Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Time 1 hour 15 minutes

Paper reference **4CH1/2CR**

Chemistry

UNIT: 4CH1
PAPER: 2CR

You must have:
Calculator, ruler

January 2023

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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.*
- Show all the steps in any calculations and state the units.

Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 7 1 8 9 5 A 0 1 2 4

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
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.***

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

Answer ALL questions.

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 In this question the answer to each part is a number.

(a) Give the pH value of a neutral solution.

(1)

.....

(b) Give a pH value of a weakly acidic solution.

(1)

.....

(c) Give the number of the Group in the Periodic Table that contains the elements that do **not** readily react.

(1)

.....

(d) Give the number of different elements present in glucose, $C_6H_{12}O_6$

(1)

.....

(Total for Question 1 = 4 marks)

2 The solubility of a solid depends on the solvent used.

(a) State one other factor that affects the solubility.

(1)

.....

(b) A student wants to find the solubility of a salt in water.

The steps in the student's method are not in the correct order.

Step A gently heat the evaporating basin and solution to remove all the water

Step B filter to obtain 50.0 cm^3 of saturated solution

Step C record the mass of the evaporating basin and salt solution

Step D record the mass of an empty evaporating basin

Step E record the mass of the evaporating basin and the dry salt

Step F put 50.0 cm^3 of water into a beaker

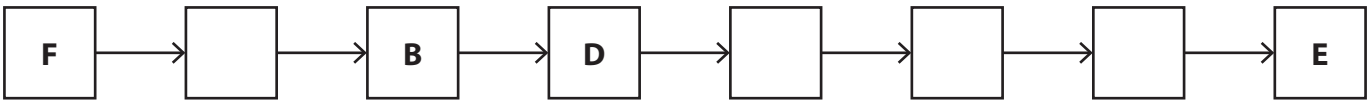
Step G add the salt to the water a little at a time and stir until no more dissolves

Step H pour the 50.0 cm^3 of saturated salt solution into the evaporating basin

(i) The flowchart shows the correct order of some of the steps.

Complete the flowchart by putting the remaining steps in the correct order.

(2)



(ii) These are the student's results.

mass of empty evaporating basin = 60.5 g

mass of evaporating basin and dry salt = 78.1 g

Calculate the solubility of the salt in grams per 100 g of water.

[1.00 cm^3 of water has a mass of 1.00 g]

(2)

solubility = ... grams per 100 g of water

(Total for Question 2 = 5 marks)

3 When 10.0 kg of a solid fuel is burned, the heat energy produced is 3.28×10^5 kJ.

(a) Calculate the heat energy, in kJ/mol, produced by the fuel.

You should assume that the fuel is pure carbon.

Give your answer to three significant figures.

[for carbon, $A_r = 12$]

(3)

heat energy = ... kJ/mol

(b) The fuel actually contains some impurities, including sulfur.

There is 600 g of sulfur in 20 kg of fuel.

(i) Calculate the percentage of sulfur in the fuel.

(2)

percentage of sulfur = ...%

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(ii) When the fuel burns, the 600 g of sulfur produces sulfur dioxide gas.

$$S + O_2 \rightarrow SO_2$$

Calculate the volume, in cm^3, of sulfur dioxide gas that would be produced at room temperature and pressure (rtp) when the fuel burns.

[for a gas, molar volume = 24 dm^3 at rtp]

(3)

volume of sulfur dioxide = ... cm^3

(iii) State the name of the environmental problem caused by sulfur dioxide in the atmosphere.

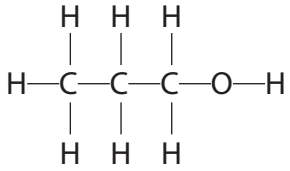
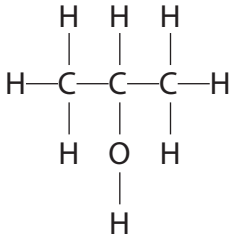
(1)

.....

(Total for Question 3 = 9 marks)

4 (a) Hand sanitiser liquids are used regularly to reduce the spread of infections.

Three compounds P, Q and R are often present in these liquids.

P	Q	R
CH_3CH_2OH		

(i) What type of formula is shown for P?

(1)

- ☒ **A** a displayed formula
- ☒ **B** an empirical formula
- ☒ **C** a molecular formula
- ☒ **D** a structural formula

(ii) Compounds P, Q and R are members of the same homologous series.

Give two properties of a homologous series.

(2)

1 .....

.....

2 .....

.....

(iii) Name the homologous series that contains compounds P, Q and R.

(1)

.....

(iv) Give the name of compound Q.

(1)

.....

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(b) Diols and dicarboxylic acids react together in polymerisation reactions to form polyesters.

(i) Explain the name given to the type of polymerisation that occurs in these reactions.

(2)

.....

.....

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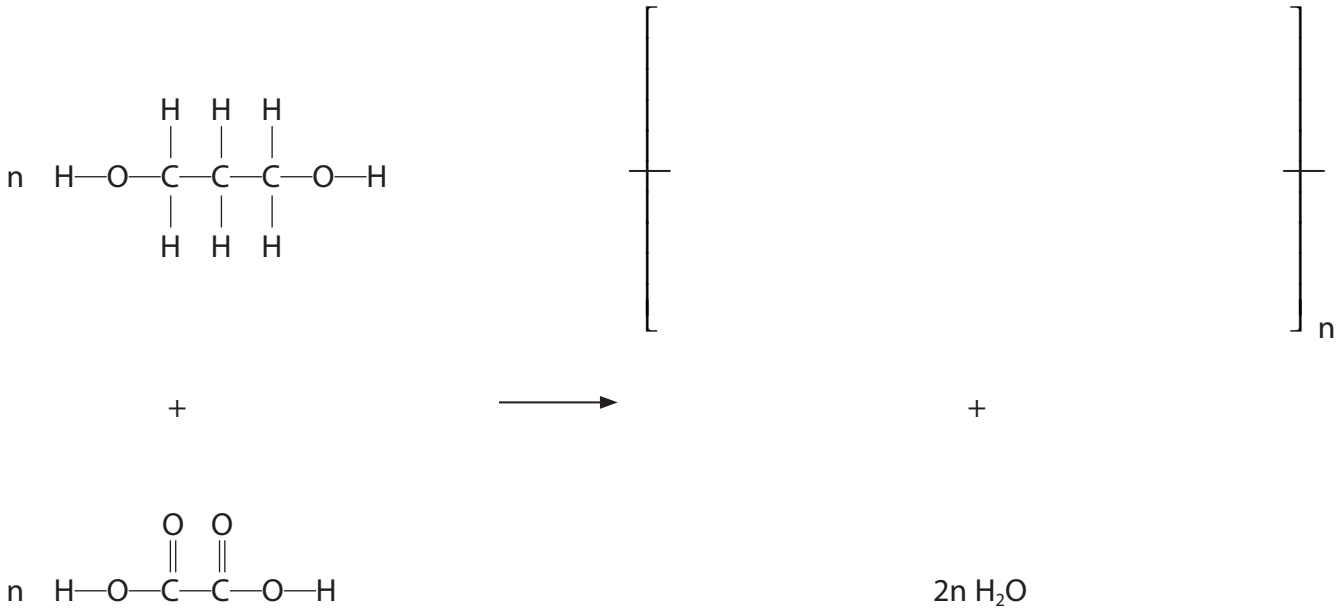
(ii) Complete the equation for the polymerisation reaction by giving the displayed formula of the repeat unit of the polymer.

(2)



(Total for Question 4 = 9 marks)

5 This question is about the element phosphorus and some of its compounds.

(a) The atomic number of phosphorus is 15

Give the electronic configuration of an atom of phosphorus.

(1)

.....

(b) Calcium phosphide is an ionic compound used in pest control.

The formula of a calcium ion is Ca^{2+}

Explain why the formula of calcium phosphide is Ca_3P_2

(2)

.....

.....

.....

.....

(c) Calcium phosphide can be produced by heating calcium phosphate with carbon.

(i) Complete the equation for the reaction.

(1)

$$Ca_3(PO_4)_2 + \text{.....} C \rightarrow Ca_3P_2 + \text{.....} CO$$

(ii) Explain the role of carbon in the reaction.

(2)

.....

.....

.....

.....

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(d) Calcium phosphide reacts with water to form calcium hydroxide and phosphine, PH_3

Give a chemical equation for this reaction.

(2)

(e) Explain why calcium phosphide has a high melting point.

You should refer to structure and bonding in your answer.

(3)

(Total for Question 5 = 11 marks)

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6 Iron metal was discovered several thousand years ago. Iron is produced industrially from iron(III) oxide by extraction using carbon.

Sodium is a metal in Group 1 of the Periodic Table. Sodium was discovered by Sir Humphrey Davy in 1807. It is produced industrially by the electrolysis of sodium chloride.

(a) (i) Explain, using the reactivity series, why carbon can be used to extract iron from iron(III) oxide.

(2)

.....

.....

.....

.....

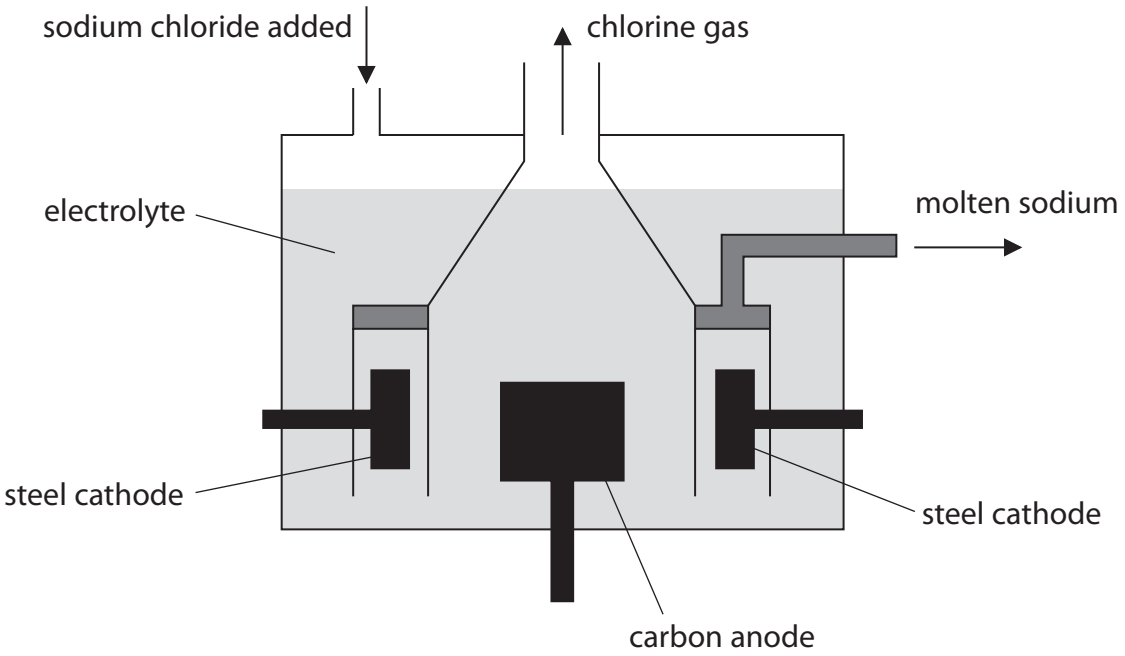
(ii) Suggest why sodium was not discovered until 1807.

(1)

.....

.....

(b) The diagram shows a simplified version of the Downs cell, which can be used to produce sodium industrially. The electrolyte is molten sodium chloride.



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(i) Explain why the molten electrolyte conducts electricity.

(2)

(ii) What is the formula of the cation in the electrolyte?

(1)

- ☒ **A** H^+
- ☒ **B** Cl^-
- ☒ **C** Na^+
- ☒ **D** OH^-

(iii) During the production of sodium, small explosions can be heard.

Explain why using sodium chloride that is not completely dry could cause these small explosions.

(2)

(iv) Give ionic half-equations for the reactions at the anode and cathode.

(2)

anode .....

cathode .....

(c) Explain why the reactivity of metals in Group 1 increases from lithium to potassium.

(3)

(Total for Question 6 = 13 marks)

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7 A student is asked to find the concentration of a solution of nitric acid by doing a titration.

The student is provided with sodium hydroxide solution with a concentration of 0.350 mol/dm^3

These are the first four steps in the student's method.

- use a pipette to add exactly 25.0 cm^3 of the nitric acid solution to a conical flask placed on a white tile
- add a few drops of indicator to the flask
- use a burette to add sodium hydroxide solution to the flask until the indicator has changed colour
- record the volume needed for the indicator to change colour

(a) Give the reason for using the white tile.

(1)

.....

.....

(b) Universal indicator is not a suitable indicator to use in a titration.

Complete the table to show the name of a suitable indicator and its final colour in this titration.

(2)

Indicator	Final colour in titration

(c) The student wants to obtain an accurate value for the volume of sodium hydroxide solution needed to neutralise the 25.0 cm^3 of nitric acid.

Describe all the further steps the student should take.

(5)

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(d) This is a summary of the student's results.

volume of HNO_3 used = 25.0 cm^3

concentration of NaOH solution = 0.350 mol/dm^3

volume of NaOH solution needed for neutralisation = 18.80 cm^3

The equation for the reaction is

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

(i) Calculate the amount, in moles, of NaOH that reacts.

(1)

amount of NaOH = ... mol

(ii) Determine the amount, in moles, of HNO_3 that reacts.

(1)

amount of HNO_3 = ... mol

(iii) Calculate the concentration, in mol/dm^3, of the HNO_3

(1)

concentration = ... mol/dm^3

(Total for Question 7 = 11 marks)

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8 This question is about reactions involving nitrogen.

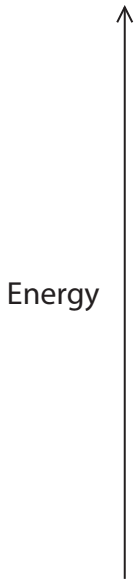
(a) In a car engine, nitrogen reacts with oxygen to form nitrogen monoxide.

The equation for the reaction is

$$N_2 + O_2 \rightarrow 2NO \qquad \Delta H = +181\ kJ$$

Draw a labelled reaction profile diagram showing ΔH and the activation energy for the reaction.

(4)



(b) In the Haber process, nitrogen reacts with hydrogen to form ammonia.
This equation represents the reaction.

$$N{\equiv}N + 3\,H{-}H \rightarrow 2\,H{-}\underset{\displaystyle H}{\overset{\displaystyle |}{N}}{-}H$$

The table gives values of some bond energies.

Bond	Bond energy in kJ/mol
N≡N	944
H—H	436
N—H	391

(i) Calculate the total amount of energy, in kJ, needed to break the bonds in the reactants.

(1)

energy needed = ... kJ

(ii) Calculate the total amount of energy, in kJ, released in forming the bonds in the product.

(1)

energy released = ... kJ

(iii) Calculate the enthalpy change, ΔH, for the reaction.

You should include a sign in your answer.

(2)

ΔH = ... kJ

(Total for Question 8 = 8 marks)

TOTAL FOR PAPER = 70 MARKS

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