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CATHOLIC HIGH SCHOOL
End-of-Year Examination
Secondary 3 (O-Level Programme)

B

CHEMISTRY

2 October 2024
2 hours 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class 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 B

Answer **all** questions.

Write your answers in the spaces provided.

For examiner's use only:

Total	/ 60
working / units / significant figures	☐ –1 if checked

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

A copy of the Periodic Table is printed on page 8 of Section C.

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

A maximum of 1 mark will be deducted from your total mark for failure to show your working in calculations and misuse of units and/or significant figures, i.e. failure to quote units where necessary, the inclusion of units in quantities defined as ratios or quoting answers to an inappropriate number of significant figures.

Section B

Answer **all** questions

- 1 The names of nine gases are given in the following list.

ammonia
argon
helium
hydrogen
neon
nitrogen monoxide
oxygen
steam
sulfur dioxide

Choose gases from the list to answer the questions.

Each gas may be used once, more than once or not at all.

Which gas

- (a) relights a glowing splint?

..... [1]

- (b) reacts with sodium hydroxide in a neutralisation reaction?

..... [1]

- (c) turns aqueous acidified potassium manganate(VII) from purple to colourless?

..... [1]

- (d) is a compound made up of diatomic molecules?

..... [1]

- (e) is monoatomic and has the electronic configuration 2,8,8?

..... [1]

[Total: 5]

- 2 **Z** is a covalent substance. In an experiment, a sample of pure solid **Z** was continuously heated for 9 minutes.

Fig. 2.1 shows how the temperature of the sample of pure **Z** changed over time.

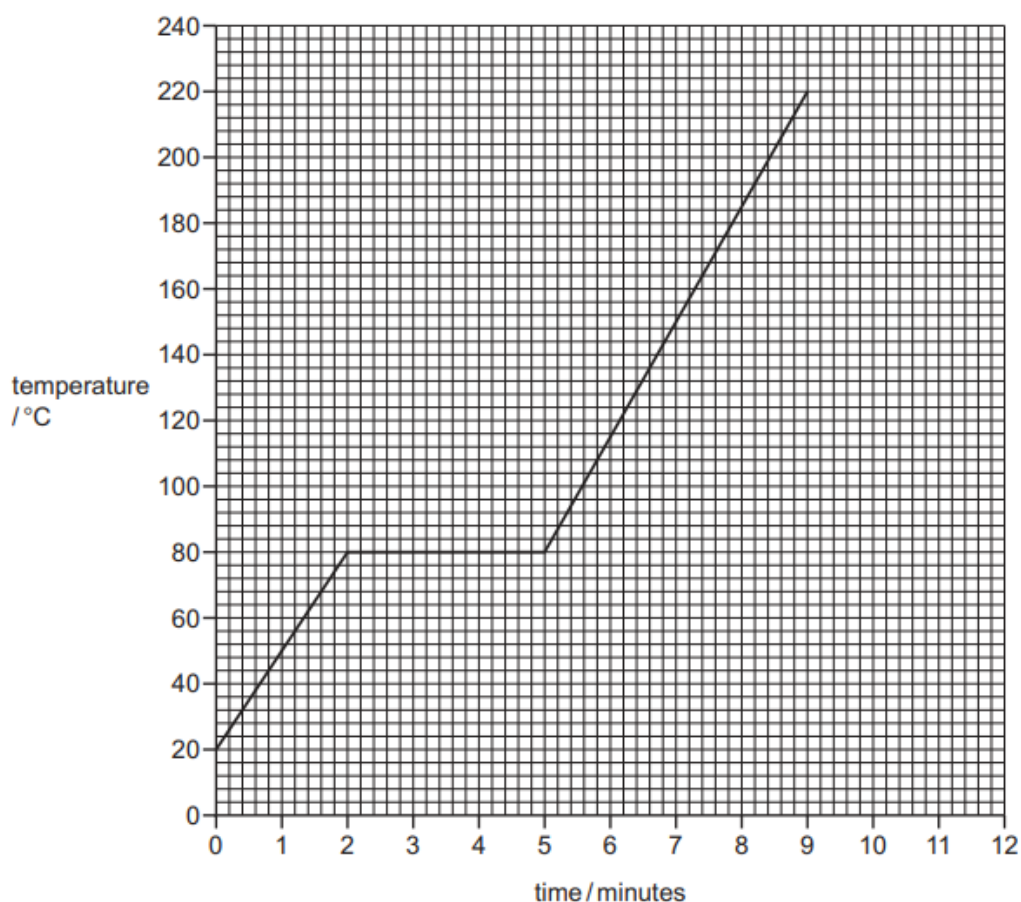


Fig. 2.1

- (a) What is the melting point of pure **Z**?

.....°C [1]

- (b) The sample of pure **Z** was continuously heated between 2 minutes and 5 minutes.

Explain, in terms of attractive forces, why there was no increase in the temperature of the sample of pure **Z** between 2 minutes and 5 minutes.

.....
 [1]

- (c) Describe how the movement of particles of pure **Z** changed from 0 to 2 minutes.

.....

 [2]

[Total: 4]

[Turn Over]

- 3 Fig. 3.1 shows the structures of two different forms of carbon, **P** and **Q**.

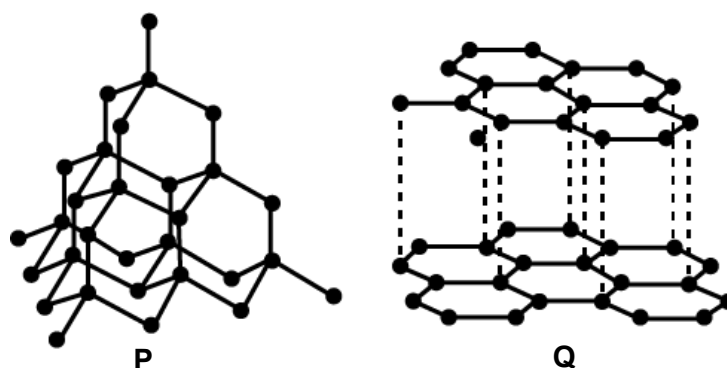


Fig. 3.1

- (a) Put a tick in **one** box in each row to show which statements about **P** and **Q** are **true** and which are **false**.

	true	false
P has a giant covalent structure, but Q has a simple molecular structure.		
P is used to coat drill bits while Q is used as a lubricant.		
The atoms in both P and Q have the electronic configuration of a noble gas.		
Both P and Q are elements.		
Both P and Q have high melting points.		

[3]

- (b) Carbon can be reacted with boron to form compound **R**.
A sample of **R** was found to contain 78.6% boron by mass.

Deduce the empirical formula of **R**.
Show your working.

[3]

[Total: 6]

4 Carbon monoxide is a toxic gas.

Fig. 4.1 shows a carbon monoxide detector that can be used at home to alert residents of its presence.

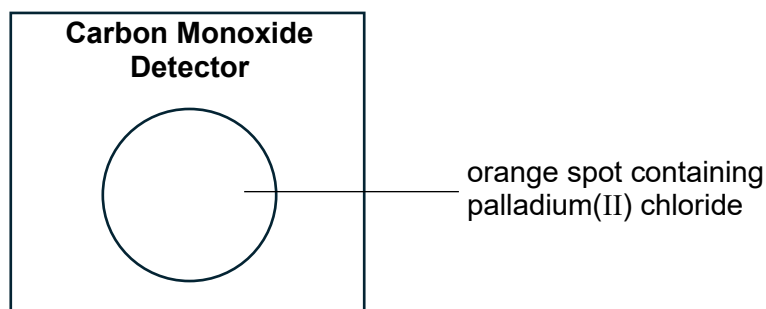
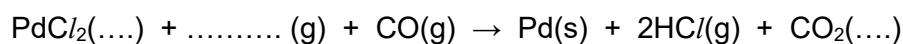


Fig. 4.1

The orange spot turns black if there is a high concentration of carbon monoxide in the air.

The spot turns black when solid palladium(II) chloride reacts with carbon monoxide and another substance to form palladium metal.



(a) Complete the above equation by filling in the blanks. [2]

(b) (i) Complete Table 4.1 to show the oxidation states of palladium and carbon before and after the reaction.

Table 4.1

element	oxidation state before the reaction	oxidation state after the reaction
palladium		
carbon		

[2]

(ii) Use your answers in (b)(i) to explain why this is a redox reaction.

.....

 [2]

(c) Name the chlorine-containing compound formed in the reaction.

..... [1]

- (d) The CO molecule does **not** completely follow normal bonding rules, although both atoms in the molecule have a stable octet electron arrangement.

Complete the 'dot-and-cross' diagram in Fig. 4.2 to show the bonding in a molecule of CO. Some of the outer electrons of oxygen have been filled in for you.

Show outer electrons only.

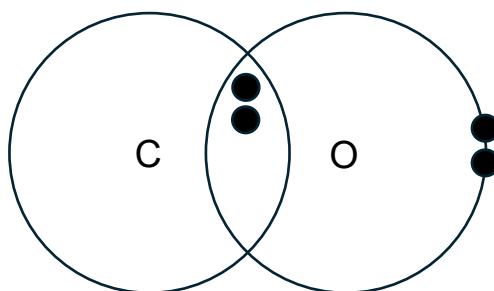


Fig. 4.2

[2]

[Total: 9]

5 Flerovium, Fl, atomic number 114, was first made in research laboratories in 1998.

- (a) With reference to the Periodic Table, deduce the number of outer electrons in an atom of flerovium.

..... [1]

- (b) Two isotopes of flerovium are ^{286}Fl and ^{289}Fl .

- (i) Define the term *isotope*.

..... [1]

- (ii) Complete Table 5.1 to show the number of protons, neutrons and electrons in the isotopes shown.

Table 5.1

isotope	number of protons	number of neutrons	number of electrons
^{286}Fl			
^{289}Fl			

[2]

- (c) It has been suggested that flerovium is a typical metal.

Predict whether flerovium will have a higher or lower melting point than oxygen.

Explain your answer in terms of bonding and structure.

.....

 [3]

[Total: 7]

6 Hydrochloric acid and sulfuric acid can be used to make salts.

(a) Table 6.1 shows information about the preparation of pure samples of solid salts.

Complete the table by filling in the missing information.

Table 6.1

name of salt	names of reagents used	method used to prepare salt	method used to obtain solid product from the reaction mixture
potassium chloride	reagent 1: dilute hydrochloric acid reagent 2:		crystallisation
lead(II) sulfate	reagent 1: dilute sulfuric acid reagent 2:	precipitation	

[4]

(b) When excess magnesium was added to a sample of dilute hydrochloric acid, 20 cm³ of hydrogen gas was produced.

In another experiment, excess magnesium was added to a sample of dilute sulfuric acid of the same volume and concentration.

Predict the volume of hydrogen gas produced and explain your reasoning.

.....

.....

.....

..... [2]

- (c) Hydrochloric acid contains chloride ions.

Draw a 'dot-and-cross' diagram to show the arrangement of outer electrons in a chloride ion.

[1]

[Total: 7]

- 7 Antacids are medications that are primarily used to neutralise stomach acidity. A common compound used as antacid is magnesium hydroxide, $\text{Mg}(\text{OH})_2$. Magnesium hydroxide is a base that is slightly soluble in water.

25.0 cm³ of a saturated solution of magnesium hydroxide required 27.60 cm³ of 0.220 mol/dm³ dilute hydrochloric acid for complete neutralisation.

- (a) (i) Write a balanced chemical equation for the reaction between magnesium hydroxide and dilute hydrochloric acid.

..... [1]

- (ii) Using your equation in (a)(i), calculate the concentration, in mol/dm³, of the saturated magnesium hydroxide solution.

[2]

- (b) Calculate the mass of magnesium hydroxide dissolved in 1.00 dm³ of the saturated magnesium hydroxide solution.

[1]

- (c) Given that a 10.0 g tablet of antacid contains 100% magnesium hydroxide by mass, calculate the minimum volume of water needed to fully dissolve the tablet.

[1]

[Total: 5]

- 8 Fig. 8.1 describes some of the substances that result from chemical reactions of a powdered mixture of compound **A** and a metal **B**.

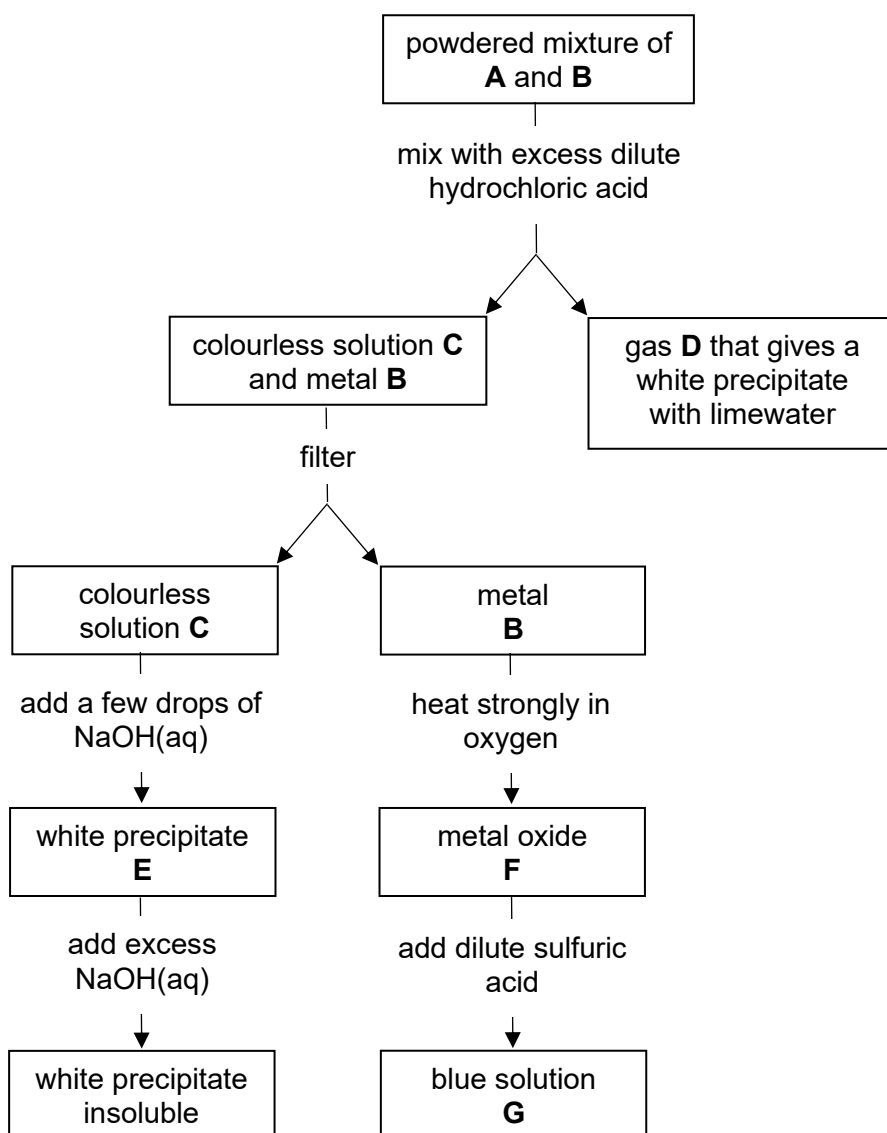


Fig. 8.1

- (a) Identify **A**, **C**, **D** and **E**

A

C

D

E

[4]

- (b) Write an ionic equation for the formation of precipitate **E**. Include state symbols.

..... [1]

- (c) A student adds aqueous barium nitrate and aqueous silver nitrate to separate samples of solution **C**.

Describe what would be observed.

aqueous barium nitrate

aqueous silver nitrate [2]

- (d) (i) Suggest the identity of metal **B**.

..... [1]

- (ii) Metal **B** reacts with oxygen to form metal oxide **F**.

State the reducing agent in the reaction.

Explain your answer in terms of **electron transfer**.

.....

..... [1]

[Total: 9]

- 9 Read the information about the chlorides of elements in Period 3 of the Periodic Table.

Elements and their chlorides

The formulae and chemical properties of the chlorides of the elements change across Period 3.

The chlorides behave differently when they are added to water. Some of the chlorides dissolve in water to form a solution. Some hydrolyse when they are added to water. This means that they react chemically with water to produce new products.

Table 9.1

element	metal / non-metal	formula of main chloride	bonding in chloride	effect of adding chloride to water	products of adding chloride to water
Na	metal	NaCl	ionic	dissolves	NaCl(aq)
Mg	metal	MgCl ₂	ionic	dissolves	MgCl ₂ (aq)
Al	metal	AlCl ₃	covalent	hydrolyses	complex mixture of products including HCl(aq)
Si	non-metal	SiCl ₄	covalent	hydrolyses	SiO ₂ (s) HCl(aq)
P	non-metal	PCl ₃	covalent	hydrolyses	H ₃ PO ₃ (aq) HCl(aq)
S	non-metal		covalent	hydrolyses	complex mixture of products including HCl(aq)
Cl	non-metal	Cl ₂	covalent	hydrolyses	HOCl(aq) HCl(aq)

- (a) Predict the formula of the main chloride of sulfur.

..... [1]

- (b) (i) Which chloride forms a precipitate when it is added to water?

..... [1]

- (ii) Write a balanced equation for the reaction of PCl₃ with water.

..... [1]

- (c) Two students talk about the data.

Student 1: 'I think that whether or not the chloride hydrolyses is linked to the metal or non-metal character of the element.'

Student 2: 'I think that whether or not the chloride hydrolyses is linked to the bonding in the chloride.'

Does the information in Table 9.1 support the ideas of the students?

Explain your reasoning.

.....

.....

.....

.....

.....

..... [3]

- (d) Another student performs an experiment to test whether some other chlorides dissolve or hydrolyse when they are added to water.

He adds each chloride to water and tests the pH of the mixture.

Explain how the result of a pH test shows whether or not a chloride has hydrolysed.

.....

.....

.....

..... [2]

[Total: 8]

– End of Section B –

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