華中國際學校
Hwa Chong INTERNATIONAL SCHOOL
A MEMBER OF THE HWA CHONG FAMILY OF SCHOOLS

PRELIMINARY EXAMINATION
International Baccalaureate 2

Chemistry
Higher level
Paper 3

Wednesday 29 August 2018 (morning)

1 hour 15 minutes

Candidate name	
Candidate session number	Class

Instructions to candidates

- Write your candidate name and session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- Write your answers in the 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 questions.	1 − 3

Section B	Questions
Answer all of the questions from the option.	
Option D – Medicinal chemistry	4 − 10

For Examiner's Use	
Section A	/ 15
Section B	/ 30
Total	/ 45

Section A

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

1. A student submitted the following report on his recent experiment to determine the concentration of a solution of hydrogen peroxide.

Method

10 cm^3 of hydrogen peroxide was measured using a 100 cm^3 measuring cylinder and placed in a 100 cm^3 conical flask. A bung and tubing was attached and the other end connected to a 100 cm^3 gas syringe. Approximately 0.2 g of the MnO_2 catalyst was weighed. The catalyst was added to the hydrogen peroxide solution and the bung quickly replaced. Oxygen gas was collected in a gas syringe and the total volume was recorded.

Results

Experiment	1	2	3
Mass of MnO_2 / g	0.211	0.242	0.202
Volume of gas produced / cm^3	15.0	13.0	13.0

Analysis

The equation for the reaction: $2H_2O_2 \rightarrow 2H_2O + O_2$

Average volume of gas produced = 13.7 cm^3

Assuming room temperature and pressure, amount (in moles) of gas $= \frac{13.7\ cm^3}{24000\ cm^3\ mol^{-1}}$

$= 5.69 \times 10^{-4}$ mol

2 mol of H_2O_2 produce 1 mol of O_2, so the amount (in moles) of H_2O_2 in 10 cm^3

$= 1.139 \times 10^{-3}$ mol

Concentration of $H_2O_2 = \frac{1.139 \times 10^{-3}\ mol}{0.010\ dm^3} = 0.114$ mol dm^{-3}

(a) The uncertainty of each piece of instrument used is shown below.

100 cm^3 measuring cylinder ± 0.5 cm^3	100 cm^3 gas syringe ± 0.5 cm^3
100 cm^3 conical flask ± 5 cm^3	Weighing balance ± 0.001 g

(This question continues on the following page)

(Question 1 continued)

(i) Calculate the percentage uncertainty of the concentration of hydrogen peroxide determined by the student. [2]

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(ii) Suggest how this percentage uncertainty can be reduced using the same equipment. [1]

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(b) (i) The theoretical value for the concentration of hydrogen peroxide is 0.130 mol dm^{-3}. Calculate the percentage error, giving your answer to **one** decimal place. [1]

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(ii) Outline a reason which may explain the difference between the theoretical and experimental values, and suggest an improvement. [2]

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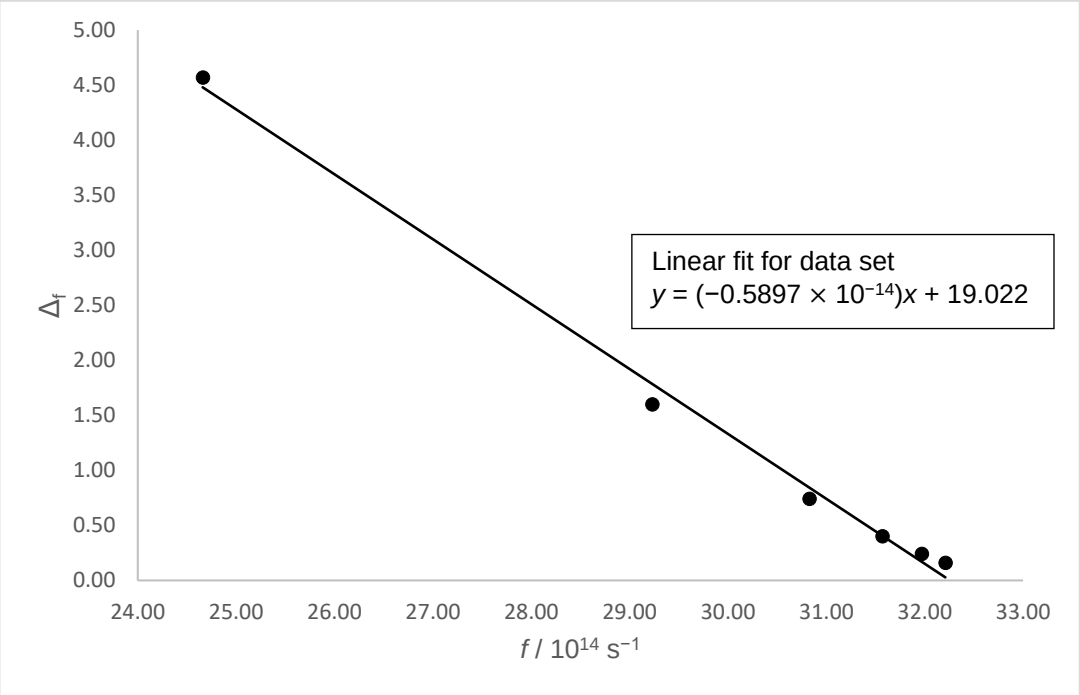
2. The frequencies, *f*, of the first six lines of the hydrogen emission spectrum which result from electronic transitions to the lowest energy level in the atom are given in the first column in the table below. The differences Δ_f between successive frequencies are given in the right hand column.

f / 10^{14} s^{-1}	Δ_f
24.66	4.57
29.23	1.60
30.83	0.74
31.57	0.40
31.97	0.24
32.21	0.16
32.37	

The graph of Δ_f (vertical axis) against *f* (horizontal axis) is plotted below.



(a) Using the linear fit for data set, calculate a value for the frequency when Δ_f is zero. [1]

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(This question continues on the following page)

(Question 2 continued)

(b) The frequency calculated when Δ_f is zero can be used to determine the ionisation energy of hydrogen using the following two steps.

Step 1:
Energy emitted due to the energy change in an atom can be calculated using $\Delta E = hf$ where h is 6.63×10^{-34} J s.

Step 2:
The energy emitted by 1 mole of atoms can be calculated using $E = (\Delta E)(L)$ where L is the Avogadro's constant.

Using the frequency calculated in part (b) and the two steps, calculate the ionisation energy of hydrogen. [2]

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3. A student is assigned the task of determining the number of moles of water in one mole of $MgCl_2 \cdot nH_2O$. The student collects the data shown in the following table.

Mass of empty container	22.347 g
Initial mass of sample and container	25.825 g
Mass of sample and container after first heating	23.982 g
Mass of sample and container after second heating	23.977 g
Mass of sample and container after third heating	23.977 g

(a) Explain why the student can correctly conclude that the hydrate was heated a sufficient number of times in the experiment. [1]

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(b) Determine the value of *n*. [3]

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(c) Another student heats the hydrate in an uncovered crucible, and some of the solid spatters out of the crucible. State and explain the effect it has on the value of *n*. [2]

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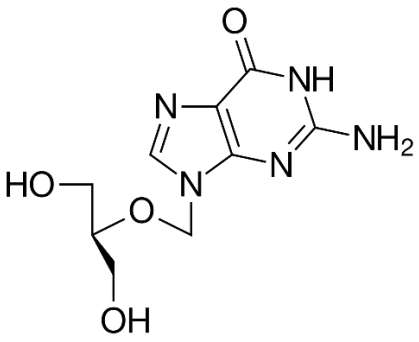
Section B

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

Option D – Medicinal chemistry

4. Ganiclovir and foscarnet are antiviral medications. Ganiclovir is used to treat or prevent infection by cytomegalovirus infections. It prevents replication of viral DNA. One of its side effects is anemia, a condition that develops when blood lacks healthy red blood cells. Ganciclovir and foscarnet show synergistic inhibition of cytomegalovirus.



Ganciclovir

(a) Identify four functional groups in Ganiclovir. [2]

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(b) Many drugs are taken orally. State **two** other methods of medicinal drugs administration and identify which method has the more rapid effect. [2]

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(Option D continues on the following page)

(Option D, question 4 continued)

(c) State what is meant by *synergistic effect*. [1]

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(d) State a reason why viral infections can be difficult to treat. [1]

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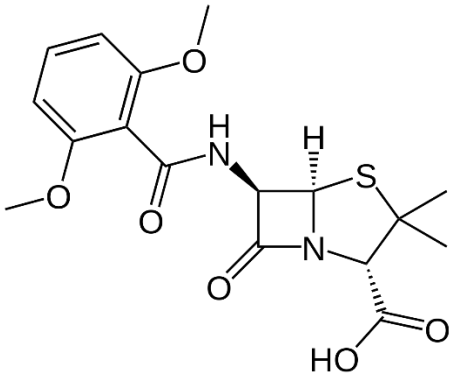
(Option D continues on the following page)

(Option D continued)

5. Methicillin was developed and introduced in 1959 to treat bacteria infections. It can only be administered by injection and has adverse side effects such as diarrhoea and allergic reactions. Now, some bacteria have developed a resistance to methicillin.



Methicillin

(a) State **two** reasons for chemically modifying the side−chain in methicillin. [2]

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(b) Describe the mode of action of methicillin in preventing the growth of bacteria. [2]

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(Option D continues on the following page)

(Option D, question 5 continued)

(c) State an effect of over−prescription of methicillin to humans. [1]

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6. The structures of some analgesics are shown on section 37 of the data booklet.

(a) Explain the difference in the method of action of mild analgesics and strong analgesics. [2]

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(b) Naturally occurring morphine can be converted into synthetic heroin by reaction with ethanoic anhydride.

(i) Identify the groups in the morphine molecule that reacts with ethanoic anhydride. [1]

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(ii) State the type of reaction. [1]

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(Option D continues on the following page)

(Option D, question 6 continued)

(c) For two comparable populations, the LD_{50} values (expressed as mg per kg body mass) for morphine and heroin are 20 and 4 respectively.

(i) Explain what is meant by the term LD_{50}. [2]

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(ii) Identify which of the two substances is more toxic. [1]

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(Option D continues on the following page)

(Option D continued)

7. (a) Outline how the drugs ranitidine (Zantac®) and omeprazole (Prilosec®) regulate acid secretion. [2]

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(b) 4.28 g of sodium ethanoate was added to 250 cm^3 of 0.50 mol dm^{-3} ethanoic acid solution. Calculate the pH of the resulting solution, using data from section 21 of the data booklet. [2]

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(Option D continues on the following page)

(Option D continued)

8. Actinium−225 is an alpha emitter used in targeted alpha therapy (TAT). In the process, actinium−225 undergoes a series of alpha decay to form bismuth−213.

(a) Deduce the nuclear equation for the decay of actinium−225 to form bismuth−213. [1]

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(b) Explain how TAT can be used for treating cancers that have spread around the body. [2]

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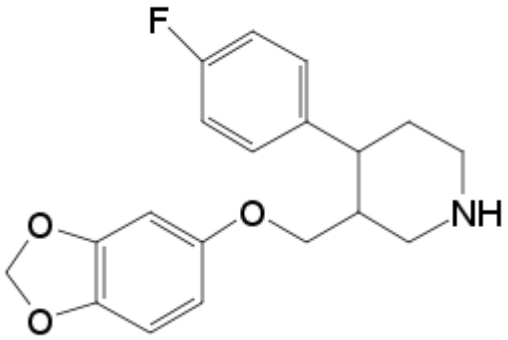
9. Paroxetine is a drug prescribed to people suffering from mental depression.



Paroxetine

(a) Identify the two chiral carbon atoms and mark them with an asterisk (*) in the above diagram. [1]

(Option D continues on the following page)

(Option D, question 9 continued)

(b) Describe the use of chiral auxillaries to synthesise the desired enantiomer of a drug. [2]

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10. Explain how anabolic steroids can be detected in athletes using gas chromatography and mass spectrometry. [2]

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End of Option D