# **Queenstown Secondary School**



## Preliminary Examination 2024 Secondary Four Normal (Academic) Science (Chemistry) 5105/04

30 July 2024 Tuesday Time: 1015 – 1130h Papers 3 and 4: 1 hour 15 minutes

Setter:

Additional Materials:

Candidates answer on the Question Paper. No Additional Materials are required.

## READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in. Write in dark blue or black pen. You may use an HB pencil for any diagrams or graphs. Do not use staples, paper clips, glue or correction fluid.

#### Section A

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

#### Section B

Answer **one** question. Write your answers in the spaces provided.

The use of an approved scientific calculator is expected, where appropriate.

In calculations, you should show all the steps in your working, giving your answer at each stage.

You are advised to spend no longer than 30 minutes on Paper 3.

You may proceed to answer Paper 4 as soon as you have completed Paper 3. A copy of the Periodic Table is printed on page 9.

At the end of the examination hand in your answers to Paper 3 and Paper 4 separately.

The number of marks is given in brackets [] at the end of each question or part question.

Examiner's Use							
Section A	/22						
Section B	/8						
TOTAL	/30						

#### **Section A**

Answer all questions.

**1** Fig. 1 shows the apparatus that is used to fractionally distill petroleum into different fractions.





- (a) (i) Name the physical property that allows the fractions to be separated.
   The fractions are miscible liquids with different boiling points.
  - (ii) State why the fractions condense in the condenser.

The fractions have a lower boiling pointthan the water in the[1]

condenser.

- (b) The petrol fraction has a boiling point range of 35°C to 70°C.
  - (i) Explain why the petrol fraction is collected over a range of temperatures rather than at a single temperature.

The petrol fraction is a mixture.

[1]

(ii) Explain what happens when a liquid boils. Your answer should explain boiling in terms of the kinetic particle theory and of the energy changes involved.
When a liquid boils, it gains energy. [1]
During boiling, the particles move further apart, from being close [1]
together [liquid] to far apart [gas]. [arrangement]
During boiling, the particles move faster, from sliding over each [1]
other [liquid] to moving randomly [gas]. [movement]

[Total: 6]

2 A student carries out an experiment to study the reaction between dilute

hydrochloric acid, HCl, and excess magnesium carbonate, MgCO<sub>3</sub>.

The carbon dioxide gas produced in this experiment is collected and its volume is measured at one-minute intervals.

The results obtained from the experiment are shown in the table below.

#### Table 2

time / min	0	1	2	3	4	5	6	7	8	9
volume of carbon dioxide / cm <sup>3</sup>	0	15	20	29	33	37	39	40	40	40

(a) (i) Name the apparatus used to measure the volume of gas collected.

#### gas syringe

(ii) Describe a positive test to identify the gas.

test Deliver the gas into limewater.

[1]

(iii) Write a balanced chemical equation for the reaction between dilute hydrochloric acid and magnesium carbonate.

 $\underline{2HCl + MgCO_3 \rightarrow MgCl_2 + H_2O + CO_2}$ 

[1]

(b) At the start of the experiment there is 29.4 g of magnesium carbonate.

Calculate the amount of magnesium carbonate, in moles.

[relative atomic masses, Ar: Mg, 24; C, 12; O, 16]

no. of mol. of  $MgCO_3 = 29.4 \text{ g} \div 84 = 0.35 \text{ mol}$ 

amount of magnesium carbonate = 0.35 mol [1]

(c) Plot a graph of these results, marking each point with a cross (x).

Draw a best-fit curve taking into account all the plotted points.



(d) Suggest why the volume of gas stops increasing after 7 minutes.

All the hydrochloric acid had fully reacted.

[1]

[Total: 7]

3 The table shows some information about the elements in Group 1 of the Periodic Table.

element	atomic number	melting point / °C	density in g / cm <sup>3</sup>
lithium	3	180	0.53
sodium	11	98	0.97
potassium	19	63	0.89
rubidium	37	39	1.53
caesium	55		

Та	bl	е	3
10		<b>U</b>	<b>U</b>

(a) (i) Explain why the elements are in Group 1 of the Periodic Table.

The atoms of these elements contain <u>1 outer (valence) electron</u>. [1]

(ii) Explain why potassium is in period 4 of the Periodic Table.

The atom of	potassium occu	ipies 4 electron s	hells.	11
	polassiam occa	$\frac{1}{4}$		·١.

## (b) (i) Describe **one** observation when a piece of sodium is added to water.

The piece of sodium <u>darts around the surface</u> of water. [1]

(ii) Describe what you would observe when a few drops of Universal Indicator are added to the reaction mixture.

(iii) Write a balanced chemical equation for the reaction between sodium and water.

 $\frac{2Na + 2H_2O \rightarrow 2NaOH + H_2}{2}$ 

[1]

[Total: 5]

4 Vegetable oil can be converted to margarine in the industries.

There are several types of polyunsaturated fatty acids in vegetable oils that can be made into margarine.

The structure shown below is linoleic acid, a common acid found in vegetable oils.





(a)	Explain, with reference to its structure, why linoleic acid is polyunsaturated.	
	It contains <u>many C=C double bonds</u> .	[1]

#### (b) (i) Name the reagent required to convert vegetable oil to margarine.

	<u>hydrogen</u>	[1]
(ii)	Describe a simple test to distinguish between a sample of	
	polyunsaturated vegetable oil and a sample of saturated margarine.	
	test Deliver aqueous bromine into both samples.	[1]
	result with vegetable oil The red-brown aqueous bromine turns	
	<u>colourless</u> immediately.	
	result with margarine No visible reaction.	[1]

[Total: 4]

#### Section B

Answer **one** question from this section.

- 1 The most common isotope of carbon in carbon dioxide is  ${}^{12}_{6}$  C.
  - (a) Define the term isotopes.

Isotopes are <u>atoms of the same element</u> with the <u>same number of</u> protons but <u>different number of neutrons</u>.

(b) Another isotope of carbon has the symbol  ${}^{13}_{6}$  C.

Determine the number of sub-atomic particles in one atom of  ${}^{13}_{6}$  C.

number of protons = <u>6</u>

number of neutrons = 13 - 6 = 7 <sup>[1]</sup>

- (c) Ethene burns completely in oxygen to produce carbon dioxide, CO<sub>2</sub>.
  - Complete and balance the equation for the complete combustion of ethene.

$$C_2H_4 + \underline{3}O_2 \rightarrow \underline{2}CO_2 + \underline{2H_2O}$$
 [2]

 $1m - for correct formula of H_2O$ 

#### 1m – for correct balancing

(ii) Draw a 'dot and cross' diagram to show the bonding in one molecule of carbon dioxide, CO<sub>2</sub>. Show only outer shell electrons.

[covalent; O=C=O]

[2]

[1]

- (d) Carbon monoxide, CO, is an atmospheric pollutant.
  - (i) Explain how carbon monoxide is formed.
     It is formed from the incomplete combustion of fuel in cars. [1]
  - (ii) Describe the effect of carbon monoxide on health.

When inhaled, the CO combines with <u>haemoglobin</u>, causing thebody to be <u>starved of oxygen</u>, leading to <u>death</u>.[1]

[Total: 8]

- 2 Calcium is an element found in Group 2 of the Periodic Table.
  - (a) Calcium and steam are reacted.

The incomplete equation for the reaction is shown.

calcium + steam  $\rightarrow$  solid X + hydrogen

(i) Name solid X.

calcium oxide

(ii) State and explain whether solid X is an acidic or basic compound.
 type of compound basic

explanation Calcium is a <u>metal</u>, which forms a <u>basic oxide</u>. [1]

(b) Calcium reacts with dilute hydrochloric acid to form calcium chloride, CaCl<sub>2</sub>.

Ca (s) + 2HCl (aq)  $\rightarrow$  CaCl<sub>2</sub> (aq) + H<sub>2</sub> (g)

- (i) Draw a 'dot and cross' diagram to show the arrangement of electrons in calcium chloride. Show only outer shell electrons.
   ionic; [Ca]<sup>2+</sup> 2[C/]<sup>-</sup>
- [2]

[1]

(ii) Explain, in terms of bonding and structure, why solid calcium chloride cannot electricity but aqueous calcium chloride can conduct electricity.
In the solid state, the ions are held rigidly in fixed positions. [1]
The absence of mobile ions prevents the electric current from being carried.
In the aqueous state, the presence of mobile ions allows the [1]

electric current to be carried.

(iii) Calculate the mass of calcium needed to produce 500 g of CaCl<sub>2</sub>. Show your working clearly.

	Ca (s) + 2HC <i>l</i> (aq) +	→ CaCl₂ (aq) + H₂ (g)	
Fr. Eqn.	.: 1	1	
Given	: ? g	500 g	
<b>A</b> r / <b>M</b> r :	: 40	111	
	4.5045 mol	4.5045 mol	[1]
mass of	f calcium = 4.5045 mol x	(40 = 180 g (3 s.f.))	[1]

mass of calcium = 4.5045 mol x 40 = 180 g (3 s.f.)

mass of calcium =  $\frac{180}{9}$  g

[Total: 8]

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The Periodic Table of Elements

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).

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