



22086118



CHEMISTRY
STANDARD LEVEL
PAPER 3

Friday 9 May 2008 (morning)

1 hour

Candidate session number

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INSTRUCTIONS TO CANDIDATES

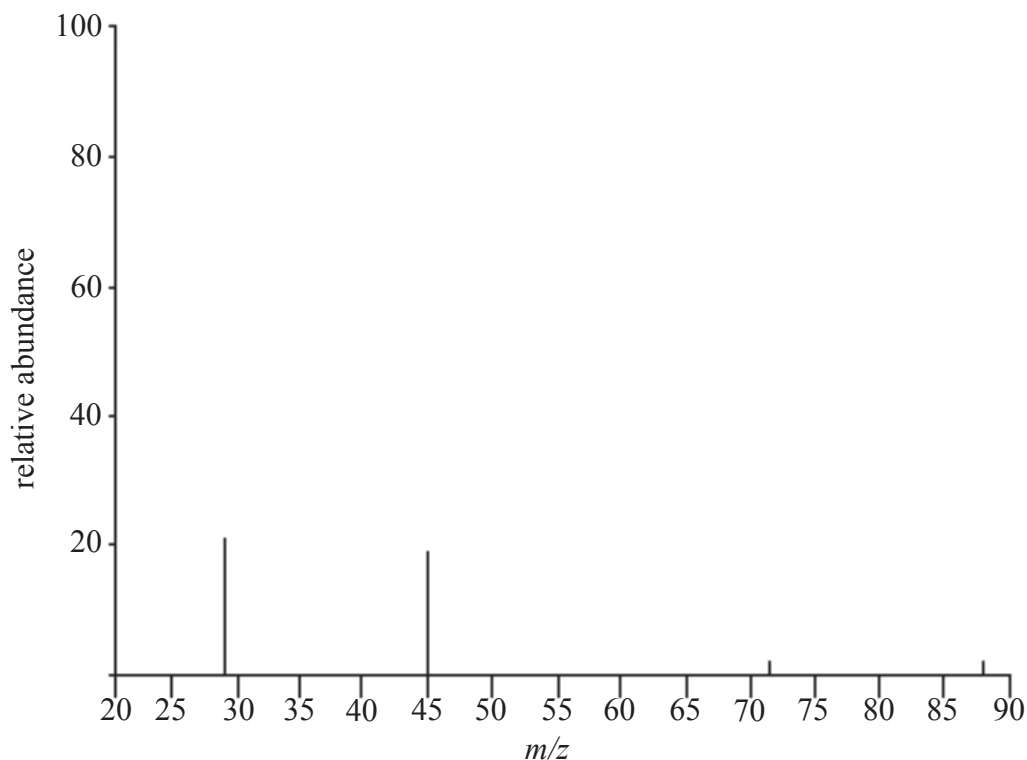
- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them 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. A compound **M**, with a molecular formula of $C_4H_{10}O$, was oxidized to compound **N** and then further oxidized to an acidic compound **P** by acidified potassium dichromate(VI) under reflux.

A simplified mass spectrum of compound **P** is given below.



[Source: D Parla *et al*, *Introduction to Spectroscopy: A Guide for Students of Organic Chemistry*, Saunders College Publishing (1979)]

(a) (i) Deduce the relative molecular mass of compound **P**. [1]

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(ii) Suggest the formula for each of the fragment ions for the peaks at m/z values of 29 and 45. [2]

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(This question continues on the following page)



(Question A1 continued)

- (b) The ^1H NMR spectrum of **P** shows four peaks with areas in the ratio 3:2:2:1. Deduce the structural formula of **P**, giving a reason for your choice. [2]

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- (c) Compound **N** is an aldehyde with a relative molecular mass of 72. Deduce the structural formula of **N** and predict the number of peaks, and the ratio of their areas, in its ^1H NMR spectrum. [3]

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- (d) (i) State what information can be obtained from a compound's infrared spectrum. [1]

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- (ii) Using Table 18 of the Data Booklet explain how infrared spectroscopy could be used to distinguish between compounds **N** and **P**. [2]

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A2. (a) Using a diagram, describe the structure of benzene. [2]

(b) State **two** different pieces of chemical or physical evidence that support this structure of benzene. [2]

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A3. (a) The formula $C_5H_{11}I$ represents several isomers. Give the structural formula of a primary halogenoalkane and a tertiary halogenoalkane with this formula.

(i) primary [1]

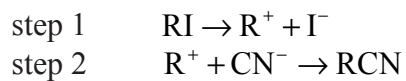
(ii) tertiary [1]

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(Question A3 continued)

- (b) RI, a tertiary halogenoalkane, reacts with CN^- via a two-step mechanism as shown below.



- (i) Define the term *rate-determining step* and identify this step in the above mechanism. [2]

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- (ii) State the molecularity of the above mechanism. [1]

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Option B – Medicines and drugs

B1. (a) Name the acid found in the gastric juices of the stomach. [1]

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(b) Sodium hydrogencarbonate can be used to treat indigestion. Write an equation to show its action. [1]

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(c) Some antacids contain alginates. Briefly explain how alginates help to prevent heartburn. [2]

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(d) Explain why dimethicone is added to antacids. [1]

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B2. The structures of morphine, codeine and heroin are shown in Table 21 of the Data Booklet.

(a) State the type of chemical reaction used to convert morphine into the semi-synthetic opiate heroin. [1]

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(b) State the structural difference between the morphine and codeine molecules. [1]

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(c) State the main advantage and main disadvantage of using morphine as an analgesic. [2]

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(d) Outline **two** different types of social problem associated with the misuse of heroin. [2]

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B3. (a) (i) Name the type of drug that increases mental alertness. [1]

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(ii) Explain the term *sympathomimetic drug*. [1]

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(b) Name the sympathomimetic drug in smoking tobacco. Outline the short-term and long-term effects of its use. [3]

name

short-term effects

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long-term effects

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(c) Identify **two** structural differences between amphetamine and the hormone it is chemically related to. [2]

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(d) (i) State the effect of caffeine on the urinary system. [1]

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(ii) Identify the functional group present in both caffeine and nicotine. [1]

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Option C – Human biochemistry

C1. (a) Proteins, carbohydrates and water are important components of a balanced diet. Name **three** other types of nutrients needed for a balanced diet. [2]

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(b) The label on a box of breakfast cereal states that a 28.0 g serving has a calorific value of 418 kJ. A 1.00 g sample of this cereal was burned completely and all the heat produced was transferred to 100 g of water. Determine the temperature rise of the water. [3]

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C2. (a) Name the type of compound formed when carboxylic acids and glycerol (propane-1,2,3-triol) combine to form fats. [1]

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(b) Stearic acid and linoleic acid are fatty acids that both have 18 carbon atoms in their molecular structure.

(i) The melting point of stearic acid ($M_r = 284$) is higher than that of linoleic acid ($M_r = 280$). Suggest the difference in the structures of the two molecules that accounts for the difference in their melting points. [1]

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(ii) Explain how this difference results in linoleic acid having a lower melting point than stearic acid. [2]

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(c) Determine the mass of iodine, I_2 , that reacts with one mole of linoleic acid. [2]

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C3. The structure of retinol (vitamin A) is given in Table 22 of the Data Booklet.

(a) Identify **two** functional groups present in retinol. [2]

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(b) State and explain whether retinol is fat-soluble or water-soluble. [2]

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(c) (i) Name the light-sensitive substance in the rods of the eye formed from retinol and explain its function. [3]

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(ii) Name **two** diseases associated with retinol deficiency. [2]

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Option D – Environmental chemistry

D1. (a) Both CO₂ and N₂O are considered greenhouse gases. State **one** major natural and **one** major man-made source for each gas. [4]

CO₂

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N₂O

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(b) State **one** reason, different in each case, why both CO₂ and N₂O are considered to be major contributors to the greenhouse effect. [2]

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(c) Increasing amounts of greenhouse gases in the atmosphere contribute to global warming. Discuss the effects of global warming on the environment. [3]

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D2. Acid rain may be defined as rain with a pH of less than 5.6.

(a) Identify an acid which originates from the burning of coal. [1]

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(b) Write the equations which show how this acid is formed. [2]

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(c) Suggest how the production of the acid formed as a result of burning coal can be reduced. [2]

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D3. (a) Eutrophication occurs due to fertilizer, sewage and detergent runoff into lakes. Describe what happens during eutrophication. [4]

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(b) Discuss the effect of heat on the dissolved oxygen and metabolism in a lake. [2]

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Option E – Chemical industries

E1. (a) Limestone and coke are added to the blast furnace in the production of iron. For each of these raw materials, state its function and write an equation to illustrate this function. *[4]*

Limestone

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Coke

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(b) Explain how iron produced in the blast furnace is converted to steel. *[4]*

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E2. (a) Explain why in industry carbon (coke) is used to reduce iron(III) oxide but not aluminium oxide. [2]

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(b) Explain why cryolite is used in the electrolysis of aluminium oxide. [2]

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(c) (i) Name the material used for the electrodes in the electrolysis of aluminium oxide. [1]

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(ii) Write **one** equation for a reaction that occurs at each electrode. [2]

positive electrode (anode)

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negative electrode (cathode)

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(iii) Explain why the anode is regularly replaced. [1]

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E3. (a) Describe how the manufacturing process used to produce polyurethane is modified to produce polyurethane foam. State **two** physical properties that result from this manufacturing process. [2]

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(b) Discuss **two** disadvantages of the use of polyurethane. [2]

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Option F – Fuels and energy

F1. List **three** desirable characteristics of an energy source. [3]

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F2. (a) Write the equations occurring at each electrode and the overall reaction for the hydrogen – oxygen alkaline fuel cell. [3]

negative electrode (anode)

positive electrode (cathode)

overall reaction

(b) The lead-acid storage battery is used in cars.

(i) Write the equations occurring at each electrode when the battery is discharging. [2]

negative electrode (anode)

positive electrode (cathode)

(ii) Explain why some lead-acid batteries need water added to them after some time. [1]

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F3. (a) Discuss how parabolic mirrors are used to convert solar energy into electrical energy. [3]

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(b) State **two** disadvantages of the use of parabolic mirrors rather than photovoltaic cells for the production of electrical energy from solar energy. [2]

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(c) The process of photosynthesis is a natural way of converting solar energy into other forms of energy. Write the equation for the process of photosynthesis and list **two** uses of the organic product of photosynthesis. [2]

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F4. Discuss how ethanol and biogas can be generated from biomass and how they can be converted into energy.

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