Paper Reference(s) 1SC0/1CH
Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Combined Science

PAPER 2

Higher Tier

Total Marks

Time: 1 hour 10 minutes plus your additional time allowance

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

Pearson

YOU MUST HAVE

Calculator, ruler

YOU WILL BE GIVEN

Diagram Booklet

Periodic table

INSTRUCTIONS

Answer ALL questions.

Answer the questions in the spaces provided – there may be more space than you need.

Calculators may be used.

Any diagrams may NOT be accurately drawn, unless otherwise indicated.

You must show all your working out with your answer clearly identified at the end of your solution.

INFORMATION

The total mark for this paper is 60.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

In the question marked with an ASTERISK (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

A periodic table is provided.

ADVICE

Read each question carefully before you start to answer it.

Try to answer every question.

Check your answers if you have time at the end.

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

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

(continued on the next page)

1 The scientist John Dalton lived over 200 years ago.

(a) John Dalton suggested an early model of atoms.

When Dalton first described atoms he said that

- **all elements are made of atoms**
- **atoms are not formed of any smaller particles**
- **all atoms of the same element are identical.**

Give two differences between Dalton's model of atoms and today's model of atoms.
(2 marks)

1_____

_____

_____

_____

_____

(continued on the next page)

1 continued.

2_____

_____

_____

_____

_____

(continued on the next page)

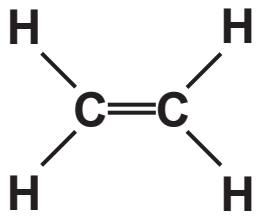
1 continued.

(b) Dalton also investigated different gases.

One of the gases that Dalton investigated was ethene.

The structure of one molecule of ethene is shown in Figure 1.

Figure 1



Give the molecular formula and the empirical formula of ethene.
(2 marks)

molecular formula

_____

empirical formula

_____

(continued on the next page)

1 continued.

(c) Another gas that Dalton investigated was chlorine.

Chlorine gas reacts with water.
The two products are a solution of hydrogen chloride and the substance HClO.

(i) Complete the balanced equation for this reaction, including the three missing state symbols.
(3 marks)

_____ (____) + _____ (____)

⇌ _____ (____) + HClO (aq)

(continued on the next page)

1 continued.

(ii) Hydrogen chloride solution is acidic.

The formulae of four ions are shown in Figure 2.

Figure 2

H^+ H^- Cl^+ Cl^-

Give the formula of the ion in Figure 2 that causes the hydrogen chloride solution to be acidic.
(1 mark)

formula _____

(iii) An acid reacts with an alkali.

Give the name of this type of reaction.
(1 mark)

_____

_____

(Total for Question 1 = 9 marks)

2 (a) A sample of potable water contains impurities.

Why is this sample of water potable even though it contains impurities?
(1 mark)

☐ A the impurities have no smell

☐ B the impurities are colourless

☐ C the impurities are harmless

☐ D the impurities are soluble

(continued on the next page)

2 continued.

(b) Waste water can be used to produce drinking water.
The processes used include sedimentation, filtration and chlorination.

(i) What is sedimentation?
(1 mark)

☐ A the waste water is heated so the impurities evaporate

☐ B the waste water has an acid added to remove impurities

☐ C the impurities in the waste water settle to the bottom of their container

☐ D the impurities in the waste water are bleached

(continued on the next page)

2 continued.

(ii) State why the waste water is filtered.
(1 mark)

_____

_____

_____

(iii) State the reason for chlorination.
(1 mark)

_____

_____

_____

_____

_____

(continued on the next page)

2 continued.

(c) Some salts can be added to waste water to remove impurities.

In an experiment, different masses of salt **A** were added to 1000 cm^3 samples of waste water.

The experiment was repeated with salt **B**.

Look at Figure 3 for Question 2(c) in the Diagram Booklet. The percentages of impurities removed from the waste water are shown in Figure 3.

It was concluded that the best way to purify 1000 cm^3 of the waste water is to add 100 mg of salt **B**.

Use the information about salt **A** and salt **B** in Figure 3 to evaluate this conclusion.

(3 marks)

(continued on the next page)

2 continued.

(d) Waste water may contain phosphate ions, PO_4^{3-}.

Aluminium ions react with phosphate ions to form aluminium phosphate.

Complete the ionic equation for the formation of aluminium phosphate in this reaction.
(2 marks)

_____ + PO_4^{3-} ⟶ _____

(Total for Question 2 = 9 marks)

3 This question is about electrolysis.

(a) A sample of molten potassium bromide is electrolysed.

What are the two products formed? (1 mark)

- ☐ **A hydrogen and oxygen**
- ☐ **B hydrogen and bromine**
- ☐ **C potassium and oxygen**
- ☐ **D potassium and bromine**

(continued on the next page)

3 continued.

(b) Zinc chloride and zinc carbonate contain ions.

Zinc chloride mixed with water can be electrolysed.
Zinc carbonate mixed with water cannot be electrolysed.

Explain this difference.
(2 marks)

(continued on the next page)

3 continued.

(c) In the electrolysis of sodium chloride solution, bubbles of a colourless gas form at the cathode. This gas, when mixed with air, burns with a squeaky pop.

(i) Identify this gas.
(1 mark)

_____

(ii) Explain how this gas is formed at the cathode.
(2 marks)

_____

_____

_____

_____

_____

_____

(continued on the next page)

3 continued.

(d) A solution of copper sulfate in a beaker is electrolysed using copper electrodes.

(i) Look at the diagram for Question 3(d)(i) in the Diagram Booklet. Draw a labelled diagram to show how this experiment would be set up.

The beaker has been drawn for you.
(2 marks)

(ii) During the electrolysis, the anode gets smaller, the cathode gets larger and the solution remains the same shade of blue.

Give the reason for each of these observations.
(3 marks)

the anode gets smaller

(continued on the next page)

3 continued.

the cathode gets larger

the solution remains the same shade of blue

(Total for Question 3 = 11 marks)

4 (a) Copper carbonate reacts with dilute nitric acid.

(i) During the reaction the copper carbonate powder completely disappears.

State what can be deduced about the amount of acid used.
(1 mark)

_____

_____

_____

(ii) During the reaction, the pH of the mixture changed from 2 to 6.

By what factor has the concentration of the hydrogen ions in the mixture changed?
(1 mark)

☐ A × 10 000

☐ B × 4

☐ C $\times \frac{1}{4}$

☐ D $\times \frac{1}{10\,000}$

(continued on the next page)

4 continued.

(b) Using different reactants, a solution of copper sulfate was prepared.

Describe what should be done to obtain copper sulfate crystals from this copper sulfate solution.
(2 marks)

(continued on the next page)

4 continued.

(c) When chloride ions are added to a pale blue solution containing copper ions, the mixture turns yellow.

This is a reversible reaction.

pale blue solution + chloride ions
$\rightleftharpoons$ yellow solution + water

What effect does the removal of chloride ions have on the colour of the yellow mixture?
(1 mark)

☐ A does not change colour

☐ B turns blue

☐ C turns colourless

☐ D turns darker yellow

(continued on the next page)

4 continued.

(d) Hydrated copper sulfate has the formula $CuSO_4.5H_2O$.
The formula tells us that each mole of copper sulfate contains 5 moles of water.

A sample of $CuSO_4.5H_2O$ was heated gently until all the water was removed to form anhydrous copper sulfate, $CuSO_4$.

$$CuSO_4.5H_2O \longrightarrow CuSO_4 + 5H_2O$$

The mass of water formed was 4·5 g.

Calculate the mass of hydrated copper sulfate that was heated.
(4 marks)

(relative atomic masses: H = 1.0, O = 16.0;
relative formula mass: $CuSO_4.5H_2O$ = 249.5)

(continued on the next page)

4 continued.

mass of $CuSO_4.5H_2O$ = _____ g

(Total for Question 4 = 9 marks)

5 (a) The order of reactivity of copper, magnesium and zinc can be determined by the displacement reactions between these metals and solutions of their salts.

You are provided with

- **samples of the three metals**
- **solutions of copper sulfate, magnesium sulfate and zinc sulfate.**

Describe the experiments that can be done to determine the order of reactivity of these metals by displacement reactions.
(3 marks)

(continued on the next page)

5 continued.

(b) **Metals can be extracted from ores found in the Earth's crust.**

Explain why aluminium cannot be extracted from its ore by heating with carbon but can be extracted by electrolysis.
(2 marks)

(continued on the next page)

5 continued.

(c) Titanium is extracted from its ore in several stages.

In the first stage, titanium chloride is formed as a gas.

The gas is cooled to form liquid titanium chloride containing DISSOLVED impurities.

Suggest how pure titanium chloride could be separated from the impurities.
(1 mark)

_____

_____

(continued on the next page)

5 continued.

(d) In another stage, the pure titanium chloride, $TiCl_4$, is reacted with 500 moles of magnesium, an excess.

$$TiCl_4 + 2Mg \longrightarrow Ti + 2MgCl_2$$

(i) Calculate the number of moles in 45 000 grams of titanium chloride.
(2 marks)

(relative atomic masses: Cl = 35.5, Ti = 48.0)

number of moles titanium chloride =

(continued on the next page)

5 continued.

(ii) Show that the 500 moles of magnesium added is an excess.
(1 mark)

(continued on the next page)

5 continued.

(e) After this reaction, there is a mixture of the solids magnesium, titanium and magnesium chloride.

Titanium does not react with dilute hydrochloric acid.

Suggest a simple method to separate titanium from the mixture.
(2 marks)

(Total for Question 5 = 11 marks)

6 (a) An ion of element X can be represented as

$^{125}X^{2-}$

This ion of element X has 54 electrons.

Calculate the number of protons and the number of neutrons in this ion.
(2 marks)

number of protons _____

number of neutrons _____

(b) A sample of silicon contains isotopes.

(i) State, in terms of subatomic particles, how atoms of these isotopes are the same.
(1 mark)

_____

_____

_____

(continued on the next page)

6 continued.

(ii) This sample of silicon contains three isotopes.

92% of the atoms are silicon-28
5% of the atoms are silicon-29
3% of the atoms are silicon-30

Calculate the relative atomic mass of silicon in this sample.
(2 marks)

relative atomic mass = _____

(continued on the next page)

6 continued.

*(c) Look at Figure 4 for Question 6(c) in the Diagram Booklet. It shows some properties of three substances, **A**, **B** and **C**.

Deduce, using the information in Figure 4, the structure and bonding of substances **A**, **B** and **C**, explaining their properties in terms of their structure and bonding.
(6 marks)

(continued on the next page)

6 continued.

(continued on the next page)

6 continued.

(continued on the next page)

6 continued.

(continued on the next page)

6 continued.

(Total for Question 6 = 11 marks)

TOTAL FOR PAPER IS 60 MARKS
END OF PAPER