



22096112



**CHEMISTRY**  
**STANDARD LEVEL**  
**PAPER 3**

Tuesday 19 May 2009 (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.



0128

**Option A — Modern analytical chemistry**

**A1.** (a) State **two** reasons for using analytical techniques. [2]

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(b) Explain what occurs at a molecular level during the absorption of infrared (IR) radiation by the sulfur dioxide molecule, SO<sub>2</sub>. [3]

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(c) Describe the operating principles of a double-beam IR spectrometer. [4]

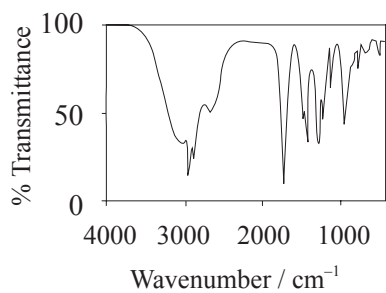
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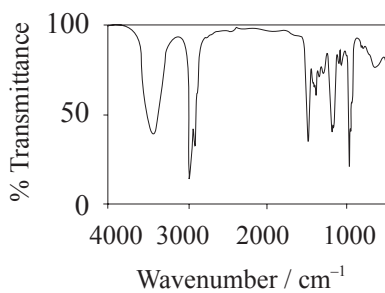


(Question A1 continued)

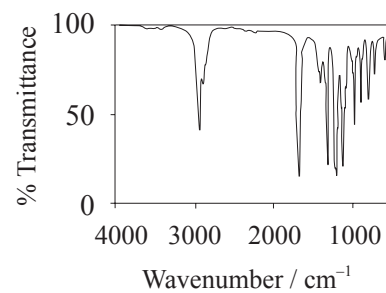
(d) Consider the IR spectra of the following three compounds.



I



II



III

Determine which IR spectrum corresponds to each compound A, B and C. Explain your reasoning. IR data can be found in Table 17 of the Data Booklet.

[5]

Compound	Spectrum	Reason
A	....	..... ..... .....
B	....	..... ..... .....
C	....	..... ..... .....



**A2.** (a) Distinguish between the  $^1\text{H}$  NMR spectra of 1-bromopropane and 2-bromopropane (splitting patterns are not required). [4]

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(b) Outline how NMR is used in body scanners. [2]

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**Option B — Human biochemistry**

**B1.** Myoglobin is a globular protein found in the muscle tissue and is formed from 2-amino acids.

(a) Describe the characteristic properties of 2-amino acids. [3]

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(b) (i) State the name of the bond or interaction that is responsible for linking the amino acids together in the primary structure. [1]

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(ii) State the name of the bond or interaction that is responsible for the secondary structure. [1]

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(iii) State **two** of the bonds or interactions responsible for the 3D shape of myoglobin. [2]

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**B2.** Many lipids are found in the human body. One type of lipid is a triglyceride.

(a) The formulas of some fatty acids are shown in Table 22 of the Data Booklet. State the equation for the reaction between glycerol and stearic acid to form a triglyceride. [3]

(b) (i) Compare the structures of the **two** fatty acids: linoleic and linolenic acids. [2]

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(ii) State why these **two** fatty acids are so important in the human diet. [1]

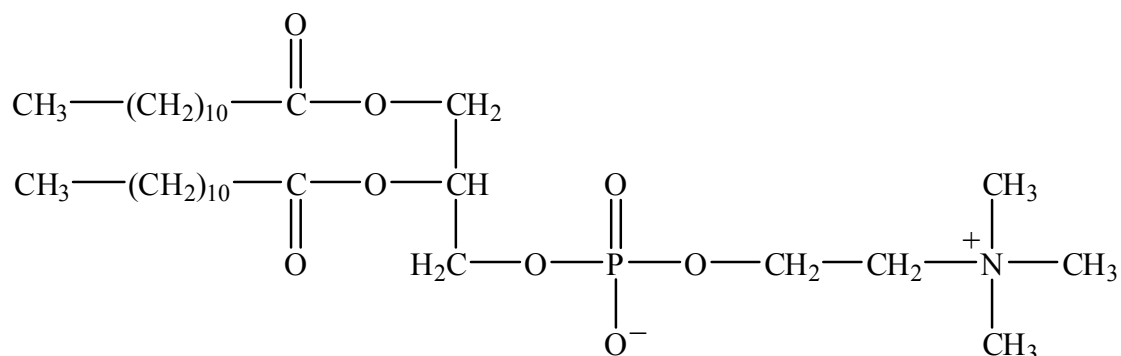
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(Question B2 continued)

- (c) Steroids and phospholipids are both classes of lipid found in the body. Cholesterol is a steroid. A structure of lecithin, a phospholipid, is shown below.



- (i) Distinguish between *HDL* and *LDL* cholesterol. [2]

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- (ii) Compare the composition of cholesterol with a phospholipid such as lecithin. [1]

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- (iii) Determine whether cholesterol or lecithin is more soluble in water. [1]

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**B3.** Steroids can act as hormones in the human body.

- (a) The structures of some hormones can be found in Table 21 of the Data Booklet. State the name of a functional group that is present in both progesterone and testosterone but not present in estradiol. [1]

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- (b) Describe how oral contraceptives function in the female body. [2]

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**Option C — Chemistry in industry and technology**

**C1.** In the last 15 years several Nobel prizes have been awarded in the area of nanotechnology, from the development of the scanning probe microscope, to the discovery of fullerenes. By 2015 nanotechnology could employ two million workers worldwide.

(a) Define the term *nanotechnology*. [1]

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(b) After the discovery of C<sub>60</sub>, chemists discovered carbon nanotubes. Describe the structure and properties of carbon nanotubes. [4]

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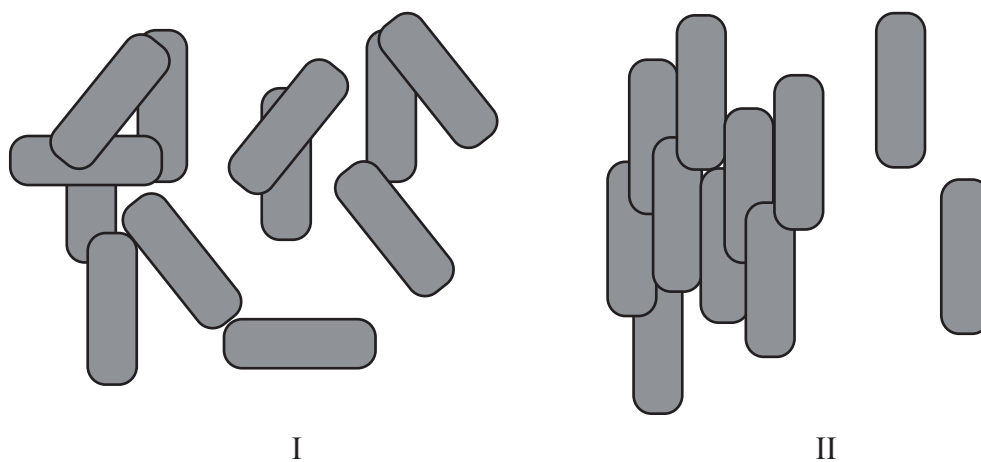
(c) Nanotechnology could provide new solutions for developing countries where basic services such as good health care, education, safe drinking water and reliable energy are often lacking. Discuss some of the potential risks associated with developing nanotechnology. [4]

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C2. Liquid crystals are widely used in electrically controlled liquid crystal display (LCD) devices such as calculators, computers and watches.

- (a) Describe the meaning of the term *liquid crystals*. State and explain which diagram, I or II, represents molecules that are in a liquid crystalline phase. [2]



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- (b) Distinguish between *thermotropic* and *lyotropic* liquid crystals and state **one** example of each type. [4]

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- (c) Discuss the properties needed for a substance to be used in liquid crystal displays. [2]

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**C3.** (a) Compare a fuel cell and a lead-acid battery, with respect to possible concerns about pollution of the environment. [2]

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(b) State with a reason whether a solid fuel could be used in a fuel cell. [1]

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**Option D — Medicines and drugs**

**D1.** Analgesics are used to relieve pain in the body. Aspirin and paracetamol (acetaminophen) are both mild analgesics.

(a) Discuss the advantages of using aspirin instead of paracetamol. [2]

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(b) Compare how mild and strong analgesics relieve pain in the body. [2]

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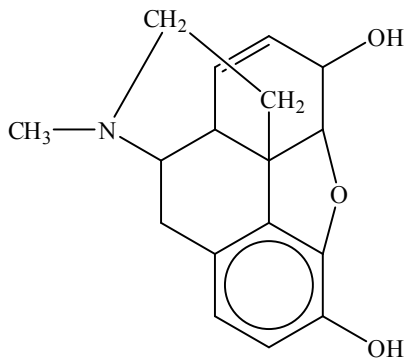
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(c) The structures of the strong analgesics morphine and heroin (diamorphine) can be found in Table 20 of the Data Booklet.

(i) Identify the amine functional group in the morphine molecule below by drawing a ring around it. [1]



(ii) Classify the type of amine present in morphine. [1]

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(iii) State the name of the functional group found in heroin but not in morphine. [1]

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*(Question D1 continued)*

(d) State **one** advantage and **one** disadvantage of using morphine as a strong analgesic. [2]

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**D2.** Medicines and drugs alter the physiological state of the body including consciousness and coordination.

(a) State **one** other effect of medicines and drugs on the body. [1]

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(b) Explain the meaning of the following terms:

(i) *therapeutic window*. [1]

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(ii) *tolerance*. [1]

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(iii) *placebo effect*. [1]

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(c) Outline the major stages in the development of a new drug. [3]

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**D3.** Ethanol is a depressant that is widely consumed in many societies. When consumed excessively it has a major impact on families and society as a whole. Other depressants such as diazepam (Valium<sup>®</sup>) may be prescribed by a doctor.

(a) Describe the effect on the individual of consuming depressants at moderate and high doses. [2]

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(b) One problem associated with ethanol consumption is an increased risk of traffic accidents. Police in many countries use a breathalyser to test drivers. The breathalyser contains potassium dichromate(VI).

(i) Describe the colour change of potassium dichromate(VI) when it reacts with ethanol. [1]

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(ii) State with a reason whether chromium in potassium dichromate(VI) is oxidised or reduced by ethanol. [1]

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**Option E — Environmental chemistry**

**E1.** The greenhouse effect maintains the earth’s temperature, which makes the planet habitable. However, over the last 100 years the average temperature of the earth has increased by almost 1°C. Most climate scientists believe this warming is due to increased levels of greenhouse gases in the atmosphere.

(a) Two of the major greenhouse gases in the atmosphere are methane and carbon dioxide. State **two** other major greenhouse gases. [2]

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(b) Discuss which **two** gases from the four gases in part (a) are the most significant for global warming. [2]

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(c) Discuss **two** effects of global warming. [2]

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**E2.** Water purity is often assessed by reference to its oxygen content.

(a) Outline the meaning of the term *biochemical oxygen demand* (BOD). [2]

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(b) Describe how the dissolved oxygen concentration in a river would decrease if

(i) a car factory releases warm water into the river after using it for cooling. [1]

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(ii) a farmer puts large quantities of a fertilizer on a field next to the river. [1]

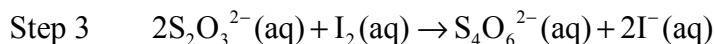
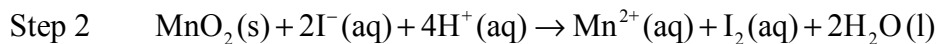
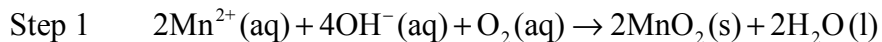
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(Question E2 continued)

- (c) The Winkler method uses redox reactions to find the concentration of oxygen in water. 100 cm<sup>3</sup> of water was taken from a river and analysed using this method. The reactions taking place are summarized below.



- (i) State what happened to the O<sub>2</sub> in step 1 in terms of electrons. [1]

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- (ii) State the change in oxidation number for manganese in step 2. [1]

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- (iii) 0.0002 moles of I<sup>-</sup> were formed in step 3. Calculate the amount, in moles, of oxygen, O<sub>2</sub>, dissolved in water. [1]

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- (d) Due to the shortage of fresh water in many parts of the planet, scientists have designed ways to convert sea water to fresh water. Outline how multi-stage distillation converts sea water to fresh water. [3]

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**E3.** The ozone in the stratosphere protects us from harmful UV radiation. Above Australia there is an area of decreased ozone concentration that has led to an increase in the incidence of some skin cancers.

(a) Write equations for the natural formation of ozone. [2]

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(b) Discuss the advantages and disadvantages of using hydrocarbons in place of CFCs. [2]

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**Option F — Food chemistry**

**F1.** Artificial food colourants have recently been linked to increased hyperactivity in children. Many foods are colourful because of the natural pigments they contain.

(a) Explain why naturally-occurring pigments are coloured. [1]

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(b) (i) State the class of pigments that give cranberries and strawberries their colour. [1]

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(ii) Describe the effect of metal ions on the colour of this pigment. [1]

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(c) (i) State the class of pigments that give carrots and tomatoes their colour. [1]

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(ii) Outline why this class of pigment is susceptible to oxidation, and the effect of oxidation on this pigment. [2]

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**F2.** Antioxidants occur naturally and are often added to extend the shelf life of our food.

(a) Define the term *antioxidant*. [1]

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(b) State **two** naturally-occurring antioxidants and **one** source of each. [2]

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(c) State **two** other traditional methods of extending the shelf life of food. [2]

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(d) Table 22 in the Data Booklet shows the structures of some antioxidants. Determine the **two** functional groups that are found in all of these synthetic antioxidants: 2-*tert*-butyl-4-hydroxyanisole (2-BHA), 3-*tert*-butyl-4-hydroxyanisole (3-BHA) and 3,5-di-*tert*-butyl-4-hydroxytoluene (BHT). [2]

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(e) Discuss **one** advantage and **one** disadvantage of using natural antioxidants. [2]

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**F3.** Genetically modified (GM) foods are now widely available, although in some countries environmental groups are campaigning against them. Define the term *genetically modified food* and discuss the benefits and concerns of using GM foods. [5]

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**Option G — Further organic chemistry**

**G1.** Benzene,  $C_6H_6$ , undergoes electrophilic substitution reactions in order to synthesize other compounds.

- (a) Describe the structure of benzene. [4]

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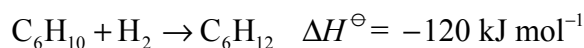
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- (b) Cyclohexene,  $C_6H_{10}$ , reacts with hydrogen to form cyclohexane,  $C_6H_{12}$ .

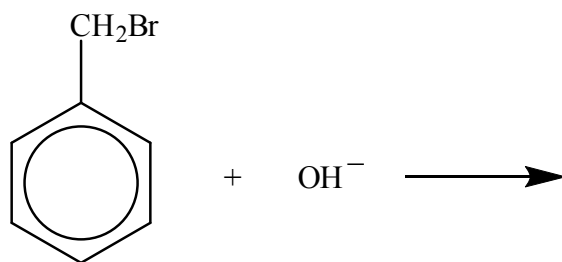


Calculate the enthalpy change of hydrogenation of benzene to cyclohexane, assuming it has the 1,3,5-cyclohexatriene structure. [1]

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- (c) (i) State the structure of the organic product for the following reaction and name the mechanism for the reaction. [2]



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*(Question G1 continued)*

- (ii) Explain why bromobenzene,  $C_6H_5Br$ , does not react with  $OH^-$ . [2]

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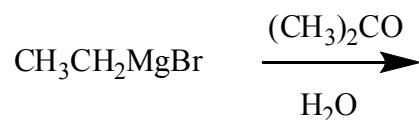
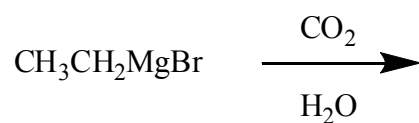


**G2.** (a) Magnesium is a very electropositive metal which can be used in the formation of Grignard reagents.

(i) State the product when bromomethane and magnesium react together in a non-polar solvent. [1]

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(ii) Draw the structural formulas of the organic products formed in the following reactions. [2]

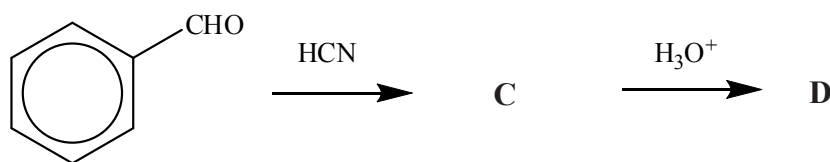
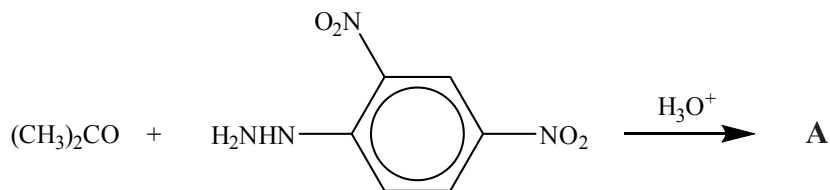


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(Question G2 continued)

- (b) Draw the structural formulas of the organic products, **A–D**, formed in the following reactions. [4]



**A:**

**B:**

**C:**

**D:**



- G3.** Elimination reactions are common for tertiary alcohols. State the organic product formed in this acid-catalysed reaction and explain the mechanism using curly arrows to show the movement of electron pairs. [4]

