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Candidates surname					Other names				
Centre Number					Candidate Number				
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**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

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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**Answer ALL questions.**

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

**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)**

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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  $50.0\text{ cm}^3$  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  $50.0\text{ cm}^3$  of water into a beaker

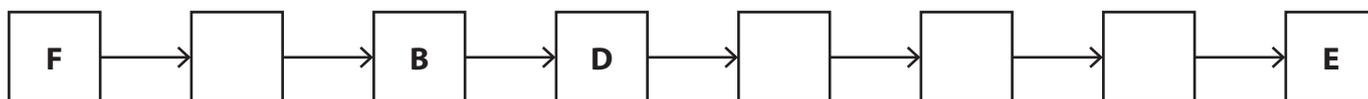
**Step G** add the salt to the water a little at a time and stir until no more dissolves

**Step H** pour the  $50.0\text{ cm}^3$  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)



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(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<sup>3</sup> of water has a mass of 1.00 g]

(2)

solubility = ..... grams per 100 g of water

**(Total for Question 2 = 5 marks)**

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3 When 10.0 kg of a solid fuel is burned, the heat energy produced is  $3.28 \times 10^5$  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 = ..... %

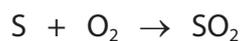
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- (ii) When the fuel burns, the 600 g of sulfur produces sulfur dioxide gas.



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

[for a gas, molar volume =  $24 \text{ dm}^3$  at rtp]

(3)

volume of sulfur dioxide = .....  $\text{cm}^3$

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

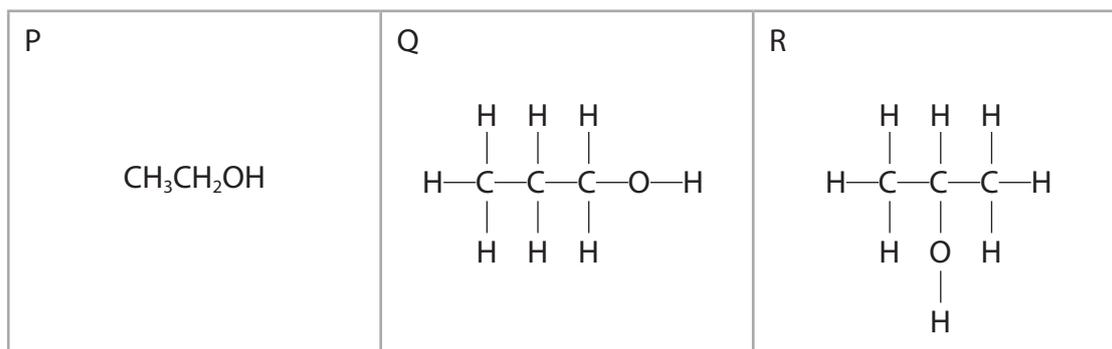
(1)

(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.



(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)

.....



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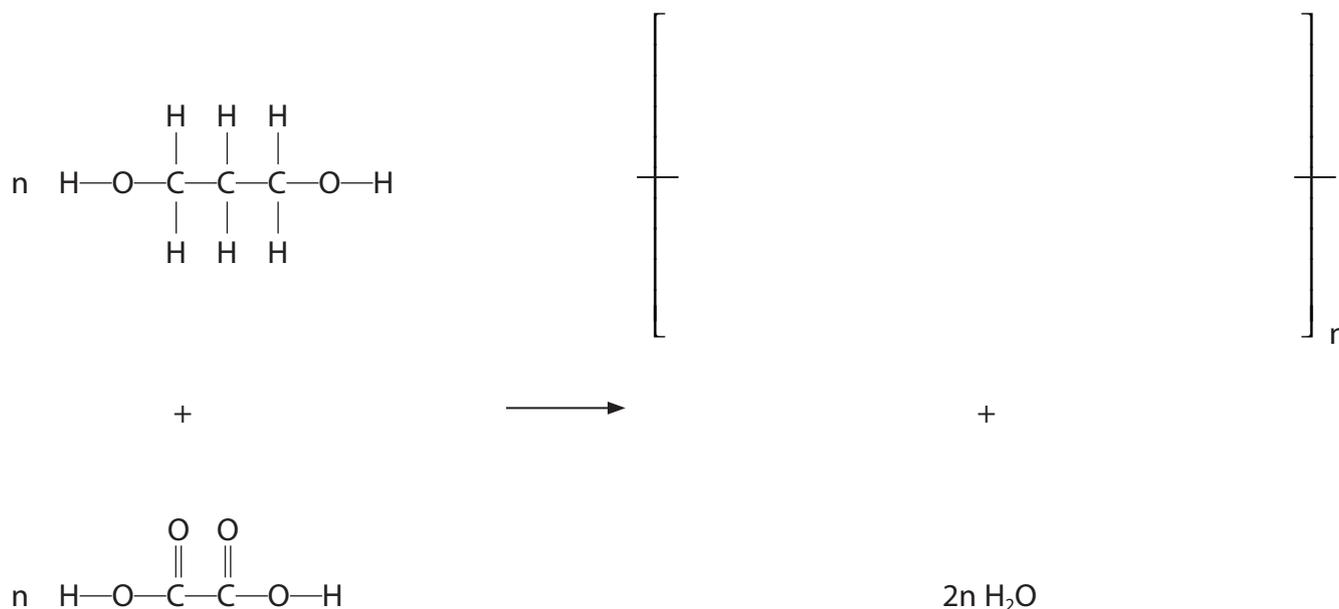
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(ii) Complete the equation for the polymerisation reaction by giving the displayed formula of the repeat unit of the polymer.

(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  $\text{Ca}^{2+}$

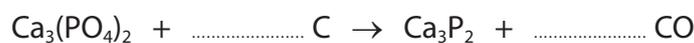
Explain why the formula of calcium phosphide is  $\text{Ca}_3\text{P}_2$

(2)

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

(i) Complete the equation for the reaction.

(1)



(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,  $\text{PH}_3$

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)**



P 7 1 8 9 5 A 0 1 1 2 4

- 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.

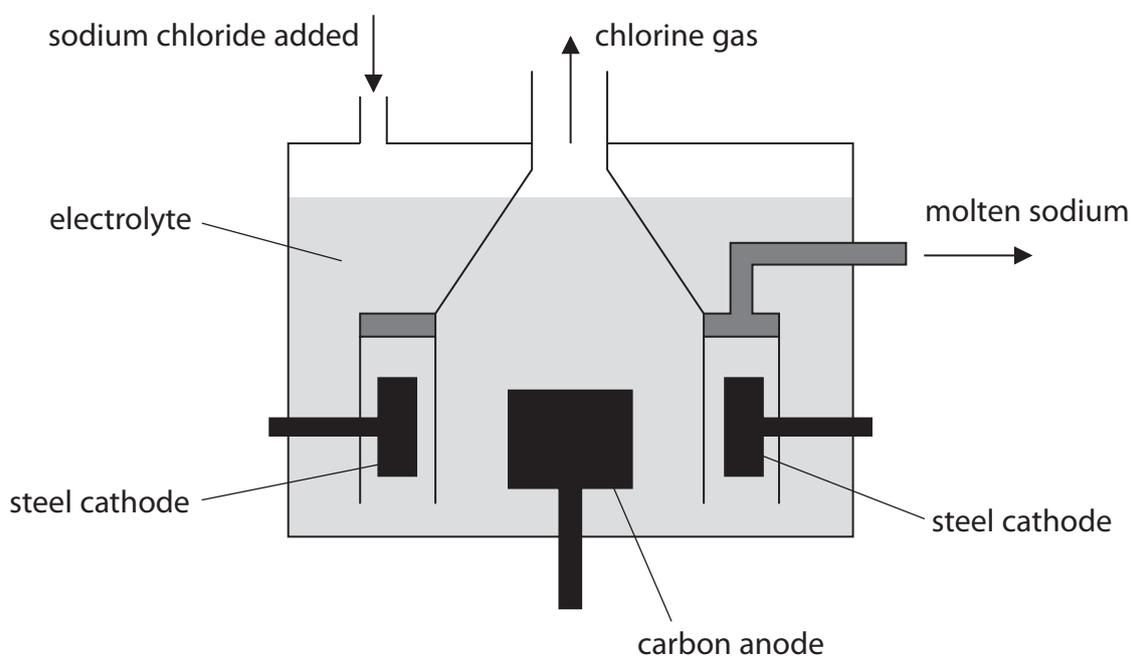
- (a) (i) Explain, using the reactivity series, why carbon can be used to extract iron from iron(III) oxide.

(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.



(i) Explain why the molten electrolyte conducts electricity.

(2)

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

(1)

- A**  $\text{H}^+$
- B**  $\text{Cl}^-$
- C**  $\text{Na}^+$
- D**  $\text{OH}^-$

(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 .....

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

(3)

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**(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  $0.350 \text{ mol/dm}^3$

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

- use a pipette to add exactly  $25.0 \text{ cm}^3$  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

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

Describe all the further steps the student should take.

(5)

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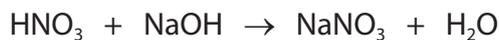
(d) This is a summary of the student's results.

volume of  $\text{HNO}_3$  used =  $25.0 \text{ cm}^3$

concentration of NaOH solution =  $0.350 \text{ mol/dm}^3$

volume of NaOH solution needed for neutralisation =  $18.80 \text{ cm}^3$

The equation for the reaction is



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

(1)

amount of NaOH = ..... mol

(ii) Determine the amount, in moles, of  $\text{HNO}_3$  that reacts.

(1)

amount of  $\text{HNO}_3$  = ..... mol

(iii) Calculate the concentration, in  $\text{mol/dm}^3$ , of the  $\text{HNO}_3$

(1)

concentration = .....  $\text{mol/dm}^3$

**(Total for Question 7 = 11 marks)**



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8 This question is about reactions involving nitrogen.

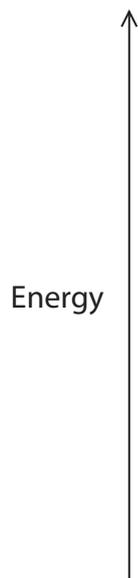
(a) In a car engine, nitrogen reacts with oxygen to form nitrogen monoxide.

The equation for the reaction is



Draw a labelled reaction profile diagram showing  $\Delta H$  and the activation energy for the reaction.

(4)



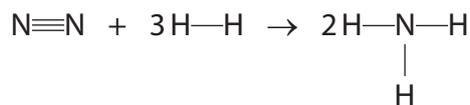
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- (b) In the Haber process, nitrogen reacts with hydrogen to form ammonia.  
This equation represents the reaction.



The table gives values of some bond energies.

Bond	Bond energy in kJ/mol
$\text{N}\equiv\text{N}$	944
$\text{H}-\text{H}$	436
$\text{N}-\text{H}$	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,  $\Delta H$ , for the reaction.

You should include a sign in your answer.

(2)

$\Delta H = \dots\dots\dots$  kJ

**(Total for Question 8 = 8 marks)**

**TOTAL FOR PAPER = 70 MARKS**

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