Cambridge Assessment International Education

Example Responses – Paper 3

Cambridge IGCSE™ / IGCSE (9–1) Chemistry 0620 / 0971

For examination from 2023

Cambridge Pathway

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge IGCSE / IGCSE (9-1) Chemistry 0620 / 0971.

This booklet contains responses to all questions from June 2023 Paper 31, which have been written by a Cambridge examiner. Responses are accompanied by a brief commentary highlighting common errors and misconceptions where they are relevant.

The question papers and mark schemes are available to download from the School Support Hub

0620 / 0971 June 2023 Question Paper 31

0620 / 0971 June 2023 Mark Scheme 31

Past exam resources and other teaching and learning resources are available from the School Support Hub

Question 1

1 Fig. 1.1 shows part of the Periodic Table.

I	II										III	IV	V	VI	VII	VIII
							H									He
												C	N	O		
Na	Mg										Al				Cl	
K	Ca						Fe			Cu					Br	
															I	

Fig. 1.1

Answer the following questions using only the elements in Fig. 1.1.
Each symbol of the element may be used once, more than once or not at all.

Give the symbol of the element that:

(a) forms 78% by volume of clean, dry air

N ..... [1]

(b) has an atom with a complete outer electron shell

He ..... [1]

(c) has an atom with five occupied electron shells

I ..... [1]

Examiner comment

Candidates confused the number of occupied electron shells with the group number and suggested nitrogen, N.

(d) forms an ion with a charge of 2–

O ..... [1]

Examiner comment

Many candidates confused the charge and group number and suggested magnesium, Mg, or calcium, Ca.

(e) forms an ion that gives a green precipitate on addition of aqueous sodium hydroxide

Fe ..... [1]

Examiner comment

The common error was candidates were confused with the green of chlorine gas and gave Cu.

(f) is used in food containers because of its resistance to corrosion.

Al ..... [1]

Examiner comment

(a), **(b)** and **(f)** were most commonly correct.

Question 2

2 **(a)** Table 2.1 shows some properties of the halogens.

Table 2.1

halogen	melting point in °C	boiling point in °C	density at room temperature and pressure in g/cm^3
fluorine	–220	–188	0.0016
chlorine	–101	–35	0.0032
bromine		+59	3.1
iodine	+114	+184	

Use the information in Table 2.1 to predict:

(i) the melting point of bromine

60 ..... [1]

Examiner comment

The common error made by many candidates was not to use the boiling point information and failing to realise that the melting point must be lower than the boiling point. Predictions of the melting point were frequently much too high. The correct answer was any value between –100° C and +58° C (inclusive).

(ii) the density of iodine at room temperature and pressure

5.2 ..... [1]

Examiner comment

The correct answer was any value between 3.20 and 10.0 (inclusive).

(iii) the physical state of chlorine at –10 °C. Give a reason for your answer.

physical state gaseous .....

reason –10° C is above chlorine's boiling point .....

.....

[2]

Examiner comment

The common error in the explanation was to simply state the boiling point of chlorine without reference to –10°C.

(b) The equation for the reaction of aqueous chlorine with aqueous potassium iodide is shown.

$$Cl_2 + 2KI \rightarrow I_2 + 2KCl$$

(i) Choose the word which best describes this type of chemical reaction.
Draw a circle around your chosen answer.

addition **displacement** **neutralisation** **polymerisation** [1]

Examiner comment

The most common incorrect answer was 'neutralisation'. The correct answer was 'displacement' and was well known.

(ii) Explain why aqueous iodine does **not** react with aqueous potassium chloride.

chlorine is more reactive than iodine ..... [1]

Examiner comment

Common errors were:

- 'chlorine is more reactive than potassium iodide'
- 'chlorine is more reactive'. This was too vague – more reactive than what?

(c) Complete the diagram in Fig. 2.1 to show the electronic configuration of a chlorine atom.

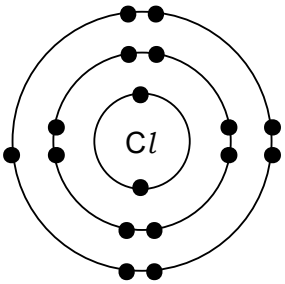


Fig. 2.1

[1]

Examiner comment

The common incorrect answer was to give the electron configuration of the ion, ie 2 : 8 : 8.

(d) Describe a test for chlorine.

test damp litmus .....

observations is bleached .....

[2]

Examiner comment

The most common error was to confuse this test with the test for chloride ions and to use aqueous silver nitrate to produce a white precipitate.

Question 3

3 **(a)** Water from natural sources contains dissolved gases.

Choose from the list, the gas that is essential for aquatic life.
Draw a circle around your chosen answer.

argon **hydrogen** **nitrogen** **oxygen** [1]

Examiner comment

The most common incorrect answer was 'hydrogen'.

(b) Polluted water may contain harmful substances such as metal compounds, plastics, nitrates and phosphates.

(i) Name one **other** harmful substance which is present in polluted water.

sewage ..... [1]

Examiner comment

The most common incorrect answers showed some confusion of water pollutants with air pollutants as gases such as carbon monoxide or methane were commonly seen. The expected correct answer from section 10.1.6 of the syllabus was 'sewage' or 'microbes', but any sensible alternative harmful pollutant of water response would have been awarded marks.

(ii) State why nitrates are harmful to aquatic life.

nitrates remove oxygen from water ..... [1]

Examiner comment

The most common incorrect answers were to state that 'it kills fish' or that 'it's toxic', which were both insufficient.

(c) Table 3.1 shows the masses of ions, in mg, present in a 1000 cm^3 sample of polluted water.

Table 3.1

name of ion	formula of ion	mass of ion present in mg / 1000 cm^3 of polluted water
	NH_4^+	0.5
calcium	Ca^{2+}	2.2
chloride	Cl^-	2.5
hydrogencarbonate	HCO_3^-	12.0
magnesium	Mg^{2+}	0.8
nitrate	NO_3^-	0.4
potassium	K^+	8.3
silicate	SiO_3^{2-}	8.0
sodium	Na^+	10.2
sulfate	SO_4^{2-}	0.2
tin(II)	Sn^{2+}	0.4

Answer these questions using information from Table 3.1.

(i) Name the negative ion present in the highest concentration.

hydrogencarbonate ..... [1]

Examiner comment

The most common incorrect answer was 'silicate'.

(ii) State the name of the NH_4^+ ion.

ammonium ..... [1]

Examiner comment

The most common errors were: ammoni**a**; ammon**iam**; nitrogen hydroxide; nitrate.

(iii) Calculate the mass of calcium ions present in 200 cm^3 of polluted water.

mass = 0.44 mg [1]

Examiner comment

Some candidates gaves answers that were out by factors of 10 e.g. 4.4 or 44.

(d) Copper(II) sulfate can be used to test for the presence of water.

$$CuSO_4(s) + 5H_2O(l) \rightleftharpoons CuSO_4 \cdot 5H_2O(s)$$

anhydrous copper(II) sulfate — hydrated copper(II) sulfate

(i) State the meaning of the term hydrated.

a substance that is chemically combined with water [1]

Examiner comment

The common incorrect responses included:

- confusing hydration with hydrogenation
- confusing hydration with dissolving in aqueous solution
- or statements such as 'it contains water' which is too vague.

(ii) Describe how hydrated copper(II) sulfate is changed to anhydrous copper(II) sulfate.

heat it [1]

Examiner comment

Common incorrect responses included descriptions of what that heating did, e.g. 'remove the water' or 'evaporate water'.

(e) Complete the symbol equation for the reaction of sodium with water.

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$ [2]

Examiner comment

The most common error was to suggest 2H rather than H_2 as the product.

Question 4

4 This question is about sulfur and compounds of sulfur.

(a) Sulfur has several isotopes.

Define the term isotopes.

an atom with the same number of protons but with a different number of neutrons [2]

Examiner comment

- The common error in M1 was not to apply the definition of the atomic level and phrases such as '**elements** with the same number of protons' were not awarded marks.
- The common error in M2 was not to state that isotopes of the same element have 'different numbers of neutrons' not that they have 'different neutrons'.

(b) Deduce the number of protons, neutrons and electrons in the sulfide ion shown.

$^{36}_{16}S^{2-}$

number of protons 16

number of neutrons 20

number of electrons 18

[3]

Examiner comment

The most common error was to assume the ion was an atom and 16 electrons was frequently seen.

(c) Sulfur burns in oxygen to produce sulfur dioxide.

Fig. 4.1 shows an incomplete reaction pathway diagram for this reaction.

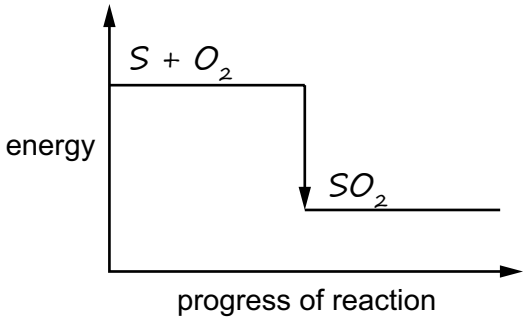


Fig. 4.1

(i) Complete Fig. 4.1 by writing these formulae on the diagram:
- S + O_2
- SO_2. [1]

Examiner comment

The common error was to transpose the reactants and products.

(ii) Explain how Fig. 4.1 shows that the reaction is exothermic.

the energy of the reactants is greater than the energy of the products

..... [1]

Examiner comment

The common error here was not to address the question which asked how the energy level diagram showed the reaction was exothermic, so any response which did not mention the relative positions of the energy levels was not awarded any marks. Typical responses such as this included 'the reaction gives out energy'.

(iii) Complete this sentence about an exothermic reaction using a word from the list.

products **reactants** **sulfur** **surroundings**

An exothermic reaction transfers thermal energy to the surroundings . [1]

Examiner comment

The most common incorrect answer was 'products'. Nearly all candidates correctly wrote 'surroundings' as the answer.

(d) Fig. 4.2 shows the apparatus used for the electrolysis of dilute sulfuric acid using graphite electrodes.

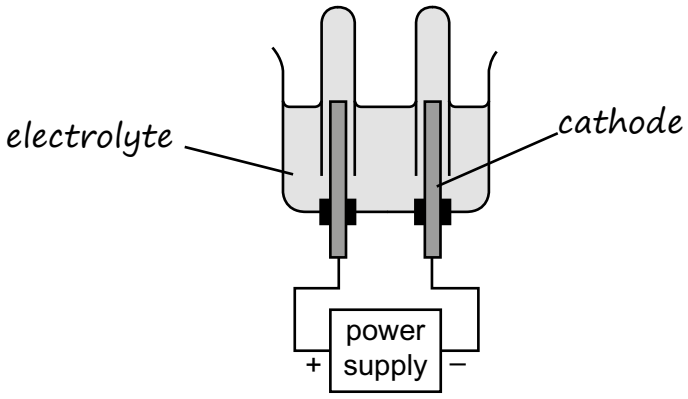


Fig. 4.2

(i) Label Fig. 4.2 to show:
- the cathode
- the electrolyte. [2]

Examiner comment

- The common error for both marks was to use 'vague' arrows which did not actually 'touch' their targets.
- The electrolyte arrow frequently hit the outside wall of the container and the cathode arrow often hit the wiring below the graphite electrode.

(ii) Name the products and state the observations at the positive and negative electrodes.

product at the positive electrode

oxygen

observations at the positive electrode

bubbles

product at the negative electrode

hydrogen

observations at the negative electrode

bubbles

[4]

Examiner comment

The most common error was to name sulfur as the product at the anode, or to switch hydrogen and oxygen around as products.

(e) Complete the word equation for the reaction of dilute sulfuric acid with sodium carbonate.

sulfuric acid	+	sodium carbonate	→	sodium sulfate	+	carbon dioxide	+	water

[3]

Examiner comment

- The most common error was to give 'hydrogen' in place of carbon dioxide or water.
- Some candidates were not awarded any marks as they wrote symbols instead of words.

(f) A few drops of thymolphthalein indicator are added to dilute sulfuric acid.

State the colour of the solution.

colourless [1]

Examiner comment

The most common error was 'red', presumably as a result of confusion with methyl orange.

Question 5

5 This question is about metals.

(a) Iron is a transition element. Potassium is an element in Group I of the Periodic Table.

State **two** differences in the physical properties of iron compared to potassium.

1 *iron has a higher melting point*

2 *iron is stronger*

[2]

Examiner comment

- Common errors were to give chemical differences or to confuse the properties of the metals and so to describe potassium as being hard or having a high melting point.
- Some candidates described physical properties associated with both metals such as 'iron conducts electricity'.

(b) Carbon is used to extract iron from iron ore in a blast furnace.

State **two** uses of carbon in the extraction process.

1 *to provide heat*

2 *to produce carbon dioxide*

[2]

Examiner comment

The most common error was to call carbon a catalyst.

(c) Steel is an alloy of iron.

(i) State the meaning of the term alloy.

a mixture of a metal with another element

[1]

Examiner comment

The common error was to omit the word 'mixture' or to use the word 'compound' in its place.

(ii) State why alloys are more useful than pure metals.

alloys are more resistant to corrosion ..... [1]

Examiner comment

Some candidates suggested a property which was common to both metals and alloys, such as 'it is malleable' or 'it conducts electricity'.

(d) Table 5.1 shows the observations made when four different metals react with dilute hydrochloric acid of the same concentration.

Table 5.1

metal	observations
iron	bubbles form slowly
lead	no bubbles formed
magnesium	bubbles form rapidly
nickel	bubbles form very slowly

Put the four metals in order of their reactivity.
Put the least reactive metal first.

least reactive → most reactive

lead	nickel	iron	magnesium

[2]

Examiner comment

Some candidates reversed the order of the metals.

Question 6

6 **(a)** A student investigates the reaction of small pieces of zinc of the same mass and size with three different concentrations of dilute hydrochloric acid in the presence of a catalyst.

The three concentrations of dilute hydrochloric acid are:

- 1.0 mol / dm^3
- 1.5 mol / dm^3
- 2.0 mol / dm^3.

All other conditions stay the same.

Table 6.1 shows the time taken for each reaction to finish.

Table 6.1

concentration of hydrochloric acid in mol / dm^3	time taken for the reaction to finish in s
1.0	200
2.0	100
1.5	150

(i) Complete Table 6.1 by writing the concentrations of hydrochloric acid in the first column. [1]

Examiner comment

Some candidates made the ratios of concentrations equivalent to ratios of times, e.g:

- 2.0
- 1.0
- 1.5.

(ii) Describe the effect on the time taken for the zinc to finish reacting with 2.0 mol / dm^3 hydrochloric acid with no catalyst present.

All other conditions stay the same.

time increases ..... [1]

Examiner comment

Some candidates stated that the 'rate decreases', but without reference to time.

(iii) Describe the effect on the time taken for the zinc to finish reacting with 2.0 mol / dm^3 hydrochloric acid when the surface area of the zinc is increased.

All other conditions stay the same.

time decreases [1]

Examiner comment

The common error was to state 'rate increases' without reference to time.

(b) Crystals of zinc chloride can be prepared by reacting excess zinc with dilute hydrochloric acid.

Choose from the list, the method used to separate the unreacted zinc from the reaction mixture.

Draw a circle around your chosen answer.

chromatography **crystallisation** **evaporation** **filtration** [1]

Examiner comment

The most common incorrect answer was 'crystallisation'.

(c) Zinc chloride is soluble in water.

Choose one **other** compound that is soluble in water.

Tick (✓) **one** box.

calcium carbonate	
lead(II) chloride	
silver chloride	
sodium nitrate	✓

[1]

Examiner comment

The most common incorrect answer was 'silver chloride'.

Question 7

7 **(a)** Fig. 7.1 shows the displayed formula of mesaconic acid.

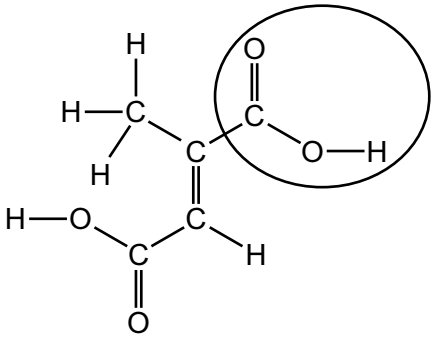
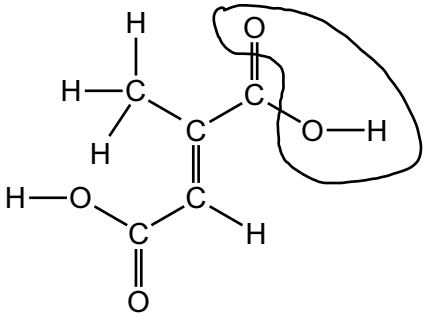


Fig. 7.1

(i) On Fig. 7.1 draw a circle around **one** carboxylic acid functional group. [1]

Examiner comment

Some candidates did not ensure that all four atoms were clearly inside the circle drawn. See below:



(ii) Deduce the molecular formula of mesaconic acid.

$C_5H_6O_4$ [1]

Examiner comment

The common error was to write the ratio of atoms non-subscript form, i.e. C5H6O4.

(iii) Mesaconic acid is a colourless compound.

Describe the colour change when excess mesaconic acid is added to aqueous bromine.

from orange to colourless [2]

Examiner comment

The common error was to reverse the order of the colour change.

(b) Ethanoic acid belongs to the homologous series of carboxylic acids.

Define the term homologous series.

compounds with similar chemical properties and have the same functional group [2]

Examiner comment

- The common error in M1 was to omit to refer to 'compounds'.
- The common error in M2 was to omit to suggest they shared a similar functional group.

(c) Complete the word equation for the reaction of ethanoic acid with magnesium.

ethanoic acid	+	magnesium	→	*magnesium ethanoate*	+	*hydrogen*

[2]

Examiner comment

Common errors were:

- misspellings for ethanoate such as 'ethanate' or 'ethanoic'
- writing 'water' instead of 'hydrogen'.

(d) Ethanoic acid reacts with ethanol.
The organic product has the molecular formula $C_4H_8O_2$.

Complete Table 7.1 to calculate the relative molecular mass of $C_4H_8O_2$.

Table 7.1

atom	number of atoms	relative atomic mass	
carbon	4	12	4 × 12 = 48
hydrogen	1	1	8
oxygen	2	16	16

relative molecular mass = ...88..... [2]

Examiner comment

- Common errors were wrong number of H and C atoms used (often H = 1 and O = 8 to give 177).
- One mark was awarded for either 32 as being the mass of O atoms or 8 as being mass of H atoms.

(e) Ethanol can be manufactured by fermentation.

Complete the word equation for one **other** method of manufacturing ethanol.

.....ethene..... + ...water..... → ethanol [2]

Examiner comment

The most common error was to give 'glucose' and 'yeast'.

Question 8

8 This question is about nitrogen and compounds of nitrogen.

(a) Nitrogen is a non-metal. Nitrogen is a poor electrical conductor.

Describe two **other** physical properties which are typical of non-metals.

1 *poor conductor of heat*

2 *low density*

[2]

Examiner comment

A common error was to repeat 'poor electrical conductor' from the question or to give chemical rather than physical properties, e.g. non-metals form acidic oxides.

(b) Oxides of nitrogen are air pollutants which contribute to acid rain.

(i) State **one** source of oxides of nitrogen in the air.

car engines [1]

Examiner comment

Some candidates gave vague responses such as 'factories'.

(ii) State one **other** adverse effect of oxides of nitrogen.

photochemical smog [1]

Examiner comment

A common error was to repeat 'acid rain' from the question.

(c) Ammonia is a simple molecule with covalent bonds.

(i) Describe a covalent bond.

a pair of electrons shared between two atoms

[2]

Examiner comment

- The most common error was to describe properties of covalent compounds such as ‘low melting point’ or ‘poor conductivity’.
- Some candidates gave answers which were close such as ‘non-metals which share electrons’.

(ii) Complete Fig. 8.1 to show the dot-and-cross diagram for a molecule of ammonia.

Show outer shell electrons only.

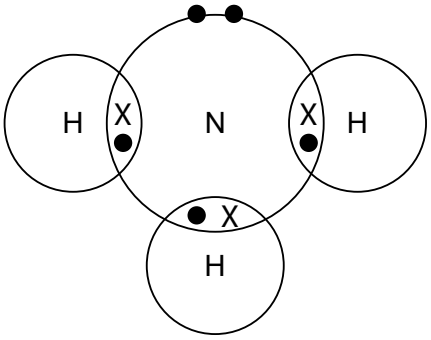


Fig. 8.1

[2]

Examiner comment

Some candidates gave an incorrect number of non-bonding electrons on N, or omit them completely.

(iii) Aqueous ammonia is alkaline.

Choose from the list, the pH value that is alkaline.

Draw a circle around your chosen answer.

pH 1 **pH 5** **pH 7** **pH 10** [1]

Examiner comment

The most common error was pH7.

(iv) Aqueous ammonia releases ammonia gas.

Ammonia gas turns damp red litmus paper blue.

A long glass tube is set up as shown in Fig. 8.2.

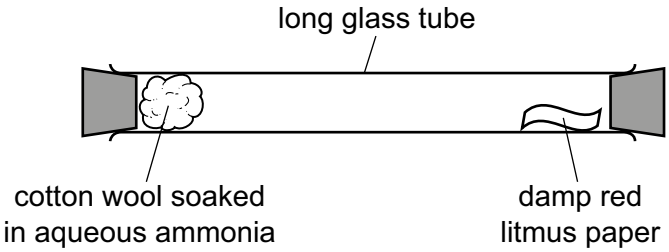


Fig. 8.2

At first, the litmus paper does **not** turn blue.
After a short time, the litmus paper turns blue.

Explain these results in terms of the kinetic particle theory.

As the ammonia evaporates the molecules spread out in random directions. The molecules move from an area of high concentration to a lower concentration and when it reaches the litmus paper it changes colour.

..... [3]

Examiner comment

Some candidates gave answers which did not refer to particles or molecules and used the term ‘gas’ instead, e.g. ‘ammonia gas is constantly moving and colliding’.

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