Paper Reference(s) 1CH0/2H
Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Chemistry

PAPER 2
Higher Tier

Total Marks

Tuesday 13 June 2023 – Morning

Time: 1 hour 45 minutes

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 in this Question Paper or in the separate Diagram Booklet – 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 100.

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 questions 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.

There is a periodic table provided as a separate insert.

There may be spare copies of some diagrams.

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 ☒.

1 Butanol is a liquid fuel.

A student investigated the mass of butanol needed to increase the temperature of 100 cm^3 of water by 1 °C.

The student used the following method.

STEP 1 add 100 cm^3 of water to a beaker

STEP 2 measure the mass of a spirit burner containing butanol

STEP 3 measure the initial temperature of the water in the beaker

STEP 4 place the spirit burner containing butanol under the beaker of water

STEP 5 light the wick of the burner and start to stir the water with the thermometer

STEP 6 stop heating the water when the temperature of the water has increased by 30 °C

STEP 7 remeasure the mass of the spirit burner containing butanol.

Look at Figure 1 for Question 1 in the Diagram Booklet. It shows the apparatus used.

(continued on the next page)

1 continued.

(a) Figure 2 shows the student's results.

FIGURE 2

mass of spirit burner at start in g	mass of spirit burner at end in g
134·67	133·59

In the student's investigation, the temperature of the 100 cm^3 water increased by 30 °C.

Calculate the mass of butanol needed to increase the temperature of the 100 cm^3 water by 1 °C.
(2 marks)

_____

_____

_____

mass of butanol = _____ g

(continued on the next page)

1 continued.

(b) The student investigated the effect of changing the fuel on the mass of fuel needed to heat the water.

The student used an identical spirit burner filled with pentanol, another liquid fuel.

Give TWO variables that the student should keep the same in this investigation.
(2 marks)

variable 1

_____

_____

_____

variable 2

_____

_____

_____

(continued on the next page)

1 continued.

(c) Suggest TWO improvements that the student could make to their apparatus so that more of the heat energy is transferred to the water.
(2 marks)

improvement 1

improvement 2

(Total for Question 1 = 6 marks)

2 Look at Figure 3 for Question 2 in the Diagram Booklet. A student used the apparatus shown in Figure 3 to investigate the reaction between marble chips and dilute hydrochloric acid.

The student recorded the volume of gas every minute as shown in Figure 4.

FIGURE 4

time in minutes	0	1	2	3	4	5	6
volume of gas in cm^3	0	52	78	91	97	100	100

(a) Look at the grid for Question 2(a) in the Diagram Booklet. On the grid, plot the results shown in Figure 4.

Draw a curve of best fit.
(3 marks)

(continued on the next page)

2 continued.

(b) Rate of reaction can be calculated using

$$\text{rate of reaction} = \frac{\text{volume of gas produced in 1 minute}}{\text{1 minute}}$$

Look at Figure 5 for Question 2(b) in the Diagram Booklet. It shows the rates of reaction calculated from the results of this experiment.

The rate of reaction for the time interval 2 to 3 minutes is missing.

(i) Calculate the rate of reaction for the time interval 2 to 3 minutes.
(1 mark)

_____

_____

rate of reaction = _____ $cm^3 min^{-1}$

(continued on the next page)

2(b) continued.

(ii) State and explain what happens to the rate of reaction as the acid reacts with the marble chips in this experiment.
(3 marks)

(continued on the next page)

2 continued.

(c) The student repeated the experiment using the same volume of acid and the same mass of marble chips but used smaller marble chips.

All other conditions remained the same.

The student found that the reaction with the smaller marble chips was faster to start with but produced the same volume of gas.

Look again at the grid for Question 2(a) in the Diagram Booklet. Using this information, draw a line on the grid in the Diagram Booklet to show the results for the reaction with the smaller marble chips.

Label this line 'C'.
(2 marks)

(Total for Question 2 = 9 marks)

3 Look at Figure 6 for Question 3 in the Diagram Booklet. It shows some information about the group 1 metals.

(a) Explain, in terms of their electronic configurations, why these metals are placed in group 1 of the periodic table.
(2 marks)

(continued on the next page)

3 continued.

(b) Which row shows two correct properties of group 1 metals?
(1 mark)

	properties of group 1 metals	
☐ A	compounds are white in colour	high density
☐ B	low melting points	compounds are blue in colour
☐ C	soft enough to be cut by a knife	low melting points
☐ D	high density	conduct electricity

(continued on the next page)

3 continued.

(c) The word equation for the reaction of potassium with bromine is

potassium + bromine ⟶ potassium bromide

Add the missing state symbol and balance the equation for this reaction.
(2 marks)

_____K(_____) + Br_2(g) ⟶ _____KBr(s)

(continued on the next page)

3 continued.

(d) A sample of potassium contains three isotopes, potassium-39, potassium-40 and potassium-41.

(i) Explain the meaning of the term ISOTOPES. (2 marks)

(continued on the next page)

3(d) continued.

(ii) This sample of potassium contains

93·25% potassium-39

0·02% potassium-40

6·73% potassium-41

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

relative atomic mass = _____

(Total for Question 3 = 9 marks)

4 (a) Atoms, molecules, nanoparticles and protons are types of particle.

List these four types of particle in order of size from smallest to largest.
(2 marks)

smallest

largest

_____

_____

_____

_____

(continued on the next page)

4 continued.

(b) Nanoparticles have a large surface area to volume ratio.

Look at Figure 7 for Question 4(b) in the Diagram Booklet. It shows a cube-shaped nanoparticle with sides of 90 nm.

(i) What is 90 nm in metres?
(1 mark)

☐ A $9{\cdot}0 \times 10^{-5}$

☐ B $9{\cdot}0 \times 10^{-6}$

☐ C $9{\cdot}0 \times 10^{-8}$

☐ D $9{\cdot}0 \times 10^{-11}$

(continued on the next page)

4(b) continued.

(ii) Calculate the simplest surface area to volume ratio for the nanoparticle in Figure 7.

Show your working.
(3 marks)

_____

_____

_____

_____

_____

_____

surface area to volume ratio = 1 : _____

(continued on the next page)

4 continued.

(c) Look at Figure 8 for Question 4(c) in the Diagram Booklet. It shows the structure of a molecule of tetrafluoroethene.

(i) Tetrafluoroethene can form the polymer poly(tetrafluoroethene).

Draw a diagram to show the structure of the repeating unit of this polymer.
(2 marks)

(continued on the next page)

4(c) continued.

(ii) Poly(tetrafluoroethene) is also known as Teflon™.

State one use of poly(tetrafluoroethene) and explain how one of its properties makes it suitable for that use.
(3 marks)

Answer space continues on the next page.

use

_____

_____

explanation

_____

_____

_____

_____

_____

_____

4(c)(ii) continued.

(Total for Question 4 = 11 marks)

5 (a) Look at Figure 9 for Question 5(a) in the Diagram Booklet. It shows the percentage of three gases, X, Y and Z, in the Earth's early atmosphere.

What is the name of gas Z?
(1 mark)

☐ A argon

☐ B carbon dioxide

☐ C nitrogen

☐ D oxygen

(continued on the next page)

5 continued.

(b) It is thought that small quantities of hydrogen sulfide, H_2S, were also in the Earth's early atmosphere.

Draw the dot and cross diagram for a molecule of hydrogen sulfide.

Show outer electrons only.
(2 marks)

Answer space continues on the next page.

5(b) continued.

(continued on the next page)

5 continued.

(c) Acid rain is caused by some pollutant gases present in the atmosphere.

Explain how impurities in fossil fuels can result in acid rain.
(3 marks)

(continued on the next page)

5 continued.

(d) A student investigates the effect of acid rain on cress plants.

The student uses this method.

STEP 1 grow 20 cress plants in each of two dishes, **A** and **B**

STEP 2 water the cress plants in dish **A** with 10 cm^3 of dilute hydrochloric acid with a pH of 2

STEP 3 water the cress plants in dish **B** with 10 cm^3 of pure water with a pH of 7

STEP 4 repeat steps 2 and 3 every day for one week

STEP 5 count how many plants are still alive after one week.

(i) State what piece of equipment the student could use to measure the pH of each liquid. (1 mark)

_____

_____

(continued on the next page)

5(d) continued.

(ii) Explain ONE improvement that the student could make to the method to make the results more valid.
(2 marks)

(Total for Question 5 = 9 marks)

6 Chlorine gas can be prepared by reacting concentrated hydrochloric acid with solid potassium manganate(VII).

Look at Figure 10 for Question 6 in the Diagram Booklet. It shows the apparatus used.

(a) Look at Figure 11 for Question 6(a) in the Diagram Booklet. It shows the hazard symbols for concentrated hydrochloric acid, potassium manganate(VII) and chlorine gas.

Use the information in Figure 11 to help you answer (a)(i) and (a)(ii).

(i) What are the hazards associated with potassium manganate(VII)?
(1 mark)

☐ A flammable, harmful and corrosive

☐ B flammable, toxic and hazardous to the environment

☐ C oxidising, harmful and hazardous to the environment

☐ D oxidising, toxic and corrosive

(continued on the next page)

6(a) continued.

(ii) Explain ONE precaution that should be taken when preparing the sample of chlorine gas. (2 marks)

precaution

_____

_____

_____

reason

_____

_____

_____

(continued on the next page)

6 continued.

(b) State the purpose of the delivery tube.
(1 mark)

(c) Suggest why damp blue litmus is placed at the top of the gas jar.
(2 marks)

(continued on the next page)

6 continued.

(d) In the reaction, potassium manganate(VII), $KMnO_4$, reacts with hydrochloric acid to form manganese chloride, $MnCl_2$, potassium chloride, chlorine and water.

Write the balanced equation for the reaction.
(3 marks)

_____

_____

(Total for Question 6 = 9 marks)

7 Look at Figure 12 for Question 7 in the Diagram Booklet. It shows the structure of the molecules of three organic compounds.

(a) (i) Each molecule in Figure 12 contains a different functional group.

Circle the alkene functional group in PROPENE.
(1 mark)

(ii) Propene reacts with bromine water.

Look at the diagram for Question 7(a)(ii) in the Diagram Booklet. Complete the equation for the reaction of propene with bromine by drawing the structure of a molecule of the product.
(2 marks)

(continued on the next page)

7(a) continued.

(iii) Propanoic acid reacts with calcium carbonate, $CaCO_3$, to form calcium propanoate, $Ca(C_2H_5COO)_2$, and two other products.

Name the TWO other products.
(2 marks)

product 1

_____

_____

product 2

_____

_____

(continued on the next page)

7 continued.

*(b) Glucose, $C_6H_{12}O_6$, is a carbohydrate.

A dilute solution of ethanol can be produced from glucose by fermentation.

The dilute solution of ethanol can then be processed to form a concentrated solution of ethanol.

Describe how the fermentation of glucose is carried out and how the dilute solution of ethanol produced can then be processed to form a concentrated solution of ethanol.

You may include diagrams in your answer.
(6 marks)

Answer space continues on the next 4 pages.

7(b) continued.

7(b) continued.

7(b) continued.

7(b) continued.

(Total for Question 7 = 11 marks)

8 Ammonia can be produced from the reaction of hydrogen with nitrogen.

(a) What is the percentage by mass of nitrogen in ammonia, NH_3?
(1 mark)

(relative atomic masses: H = 1·0, N = 14)

☐ A 18%

☐ B 42%

☐ C 51%

☐ D 82%

(continued on the next page)

8 continued.

(b) The reaction between hydrogen and nitrogen is exothermic.

Look at Figure 13 for Question 8(b) in the Diagram Booklet. It shows the reaction profile of this exothermic reaction.

(i) Which arrow represents the activation energy for the reaction?
(1 mark)

☐ A arrow **P**

☐ B arrow **Q**

☐ C arrow **R**

☐ D arrow **S**

(continued on the next page)

8(b) continued.

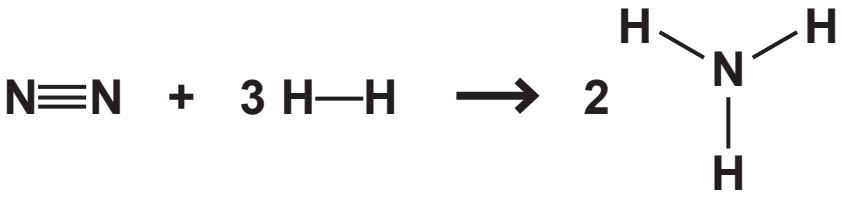
(ii) Describe what the reaction profile shows about the energy involved in bond breaking and bond making in this reaction.
(2 marks)

(continued on the next page)

8(b) continued.

(iii) Look at Figure 14 for Question 8(b)(iii) in the Diagram Booklet. It shows the energies of some bonds.

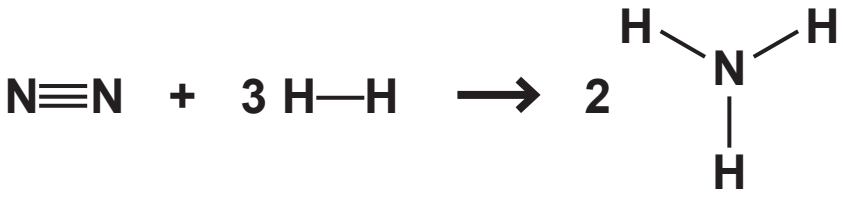
The equation for the reaction between nitrogen and hydrogen to form ammonia is



Calculate the energy change, in $kJ\,mol^{-1}$, for this reaction.
(4 marks)

Answer space continues on the next page.

8(b)(iii) continued.



energy change = _____ kJ mol^{-1}

(continued on the next page)

8 continued.

(c) Ammonia, NH_3, and silicon dioxide, SiO_2, are both compounds that are made of two non-metallic elements.

Ammonia has a boiling point of –33 °C.
Silicon dioxide has a boiling point of 2230 °C.

Explain why the boiling points of ammonia and silicon dioxide are so different.
(3 marks)

(Total for Question 8 = 11 marks)

9 Crude oil is a mixture of hydrocarbons.

Crude oil can be separated into useful fractions by the process of fractional distillation in a fractionating column.

(a) Look at Figure 15 for Question 9(a) in the Diagram Booklet. It shows a fractionating column, the fractions obtained and the trend in viscosity of the fractions.

(i) Which row shows the correct uses for bitumen, diesel oil and fuel oil? (1 mark)

	bitumen	diesel oil	fuel oil
☐ A	fuel for large ships	surfacing roads	fuel for trains
☐ B	fuel for large ships	fuel for trains	surfacing roads
☐ C	surfacing roads	fuel for trains	fuel for large ships
☐ D	surfacing roads	fuel for large ships	fuel for trains

(continued on the next page)

9(a) continued.

(ii) Explain the trend in the viscosity of the fractions.
(2 marks)

(continued on the next page)

9 continued.

(b) Hydrocarbon **X** was cracked to form one molecule of hexane, C_6H_{14}, and one molecule of alkene **Y**.

$$X \longrightarrow C_6H_{14} + Y$$

The relative formula mass of **Y** is 56
The empirical formula of **Y** is CH_2

Deduce the molecular formula of hydrocarbon **X**.

Show your working.
(4 marks)

(relative atomic masses: H = 1·0, C = 12)

Answer space continues on the next page.

9(b) continued.

_____

_____

_____

_____

_____

molecular formula of X = _____

(continued on the next page)

9 continued.

***(c) Large quantities of methane are used as a fuel.**

Look at Figure 16 for Question 9(c) in the Diagram Booklet. It shows a Bunsen burner.

Methane can be used as fuel for the Bunsen burner.

The air-hole on the chimney of the Bunsen burner can be opened and closed.

Explain the effect of opening and closing the air-hole of the Bunsen burner on the products of combustion of methane and the harm that using large quantities of methane as a fuel can cause. (6 marks)

Answer space continues on the next 4 pages.

9(c) continued.

9(c) continued.

9(c) continued.

9(c) continued.

(Total for Question 9 = 13 marks)

10 (a) A student carried out a flame test on a sample of solid potassium chloride.

The student followed this method.

STEP 1 dip a dry wooden splint into water

STEP 2 then dip the wooden splint into the sample of potassium chloride

STEP 3 hold the wooden splint in a roaring Bunsen burner flame

STEP 4 observe the colour seen in the flame.

(continued on the next page)

10(a) continued.

(i) The student made the following observation and conclusion.

‘I saw that the flame colour was yellow so the sample must contain sodium ions.’

Due to the way the student carried out the experiment, this is not a valid conclusion.

Explain ONE improvement that the student could make to their method to obtain a valid conclusion.
(2 marks)

Answer space continues on the next page.

improvement

_____

_____

_____

10(a)(i) continued.

reason

_____

_____

_____

(continued on the next page)

10(a) continued.

(ii) What colour should the student have seen in the flame if the test had been carried out correctly?
(1 mark)

☐ A blue-green

☐ B lilac

☐ C orange-red

☐ D red

(continued on the next page)

10 continued.

(b) A sample of the potassium chloride was also tested for chloride ions.

Describe the test for chloride ions.
(3 marks)

(continued on the next page)

10 continued.

(c) (i) A student was asked to test a sample of aluminium sulfate for sulfate ions.

The student needed 25 cm^3 of barium chloride solution of concentration 83 g dm^{-3} for the test.

Calculate the mass of barium chloride that must be dissolved in water to make 25 cm^3 of solution of this concentration.

Give your answer to 2 significant figures.
(3 marks)

mass of barium chloride = _____ g

(continued on the next page)

10(c) continued.

(ii) When the barium chloride solution was added to the aluminium sulfate solution, a precipitate was formed.

The balanced equation for this reaction is

$$3BaCl_2(aq) + Al_2(SO_4)_3(aq) \longrightarrow 3BaSO_4(s) + 2AlCl_3(aq)$$

Write the ionic equation for this reaction.
(3 marks)

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER