

### CHEMISTRY Higher level Paper 3 Preliminary Examinations

Tuesday 29 August 2023

1 hour 15 minutes

### INSTRUCTIONS TO CANDIDATES

- Write your name, class and index number in the blanks below.
- Do not open this examination paper until instructed to do so.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- A clean copy of the **chemistry data booklet** is required for this paper.
- The maximum mark for this examination paper is [45 marks].

Section A	Questions
Answer all the questions.	1 — 2

Section B	Questions
Answer all the questions.	
Option D — Medicinal chemistry	3 — 11

Name:		
Class:		
Index:		



# **Section A**

Answer all questions. Write your answers in the boxes provided.

**1.** A group of chemistry students read that fish is a good source of iodine in the form of iodide ions. They decided to extract the iodine from 600 g of fish.

The students blended the fish in a food processor with 100 cm<sup>3</sup> of water, left it to stand overnight and then filtered the mixture into a beaker.

(a) One of the students suggested that the presence of iodide ions in the solution could be confirmed by adding silver nitrate solution. The silver ions reacted with iodide ions to form pale yellow silver(I) iodide precipitate.

Formulate an **ionic** equation, including state symbols, for this reaction. [2]

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- (b) 5 cm<sup>3</sup> of dilute sulfuric acid and 5 cm<sup>3</sup> of hydrogen peroxide solution were added to the filtrate containing iodide ions. Aqueous iodine was formed.
  - (i) State the role of hydrogen peroxide solution in this reaction. [1]

(ii) Suggest the role of dilute sulfuric acid in this reaction. [1]

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(c) 25.00 cm<sup>3</sup> of the aqueous iodine from (b) was titrated against 0.0010 mol dm<sup>-3</sup> standard sodium thiosulfate solution.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^{-}(aq) + S_4O_6^{2-}(aq)$$

The titration readings are tabulated as shown.

	Titration 1	Titration 2	Titration 3
Final burette reading / ±0.05cm <sup>3</sup>	5.20	10.10	15.40
Initial burette reading / ±0.05cm <sup>3</sup>	0.00	5.20	10.10
Volume of $S_2O_3^{2-}$ used / ±0.10 cm <sup>3</sup>	5.20	4.90	5.30

(i) Determine the average titre value using the table above.

[1]

[1]

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(ii) Calculate the percentage uncertainty using your answer obtained in (c)(i). [1]

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(iii) Suggest how the experiment could be modified to improve the precision of this investigation.

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2. Raoult's Law states that the partial vapour pressure of a component of a liquid mixture is equal to the vapour pressure of the pure component multiplied by its mole fraction. The partial vapour pressure can be represented by the following equation:

$$P_A = \chi_A \times P_A^o$$

where

 $P_A$  refers to the partial vapour pressure of a component (liquid A) in the mixture,

 $\chi_A(=\frac{moles \ of \ liquid \ A}{total \ moles \ of \ liquids})$  refers to the mole fraction of a liquid in the mixture, and

 $P_A^o$  refers to the vapour pressure of pure liquid A.

An ideal solution is a mixture of liquids in which the intermolecular forces are the same as in the pure liquids. Hence the tendency for a liquid to evaporate is the same in the pure liquid as in the solution.

For a solution consisting of two miscible components, liquid A and liquid B, the total pressure, P may be expressed as

$$\mathsf{P} = P_A + P_B = \chi_A \times P_A^o + \chi_B \times P_B^o$$

The following graph shows the partial vapour pressure of an ethanol-water mixture at different mole fractions of ethanol.



(a) State the vapour pressure of pure water.

[1]



(b) Predict how the vapour pressure of a liquid will be affected by an increase in temperature. [1]



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# Section B

Answer **all** the questions. Write your answers in the boxes provided.

### **Option D** --- **Medicinal Chemistry**

- **3.** Drugs are tested to determine their safety and effectiveness before they are sold to the public.
  - (a) Distinguish between toxic dose (TD50) and lethal dose (LD50). [2]

(b) The therapeutic index of a drug is 1.5. Comment on the risk of overdose when taking the drug. [1]

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(c) State the method of drug administration that gives the maximum bioavailability. [1]

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(d) Suggest **one** ethical consideration faced by pharmaceutical companies when developing drugs. [1]

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**4.** Salicylic acid has been used to relieve pain and reduce fever, but it causes severe irritation of the stomach lining. Its molecular structure is shown below.



(a) Suggest **one** reactant used to prepare aspirin from salicylic acid. The structure of aspirin is shown in section 37 of the data booklet. [1]

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(b) Suggest why aspirin is **slightly** soluble in water by referring to its structure. [2]

(c) Formulate an equation for the conversion of aspirin to a more water-soluble derivative. [1]



(d) The infrared spectra for salicylic acid and aspirin are shown.



Compare and contrast the two spectra with respect to the bonds present, using information from section 26 of the data booklet.

[3]

Similarities:

5. Explain how opiates provide pain relief.

[2]

6. (a) Outline why the development of Ranitidine (Zantac) was based on a detailed knowledge of the structure of histamine as shown below. [1]



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[2]

(b) Omeprazole (Prilosec) and esomeprazole (Nexium) can be used to prevent the release of acid into the stomach. Identify the site of action in the human body. [1]

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7. Outline **two** different ways in which antiviral medications work.

- 8. Hospitals generally produce nuclear waste which are classified as low-level waste.
  - (a) Outline what is meant by low-level waste. [1]

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(b) Describe how the low-level waste can be disposed of safely. [1]

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- **9.** Taxol is used to treat cancer.
  - (a) State why it was a major challenge to produce Taxol synthetically, by referring to its structure. Use section 37 of the data booklet. [1]

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(b) Describe how the challenge in (a) was resolved by pharmaceutical companies. [1]

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- (c) Explain the process of solvent extraction by which Taxol is isolated.
- [2]


[2]

- **10.** Technetium-99m is a commonly used radioisotope in nuclear medicine. It has a halflife of 6.0 hours.
  - (a) Evaluate the suitability of technetium-99m for this use. [2]

(b) Calculate the percentage of technetium-99m remaining after 15.0 hours. Use section 1 of the data booklet.

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**11.** (a) State an analytical technique used to separate anabolic steroids from other substances found in a blood or urine sample of an athlete. [1]

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(b) The concentration of alcohol in the breath can be determined using infrared spectroscopy. Explain why the O-H bond absorption is **not** useful for detecting ethanol in breath.
[1]

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