste water treatment are known as primary and secondary stages. For each stage, outline the nature of the treatment and the substance removed. [4]

*primary stage*

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*substance removed*

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*secondary stage*

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*substance removed*

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- (b) State **two** types of substances removed during the tertiary treatment of waste water and explain how they are removed during this stage. [4]

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**Option E – Chemical industries**

**E1.** (a) Describe the structural difference between isotactic and atactic polypropene. You may use a diagram to show the difference.

[2]

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(b) List **two** properties of isotactic polypropene and outline how its structure leads to these properties.

[2]

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**E2.** (a) The properties of polyvinyl chloride, PVC, may be modified to suit a particular use. State the main method of modifying PVC and the effect this has on its properties [2]

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(b) Outline **two** disadvantages of using polymers such as polypropene and PVC, and give **one** disadvantage that is specific to PVC. [3]

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**E3.** (a) State the essential chemical process in the extraction of iron and aluminium. [1]

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(b) Using iron and aluminium as examples, discuss the major factor that determines the ease of extraction of metals. [2]

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**E4.** (a) Iron is produced in a blast furnace.

(i) State the name and formula of the main impurity in iron ore. [1]

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(ii) Name the raw material used to remove the impurity. Show with equations how the impurity is removed. [2]

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(b) State the process used to extract aluminium on an industrial scale and write equations for the reactions involved. [3]

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(c) Explain the use of cryolite in the production of aluminium, other than cost. [2]

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**Option F – Fuels and energy**

**F1.** State **two** desirable characteristics of energy sources other than the fact that they release energy. [2]

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**F2.** A source of energy that shows great promise is solar energy.

(a) One method of capturing solar energy is through its conversion to biomass. State what is meant by the term *biomass*. Write an equation to show how glucose is produced with the aid of solar energy. [3]

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*(This question continues on the following page)*

(Question F2 continued)

(b) The energy stored in biomass can be released in several ways. Two of these are direct combustion and conversion to ethanol. For **each** of these two methods, give **one** advantage and **one** disadvantage.

(i) direct combustion

[2]

*advantage*

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*disadvantage*

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(ii) conversion to ethanol

[2]

*advantage*

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*disadvantage*

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(c) Solar energy can be converted to electricity by means of photovoltaic cells. Give **one** advantage and **one** disadvantage of using photovoltaic cells.

[2]

*advantage*

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*disadvantage*

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**F3.** Electrical energy can be produced from chemical energy by the use of batteries.

- (a) (i) Explain the workings of the lead-acid storage battery. Your answer should include
- the materials used for each electrode
  - the identity of the electrolyte
  - the half-equation for the reaction that occurs at each electrode.

[5]

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- (ii) Identify the type of reaction that occurs at the negative electrode (anode) and explain your answer.

[2]

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(b) With reference to a lead-acid storage battery, identify the factors that affect the

- (i) voltage produced.

[1]

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- (ii) power obtained.

[1]

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