Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Friday 17 May 2024

Morning (Time: 1 hour 45 minutes)

Paper reference **1CH0/1H**

Chemistry

PAPER 1

Higher Tier

You must have:
Calculator, ruler, Periodic Table (enclosed)

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- 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 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.

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.

Turn over ▶

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P 7 4 4 2 3 A 0 1 3 2

Pearson

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 (a) Chemical cells produce a voltage.

A chemical cell can be made by placing the metals copper and iron in a beaker of sodium chloride solution as shown in Figure 1.

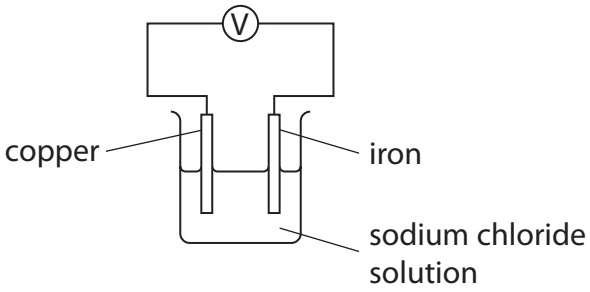

Figure 1

Describe what will happen to the reading on the voltmeter over a long period of time.

(2)

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(b) Iron is a transition metal.

Which of the following is most likely to be a property of iron?

(1)

☒ **A** iron forms a colourless oxide

☒ **B** iron is a poor conductor of heat

☒ **C** iron has a low boiling point

☒ **D** iron has a high density

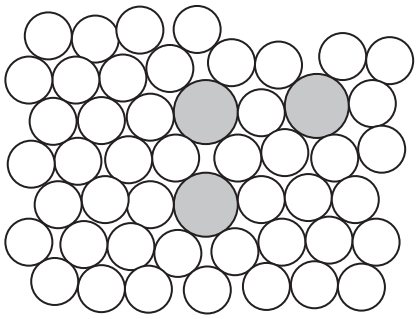
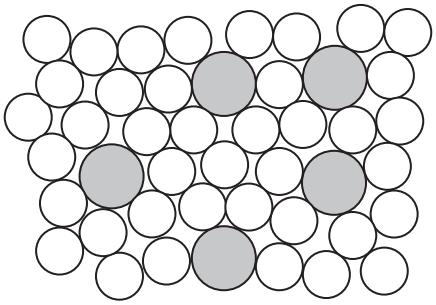
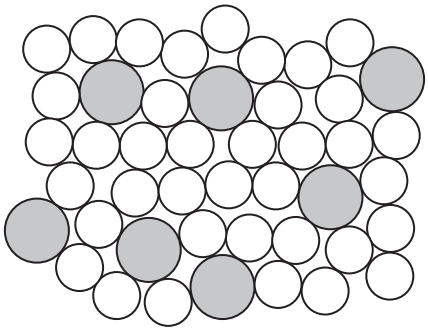
(c) An iron atom has a diameter of 2.52×10^{-10} m.

What is the size of this iron atom in nanometres?

(1)

- ☒ **A** 2.52
- ☒ **B** 0.252
- ☒ **C** 0.0252
- ☒ **D** 0.00252

(d) Figure 2 shows the arrangement of atoms in three different alloys of copper and zinc, **A**, **B** and **C**.

Alloy A	Alloy B	Alloy C
		

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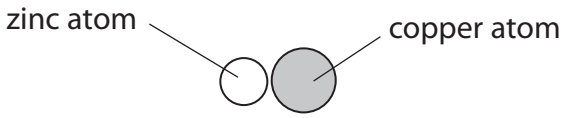

Figure 2

Explain which of the three alloys, **A**, **B** and **C**, is the strongest.

(2)

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(Total for Question 1 = 6 marks)

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2 Barium hydroxide reacts with dilute hydrochloric acid to form barium chloride solution and water.

(a) (i) Complete the balanced equation for the reaction by adding a **number** in front of HCl(aq).

(1)

$$Ba(OH)_2(s) + \ldots\ldots HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$$

(ii) State what you would **see** during the reaction.

(1)

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.....

(b) A student investigated how the pH of the mixture changed as barium hydroxide was added to dilute hydrochloric acid.

The student used this method.

step 1 measure out 50 cm^3 of dilute hydrochloric acid into a beaker using a measuring cylinder

step 2 use a glass rod to place a drop of the acid onto a piece of universal indicator paper and record the pH

step 3 add one spatula measure of barium hydroxide to the acid in the beaker and stir

step 4 use the glass rod to place a drop of the mixture onto a new piece of universal indicator paper and record the pH again

step 5 repeat steps 3 and 4 until there is no further change in the pH.

(i) Name a piece of equipment that could be used to measure the pH of a substance more accurately than universal indicator paper.

(1)

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(ii) Explain why, in step 3, the mixture was stirred after adding the barium hydroxide.

(2)

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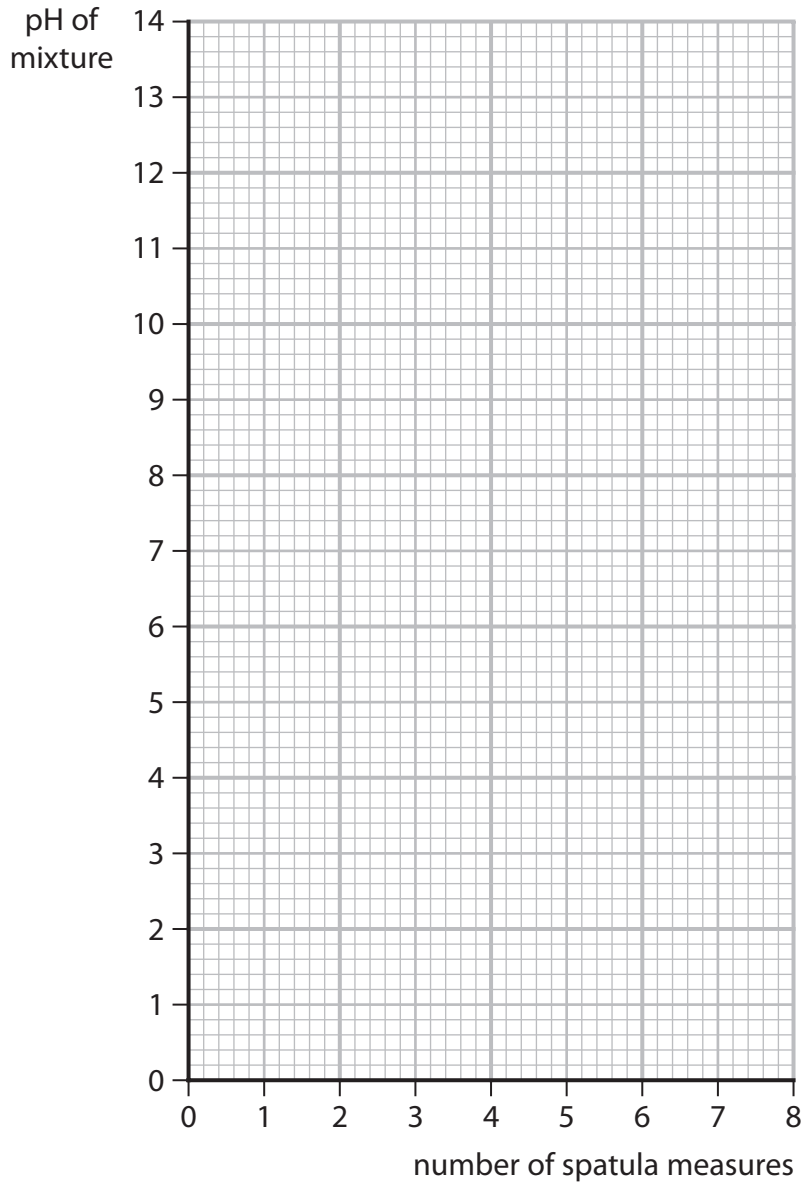
(iii) Figure 3 shows the student's results.

number of spatula measures of barium hydroxide	pH of mixture
0	1
1	1
2	1
3	1
4	3
5	8
6	12
7	13
8	13

Figure 3

Plot a graph of the pH of the mixture against the number of spatula measures of barium hydroxide.

(3)



(iv) Use the graph to find the pH of the mixture when 4.5 spatula measures of barium hydroxide are added.

(1)

pH of the mixture = ...

(Total for Question 2 = 9 marks)

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3 Sodium carbonate has the formula Na_2CO_3.

(a) Sodium carbonate contains Na^+ ions and CO_3^{2-} ions.

(i) The atomic number of sodium is 11.

What is the electronic configuration of the Na^+ ion?

(1)

☒ **A** 1

☒ **B** 2.8

☒ **C** 2.8.1

☒ **D** 2.8.2

(ii) Explain why solid sodium carbonate **cannot** conduct electricity but a solution of sodium carbonate **can** conduct electricity.

(3)

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(b) Calculate the percentage by mass of sodium in sodium carbonate, Na_2CO_3.

$$\text{percentage by mass of element} = \frac{\text{total relative atomic mass of element}}{\text{relative formula mass of compound}} \times 100$$

(relative atomic masses: C = 12, O = 16, Na = 23)

(3)

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.....

percentage by mass of sodium = ...

(Total for Question 3 = 7 marks)

4 (a) Titanium can be extracted from titanium oxide, TiO_2, by reaction with magnesium.

(i) 100 tonnes of titanium oxide was heated with magnesium.
The titanium formed in the reaction was separated and purified.
The mass of titanium was then determined.

The results are shown in Figure 4.

	mass in tonnes
mass of titanium oxide	100.00
mass of titanium produced	45.26
theoretical mass of titanium formed	60.00

Figure 4

Use the information in Figure 4 to calculate the percentage yield of titanium in this process.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Give your answer to 1 decimal place.

(3)

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percentage yield = ...

(ii) Give **two** reasons why the percentage yield for **this process** is less than 100%.

(2)

1 .....

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2 .....

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(iii) The balanced equation for this process is

$$TiO_2 + 2Mg \rightarrow Ti + 2MgO$$

Calculate the atom economy of this process to produce titanium.

$$\text{atom economy (\%)} = \frac{\text{total formula mass of desired product}}{\text{total formula mass of all reactants or products}} \times 100$$

Give your answer to 2 significant figures.

(relative atomic masses: O = 16, Mg = 24, Ti = 48)

(3)

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atom economy = ...%

(b) Ethanol, C_2H_5OH, can be produced by two different methods.

- by the hydration of ethene, C_2H_4

  $C_2H_4 + H_2O \rightarrow C_2H_5OH$ atom economy = 100%

- and by the fermentation of a carbohydrate, e.g. sucrose, $C_{12}H_{22}O_{11}$

  $C_{12}H_{22}O_{11} + H_2O \rightarrow 4C_2H_5OH + 4CO_2$ atom economy = 51.1%

(i) State why the hydration of ethene has an atom economy of 100%.

(1)

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(ii) Explain how the atom economy of the fermentation reaction can be improved.

(2)

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(Total for Question 4 = 11 marks)

5 This question is about the extraction of metals.

(a) Give **two** advantages of obtaining metals by recycling rather than by extracting them from their metal ores.

(2)

1 .....

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2 .....

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(b) (i) Small amounts of some metals are extracted using displacement reactions.

In one process, zinc dust is used to precipitate cadmium metal from a solution containing cadmium ions.

$$\underset{\text{cadmium ions}}{Cd^{2+}(aq)} + Zn(s) \rightarrow \underset{\text{cadmium}}{Cd(s)} + Zn^{2+}(aq)$$

Explain why this displacement reaction can be described as a **redox reaction**.

(3)

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(ii) The formula of the cadmium ion is Cd^{2+}.
The formula of the phosphate ion is PO_4^{3-}.

Which is the formula of cadmium phosphate?

(1)

- ☒ **A** $Cd_2(PO_4)_3$
- ☒ **B** Cd_3PO_{12}
- ☒ **C** $Cd_3(PO_4)_2$
- ☒ **D** $Cd_3P_2O_8$

(c) One of the alternative biological methods of extracting metals from very low-grade ores is bioleaching using bacteria.

Give one **disadvantage** of this method of extracting metals from low-grade ores.

(1)

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(d) Lead is low in the reactivity series.

Describe how to obtain a sample of lead from some lead oxide in the laboratory.

(2)

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(Total for Question 5 = 9 marks)

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6 Titration can be used to find the volume of dilute hydrochloric acid needed to neutralise 25.0 cm^3 of barium hydroxide solution.

(a) Before the titration is carried out, the pipette and conical flask are rinsed out with pure water.

Explain the effect, if any, that traces of water in the pipette and conical flask after rinsing could have on the titration result.

(4)

pipette

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conical flask

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(b) In the titration, a few drops of phenolphthalein indicator are added to the barium hydroxide solution.

(i) State the change in colour of phenolphthalein at the end point, when the barium hydroxide solution has just been neutralised.

(1)

from ..... to .....

(ii) Write the ionic equation for the neutralisation reaction that occurs when hydrochloric acid is added to barium hydroxide solution.

(2)

.....

(c) When barium hydroxide solution is neutralised by dilute sulfuric acid, a white precipitate of barium sulfate is formed in the conical flask.

Describe an experiment to obtain a sample of pure, dry barium sulfate from the contents of the conical flask.

(3)

(Total for Question 6 = 10 marks)

7 (a) Water, acidified with dilute sulfuric acid, was electrolysed for 10 minutes using inert electrodes.

Figure 5 shows the apparatus used.

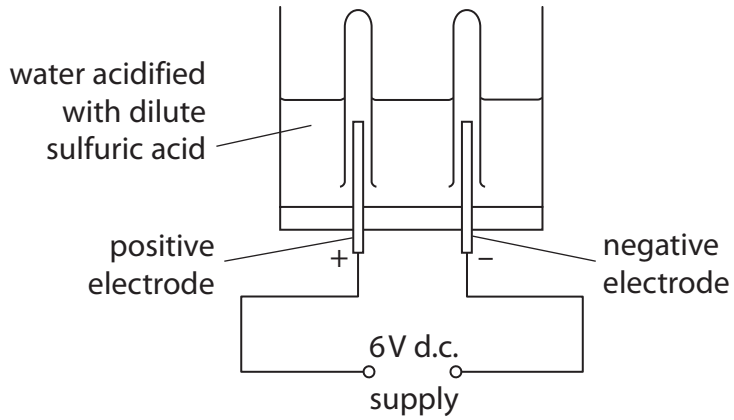

Figure 5

(i) In this electrolysis, the acidified water is an electrolyte.

Explain why acidified water is an electrolyte.

(2)

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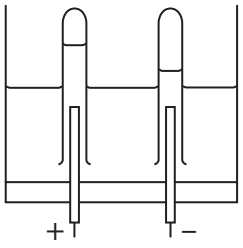
(ii) Hydrogen collects at the negative electrode and oxygen collects at the positive electrode.

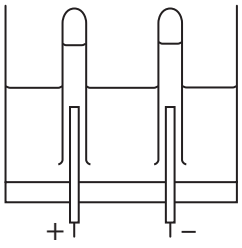
Which of these shows the results after 10 minutes of this electrolysis?

(1)

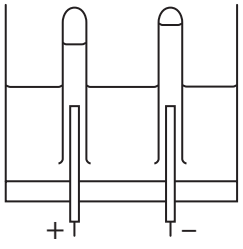
☒ **A**



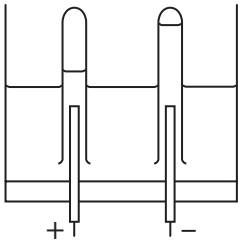
☒ **B**



☒ **C**



☒ **D**



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(iii) Complete and balance the half equation for the formation of oxygen at the positive electrode in this electrolysis.

(2)

$4OH^- \rightarrow$ .....

(b) Copper sulfate solution was electrolysed for 10 minutes using copper electrodes.

Figure 6 shows the mass of the cathode and the appearance of the copper sulfate solution before electrolysis and after electrolysis.

	mass of cathode in g	appearance of copper sulfate solution
before electrolysis	5.32	pale blue solution
after electrolysis	5.87	pale blue solution

Figure 6

(i) Describe what should be done to the copper cathode, after it has been removed from the copper sulfate solution, before its final mass is determined.

(2)

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(ii) Explain, in terms of ions, the change in mass of the cathode shown in Figure 6.

(2)

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(iii) Explain why the appearance of the copper sulfate solution did not change during the electrolysis.

(2)

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(Total for Question 7 = 11 marks)

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8 This question is about the properties of different substances.

(a) Silicon tetrachloride is a simple molecular covalent compound.

(i) A molecule of silicon tetrachloride is composed of a silicon atom and four chlorine atoms.

- a silicon atom has 4 outer electrons
- a chlorine atom has 7 outer electrons

Draw a dot and cross diagram of a molecule of silicon tetrachloride, $SiCl_4$.

Show outer electrons only.

(2)

(ii) Explain why simple molecular covalent compounds such as silicon tetrachloride have low melting and boiling points.

(2)

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(b) Part of the structure of rubidium bromide is shown in Figure 7.

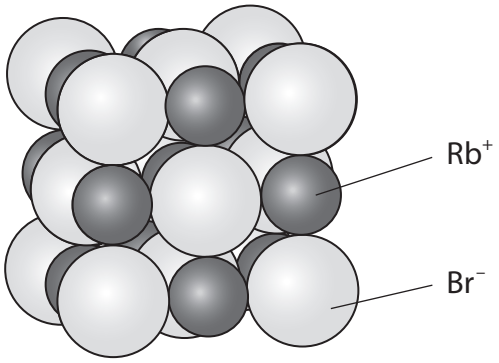


Figure 7

Which row shows the most likely melting point and boiling point of rubidium bromide?

(1)

	melting point in °C	boiling point in °C
☒ **A**	6.93	134.0
☒ **B**	69.3	134.0
☒ **C**	69.3	1340
☒ **D**	693	1340

*(c) Diamond and graphite are two forms of carbon.

Figure 8 shows how the carbon atoms are arranged in a part of the structure of each of these forms of carbon.

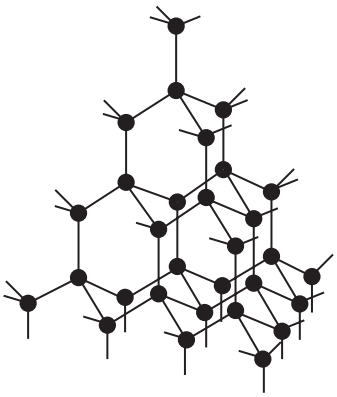
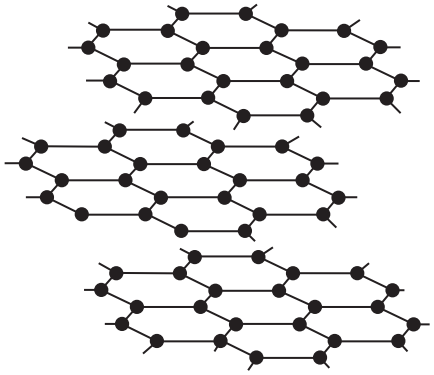
diamond	graphite
	

Figure 8

- diamond is one of the hardest known substances on Earth and is used in cutting tools.
- graphite is soft and flaky.
- diamond is a poor electrical conductor, but graphite is a good electrical conductor.

Explain, in terms of structure and bonding, these properties of diamond and graphite.

(6)

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(Total for Question 8 = 11 marks)

9 (a) An investigation was carried out on the reactivity of four metals, **D**, **E**, **F** and **G**.

Equal sized pieces of these metals were placed in excess dilute hydrochloric acid and left for three minutes.

Figure 9 shows the observations of the reactions for metals **D**, **E** and **F**.

metal	observations with dilute hydrochloric acid
D	Bubbles formed quickly. After three minutes all the metal had reacted.
E	Bubbles formed very quickly. No metal remaining after three minutes.
F	A few bubbles were seen to form. The metal looked unchanged after three minutes.
G	

Figure 9

The order of reactivity for these metals is shown in Figure 10.

E	**D**	**G**	**F**

most reactive least reactive

Figure 10

(i) Use the information in Figure 9 and Figure 10 to suggest the observations that would be made for metal **G**.

(2)

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(ii) The dilute hydrochloric acid used in this reaction is a strong acid.

Explain the meaning of the terms **dilute** and **strong acid**.

(4)

dilute

strong acid

(b) The formula of lead ethanoate is $Pb(CH_3COO)_2$.

Calculate the number of **atoms** that combine together to form 16.25 g of lead ethanoate.

(relative atomic masses: H = 1.00, C = 12.0, O = 16.0, Pb = 207

Avogadro number = 6.02×10^{23})

(4)

number of atoms = ...

(c) Iron is more reactive than copper.

Iron will displace copper from copper nitrate solution.
Two possible balanced equations for the reaction are

Equation **1** $Fe + Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cu$

Equation **2** $2Fe + 3Cu(NO_3)_2 \rightarrow 2Fe(NO_3)_3 + 3Cu$

It was found that 2.24 g of iron reacted with excess copper nitrate solution to form 3.81 g of copper.

Carry out a calculation, using the information above, to show which equation represents the reaction taking place.

(relative atomic masses: Fe = 56.0, Cu = 63.5)

(3)

(Total for Question 9 = 13 marks)

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10 Hydrogen can be produced by the reaction of methane with steam.

(a) Methane reacts with steam in the presence of a nickel catalyst to produce hydrogen and a dynamic equilibrium is reached.

The equation for this equilibrium reaction is

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

methane

The forward reaction takes in heat energy and is endothermic.

(i) Describe the effect of the catalyst on the rate of attainment of equilibrium and on the equilibrium yield of products.

(2)

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*(ii) A manufacturer produces hydrogen by the reaction of methane with steam in the presence of a nickel catalyst using the conditions

temperature 600 °C
pressure 20 atmospheres

Explain what effect there would be on the rate of attainment of equilibrium and the equilibrium yield of hydrogen if the manufacturer were to use a higher temperature of 1000 °C at a lower pressure of 10 atmospheres without changing the catalyst.

(6)

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(b) Using the equation for the reaction

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

calculate the maximum volume of products, in dm^3, that could be formed by the complete reaction of 650 dm^3 of methane.

(assume all volumes of gases are measured under the same conditions of temperature and pressure)

(2)

maximum volume of products = ... dm^3

(c) Using the same equation for the reaction

$$CH_4(g) + 2H_2O(g) \rightleftharpoons 4H_2(g) + CO_2(g)$$

calculate the maximum mass, in g, of carbon dioxide for every 1800 dm^3 of hydrogen, measured at room temperature and pressure, produced in this reaction.

(relative formula mass: $CO_2 = 44$;
1 mol of any gas at room temperature and pressure occupies 24 dm^3)

(3)

mass of carbon dioxide = ... g

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS

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Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Friday 17 May 2024

Paper reference 1CH0/1H

Chemistry

PAPER 1

Higher Tier

Periodic Table Insert

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Turn over ▶

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Pearson

The periodic table of the elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

* The elements with atomic numbers from 58 to 71 are omitted from this part of the periodic table.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.