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Surname

Other names

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Centre Number

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# Chemistry

**Unit: KCH0/4CH0**

**Science (Double Award) KSC0/4SC0**

**Paper: 1C**

Thursday 18 May 2017 – Morning

**Time: 2 hours**

Paper Reference

**KCH0/1C 4CH0/1C  
KSC0/1C 4SC0/1C**

**You must have:**

Calculator, ruler

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.*
- Show all the steps in any calculations and state the units.
- 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 ☒.

## Information

- The total mark for this paper is 120.
- 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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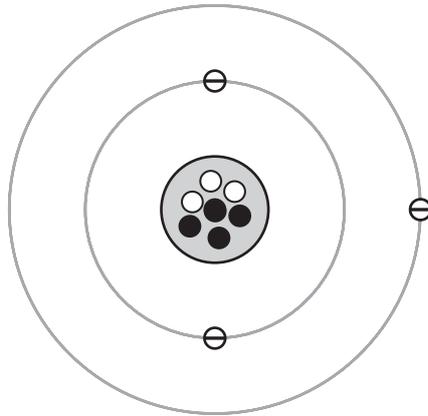
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**Answer ALL questions.**

1 The diagram represents an atom of an element.



**Key:**

- ⊖ electron
- proton
- neutron

Use numbers from the box to complete the table.

You may use each number once, more than once or not at all.

- |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|

(5)

atomic number of the atom	
number of shells shown	
mass number of the atom	
number of protons in an isotope of this element	
group where the element is found in the Periodic Table	

**(Total for Question 1 = 5 marks)**



2 Substances can be classified as elements, compounds or mixtures.

(a) Which of these is the formula for a molecule of an element?

(1)

- A H
- B H<sub>2</sub>
- C H<sub>2</sub>O
- D H<sub>2</sub>O<sub>2</sub>

(b) Which of these is a mixture?

(1)

- A sodium
- B chlorine
- C sodium chloride
- D sodium chloride solution

(c) Which method can be used to separate the dyes in a food colouring?

(1)

- A chromatography
- B crystallisation
- C evaporation
- D filtration



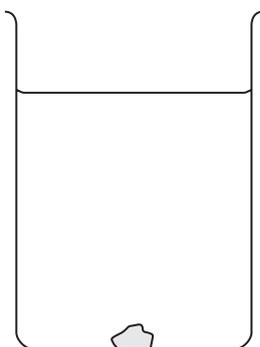
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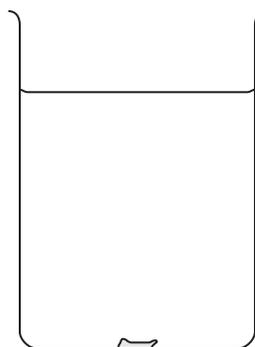
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(d) A student adds a large crystal of sodium chloride to some water in a beaker and leaves the beaker for a day.

The diagram shows the beaker immediately after adding the crystal, and after one day.



immediately after adding crystal



after a day

After a day, the student takes a sample from the top of the liquid and tests it to see if it contains chloride ions.

The test is positive.

(i) Describe how the student should do the test.

Include the observation for a positive test in your answer.

(3)

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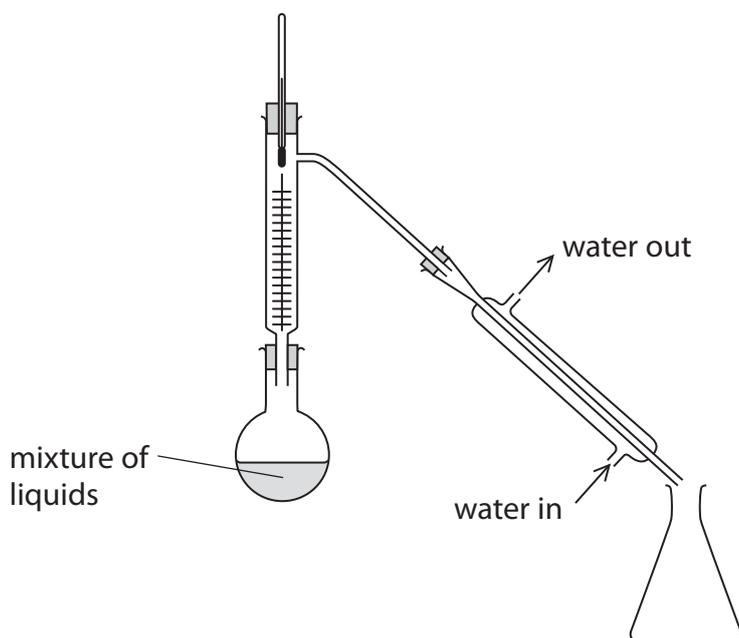
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(ii) Name the process by which chloride ions move from the crystal to the top of the liquid.

(1)

.....

- (e) This apparatus is used in a laboratory to separate a mixture of liquids with similar boiling points.



- (i) The passage describes what happens when the apparatus is used.

Use words from the box to complete the passage.

You may use each word once, more than once or not at all.

(3)

beaker	burette	column
condenser	flask	thermometer

The mixture of liquids is placed in the .....

During heating, part of the mixture boils and passes up the .....

Water is used to cool the vapour in the .....

(ii) Which of these changes of state occurs in the separation?

(1)

**A** (s) → (aq)

**B** (l) → (s)

**C** (g) → (l)

**D** (aq) → (s)

(Total for Question 2 = 11 marks)

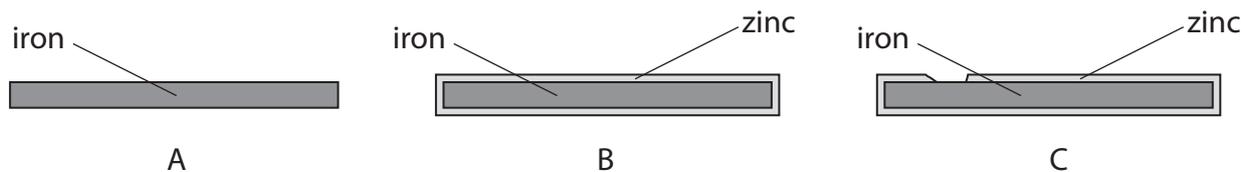
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3 The diagram shows three pieces of iron.



A is a piece of iron.

B is a piece of iron with a thin coating of zinc.

C is a piece of iron with some of the zinc coating missing.

(a) Name the process used to coat iron with zinc.

(1)

(b) The three pieces of iron are left in separate troughs of water and exposed to the atmosphere for several weeks.

The table shows the appearance of the pieces of iron after several weeks.

	Appearance
A	covered in a brown solid
B	shiny and unchanged in appearance
C	shiny and unchanged in appearance

(i) The brown solid contains hydrated iron(III) oxide.

What is the common name for this brown solid?

(1)

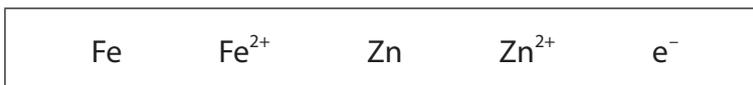
(ii) Identify the two substances that react with iron to form the brown solid.

(2)

1 .....

2 .....

(iii) Explain, with reference to the symbols in the box, why the brown solid does not form on C.



(3)

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**(Total for Question 3 = 7 marks)**

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4 The table shows the formulae of some positive and negative ions.

It also shows the formulae of some compounds containing these ions.

	$\text{Cu}^{2+}$	$\text{Fe}^{3+}$	$\text{NH}_4^+$
$\text{Cl}^-$		$\text{FeCl}_3$	$\text{NH}_4\text{Cl}$
$\text{SO}_4^{2-}$	$\text{CuSO}_4$	$\text{Fe}_2(\text{SO}_4)_3$	
$\text{CO}_3^{2-}$	$\text{CuCO}_3$		$(\text{NH}_4)_2\text{CO}_3$

(a) Complete the table by giving the formulae of the three missing compounds.

(3)

(b) The correct name of the compound with the formula  $\text{CuSO}_4$  is

(1)

- A copper(I) sulfate
- B copper(I) sulfite
- C copper(II) sulfate
- D copper(II) sulfite

(c) Which of these descriptions is correct for  $\text{NH}_4\text{Cl}(\text{s})$  and for  $\text{NH}_4\text{Cl}(\text{aq})$ ?

(1)

	$\text{NH}_4\text{Cl}(\text{s})$	$\text{NH}_4\text{Cl}(\text{aq})$
<input type="checkbox"/> A	colourless	colourless
<input type="checkbox"/> B	colourless	white
<input type="checkbox"/> C	white	colourless
<input type="checkbox"/> D	white	white

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(d) These tests are carried out on two separate samples of iron(III) sulfate solution.

test 1    add sodium hydroxide solution

test 2    add dilute hydrochloric acid, then add barium chloride solution

(i) Which observation is correct for test 1? (1)

- A brown precipitate
- B brown solution
- C green precipitate
- D green solution

(ii) Give the names of the two products formed in test 1. (2)

..... and .....

(iii) In test 2, there is no visible change after adding dilute hydrochloric acid.  
State why the acid is added. (1)

(iv) In test 2, barium sulfate is formed after adding barium chloride solution.  
State the observation that is made. (1)



(e) Describe a test to show that a sample of  $\text{CuCO}_3$  contains the  $\text{CO}_3^{2-}$  ion.

(3)

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**(Total for Question 4 = 13 marks)**

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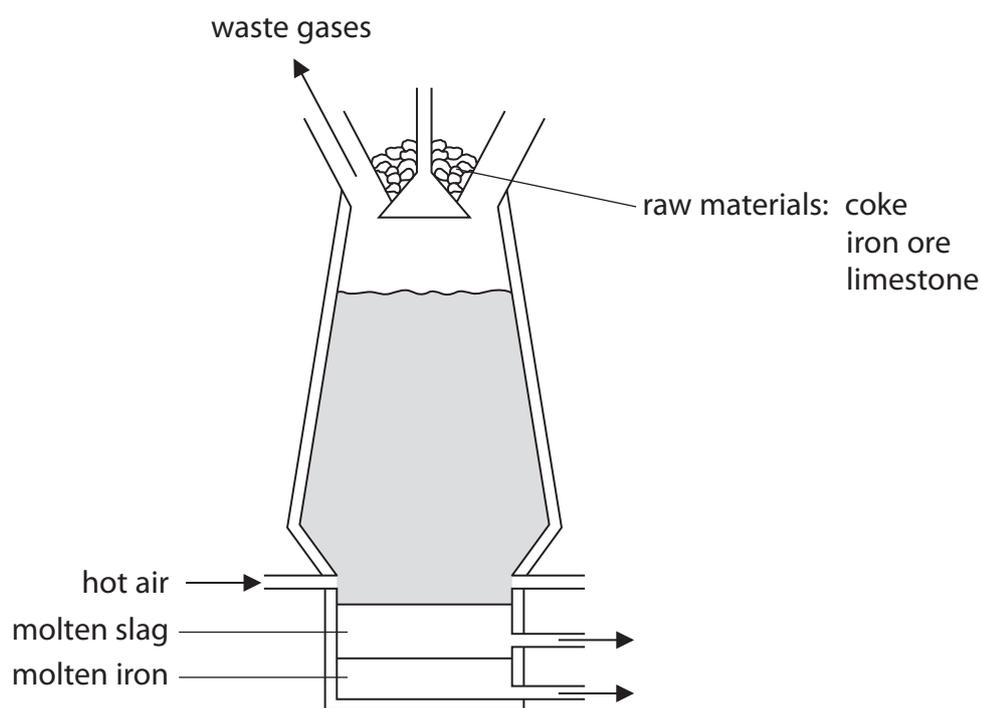
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5 The diagram shows a blast furnace used to extract iron from its ore.



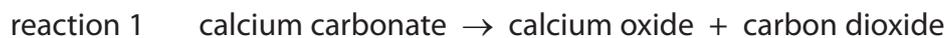
(a) State the purpose of these reactions in the blast furnace.



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(b) Iron ore contains the impurity silicon dioxide. The purpose of the limestone is to remove this impurity.

The word equations for the reactions that occur are



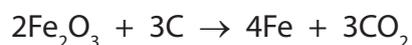
Write a chemical equation for each of these reactions.

(2)

reaction 1 .....

reaction 2 .....

(c) The equation for a reaction that occurs in the blast furnace is



Explain, with reference to the reactants in this equation, why this is a redox reaction.

(2)

.....  
.....  
.....  
.....

**(Total for Question 5 = 6 marks)**



6 Poly(ethene) is a common polymer. It is obtained from crude oil by fractional distillation, cracking and polymerisation.

(a) The passage is about the fractional distillation of crude oil.

Use words from the box to complete the passage.

You may use each word once, more than once or not at all.

(4)

boiling point	condensation	melting point
sublimation	temperature	vaporisation

The crude oil is heated so that ..... occurs. The column has a ..... gradient. The compounds in the crude oil pass up the column and ..... occurs at different heights depending on the ..... of each fraction.

(b) The table lists some statements about cracking.

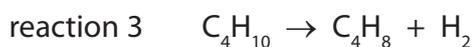
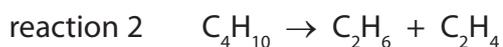
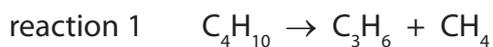
Place ticks (✓) in the boxes to show the three correct statements.

(3)

the molecules that are cracked are hydrocarbons	
catalytic cracking uses iron as the catalyst	
cracking is used because of different demands for hydrocarbons	
cracking reactions are examples of addition reactions	
cracking produces molecules with shorter chains	
$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ is an equation for a cracking reaction	

(c) When one molecule of butane is cracked, there are three possible reactions.

The equations for these reactions are



(i) One product in each of these reactions is an alkene.

What is the general formula for the homologous series of alkenes?

(1)

(ii) What are the names of the products of reaction 1?

(2)

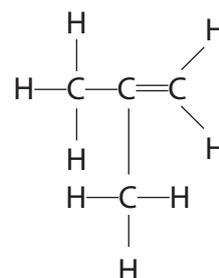
and

(iii) Draw the displayed formula of the saturated product of reaction 2.

(1)

(iv) The hydrocarbon formed in reaction 3 has three isomers.

The displayed formula for one of the isomers is



Draw the displayed formula for each of the two other isomers.

(2)

isomer 1	isomer 2
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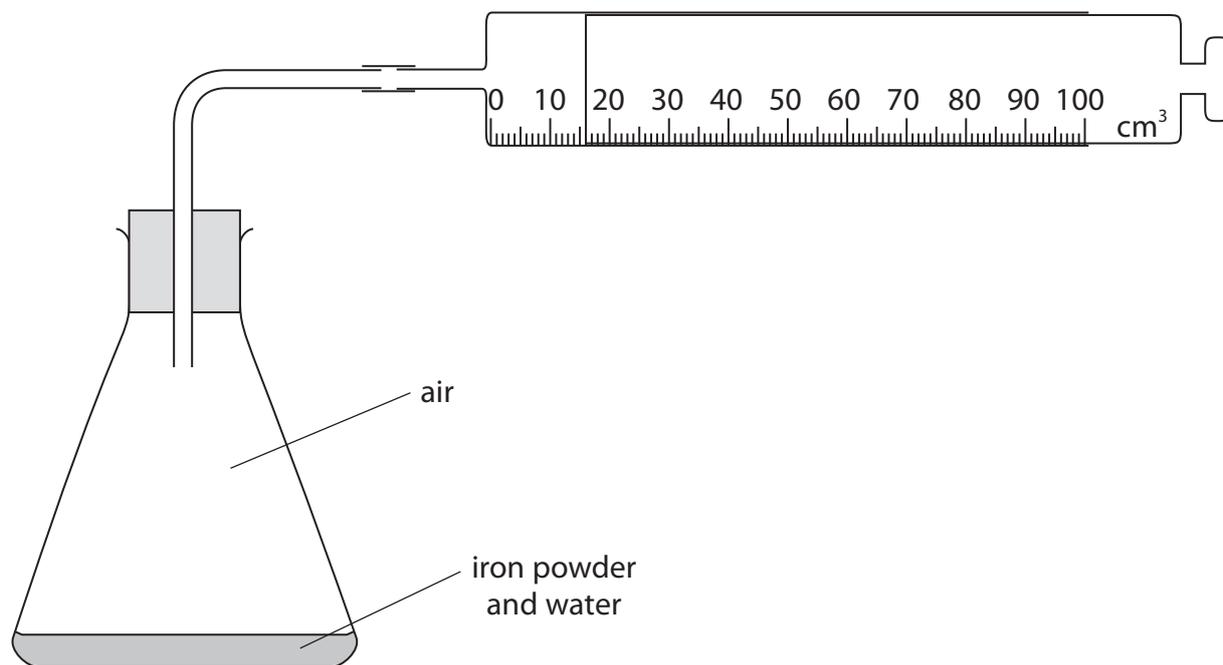
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7 A student uses the reaction between iron and oxygen in an experiment to find the percentage by volume of oxygen in air.

The diagram shows his apparatus.



(a) State the advantage of using iron powder rather than pieces of iron.

(1)

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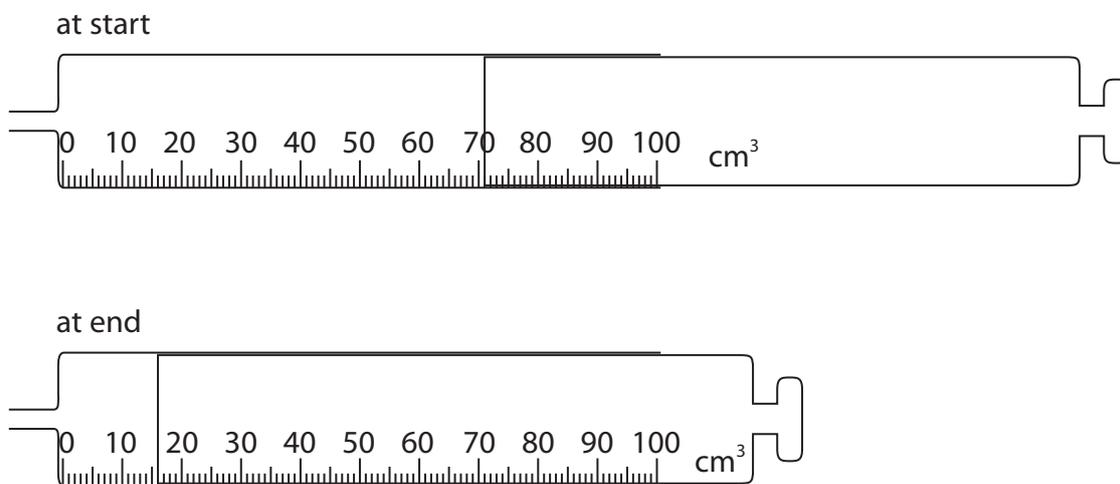
(b) Why is it necessary for the student to mix the iron powder with water?

(1)

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- (c) The student records the reading on the syringe at the start of the experiment. He then records the reading every day until there is no further change.

The diagram shows the syringe at the start and at the end of the experiment.



Use the readings to complete the table, entering all values to the nearest  $1 \text{ cm}^3$ .

(3)

volume reading at start in $\text{cm}^3$	
volume reading at end in $\text{cm}^3$	
change in volume in $\text{cm}^3$	

- (d) The student repeats the experiment but obtains a much smaller change in volume.

Which of these could be a reason for the smaller change in volume?

(1)

- A** he uses  $10 \text{ cm}^3$  of water instead of  $5 \text{ cm}^3$
- B** he leaves the apparatus for a longer time
- C** he leaves the apparatus in a warmer place
- D** he uses a smaller mass of iron powder

(e) During another experiment, the student writes down these values.

volume of air in conical flask and glass tube	250 cm <sup>3</sup>
syringe reading at start	90
syringe reading at end	20
volume of oxygen reacting	70 cm <sup>3</sup>

The student incorrectly calculates the percentage by volume of oxygen in air.

This is his working.

$$\frac{70 \times 100}{90} = 78\%$$

(i) Identify the mistake in his working.

(1)

(ii) Use values from the table to correctly calculate the percentage by volume of oxygen in air.

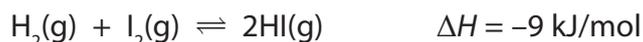
(2)

percentage = ..... %

**(Total for Question 7 = 9 marks)**

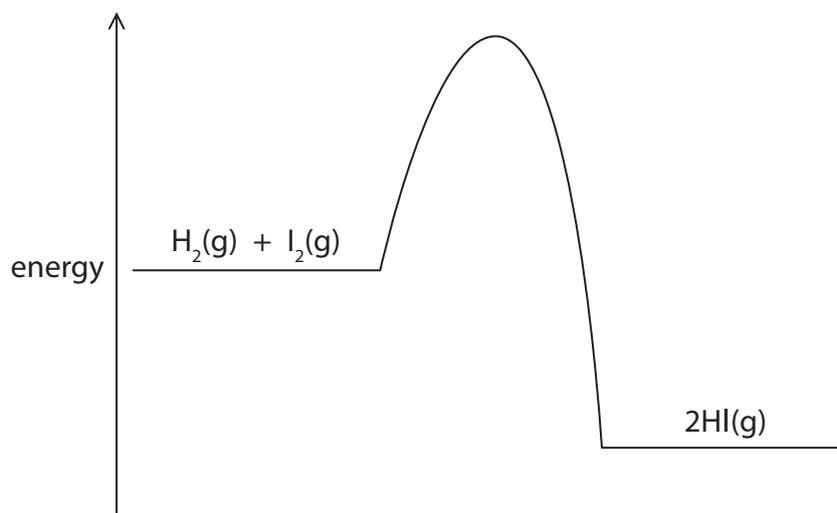


- 8 Hydrogen iodide can be manufactured from its elements using this reaction.



A temperature of  $500^\circ\text{C}$ , a pressure of 4 atm and a platinum catalyst are used in this manufacturing process.

- (a) The diagram shows the reaction profile if a catalyst is not used.



- (i) On the diagram, draw the reaction profile when a platinum catalyst is used. (1)
- (ii) Label the diagram to show the enthalpy change ( $\Delta H$ ) and the activation energy ( $E_{\text{cat}}$ ) for the reaction with the catalyst. (2)
- (b) A manufacturer carries out this reaction using the same catalyst, a pressure of 4 atm, but a temperature of  $400^\circ\text{C}$ .
- (i) State the effect of this change in temperature on the rate of the reaction. (1)

- (ii) Explain the effect of this change on the yield of hydrogen iodide. (2)

(c) The manufacturer then carries out this reaction using the same catalyst, a temperature of 500 °C, but a pressure of 2 atm.

(i) Suggest what effect this change in pressure would have on the rate of the reaction. (1)

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.....

(ii) Explain the effect of this change on the yield of hydrogen iodide. (2)

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**(Total for Question 8 = 9 marks)**

9 Bromine, chlorine and iodine are elements in Group 7 of the Periodic Table.

(a) Place ticks (✓) in the boxes to show the three correct statements about the elements in Group 7.

(3)

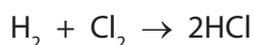
the elements can be obtained by electrolysis of molten metal halides	
the elements with paler colours are lower down the group	
the boiling points decrease down the group	
the elements form covalent compounds with other non-metals	
their molecules contain two atoms	
all are gases at room temperature	

(b) Group 7 elements are called halogens because they react with metals to form salts.

Write a chemical equation to show the formation of the salt potassium iodide from a metal and a halogen.

(1)

(c) The equation for the reaction between hydrogen and chlorine is



At room temperature, hydrogen chloride and hydrochloric acid can both be represented by the formula HCl.

Insert the state symbol after each formula.

(2)

hydrogen chloride, HCl(.....)

hydrochloric acid, HCl(.....)

(d) Hydrogen chloride is dissolved in methylbenzene.

When a piece of magnesium ribbon is then added to this solution there is no reaction.

When water is added to this mixture and it is shaken, a reaction occurs.

Explain the observation in this reaction.

(3)

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(e) Halogens can take part in displacement reactions with halides.

The table gives information about the addition of halogen solutions to halide solutions.

Test	Halogen solution added	Halide solution	Result
1	bromine	sodium iodide	displacement reaction occurs
2	chlorine	sodium chloride	no reaction
3	iodine	sodium chloride	no reaction

(i) Explain which test gives a result that **cannot** be used to compare the reactivities of halogens.

(2)

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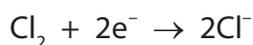
(ii) Which observation shows that a displacement reaction occurs in test 1?

(1)

- A effervescence is seen
- B purple fumes appear
- C the solution becomes darker
- D a white precipitate forms

(f) Astatine is an element in Group 7 that could also be involved in displacement reactions.

The ionic half-equations for one of these reactions would be



(i) Write an ionic equation for this displacement reaction.

(1)

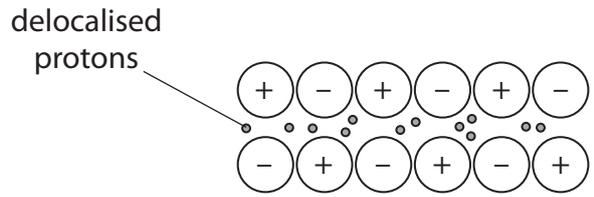
(ii) Explain, with reference to the appropriate species and to electrons, why this reaction is described as a redox reaction.

(2)

**(Total for Question 9 = 15 marks)**

10 This question is about magnesium and its compounds.

(a) A student draws this labelled diagram to show the particles in magnesium metal.



He makes two mistakes.

State the two corrections he should make to his labelled diagram.

(2)

1 .....

2 .....

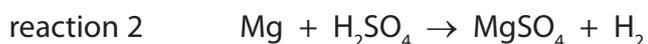
(b) Explain why magnesium metal is malleable and a good conductor of electricity.

(4)

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- (c) Magnesium is a reactive metal. Its reactivity can be seen in its reactions with oxygen and dilute sulfuric acid.

The chemical equations for these reactions are



- (i) In reaction 1, some magnesium is ignited and then placed in a jar of oxygen gas.

State two observations that would be made.

(2)

1 .....

2 .....

- (ii) Which of these is a correct statement about the gas formed in reaction 2?

(1)

- A** it makes a squeaky pop with a lighted splint
- B** it relights a glowing splint
- C** it turns damp blue litmus paper red
- D** it turns limewater milky

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(d) The student used this method to obtain a sample of magnesium sulfate crystals from the solution formed in reaction 2.

- heat the solution in a beaker for several minutes
- dip a glass rod into the hot solution for a few seconds and then remove it
- allow the solution to cool to room temperature
- filter off the crystals and then dry them

(i) Why does the student heat the solution?

(1)

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.....

(ii) Explain why the student dips a glass rod into the heated solution.

(2)

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(iii) Give the formulae of the two compounds that pass through the filter paper.

(2)

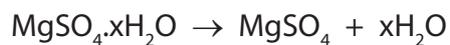
1 .....

2 .....



- (e) After drying the crystals, the student weighs them and then heats them until they reach a constant mass.

This equation represents the change that occurs during heating.



These are the student's results.

mass of dry crystals before heating = 17.2 g

mass of crystals after heating to a constant mass = 8.3 g

Use these results to find the value of  $x$  in the formula of  $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$

[ $M_r$  values:  $\text{MgSO}_4 = 120$ ,  $\text{H}_2\text{O} = 18$ ]

(4)

value of  $x = \dots\dots\dots$

**(Total for Question 10 = 18 marks)**

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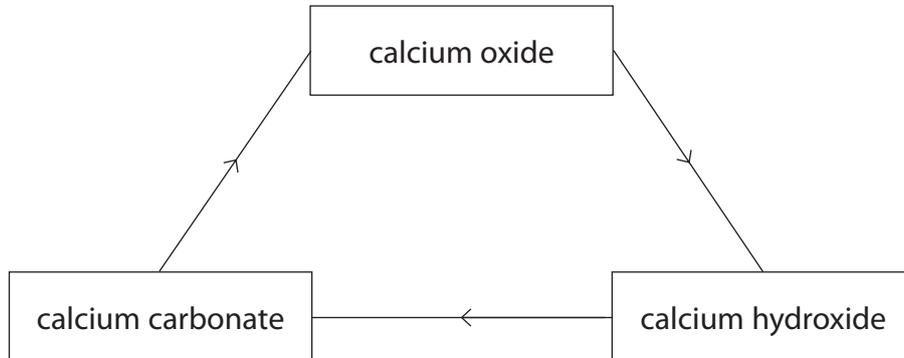
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11 This question is about calcium compounds.

(a) The diagram gives information about the reactions of some calcium compounds used to make mortar.

Mortar contains calcium hydroxide and is used to join bricks together when building walls.

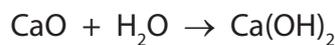


These reactions occur when the calcium hydroxide in mortar is obtained from calcium carbonate.

- calcium carbonate is strongly heated to form calcium oxide
- water is added to calcium oxide to form calcium hydroxide

The calcium hydroxide in mortar reacts with carbon dioxide from the atmosphere to form calcium carbonate.

(i) The equation for one of these reactions is



Calculate the mass of water needed to react exactly with 28 kg of calcium oxide.

(3)

mass of water = .....

(ii) Explain why the reaction between carbon dioxide and calcium hydroxide can be described as neutralisation.

(2)

.....

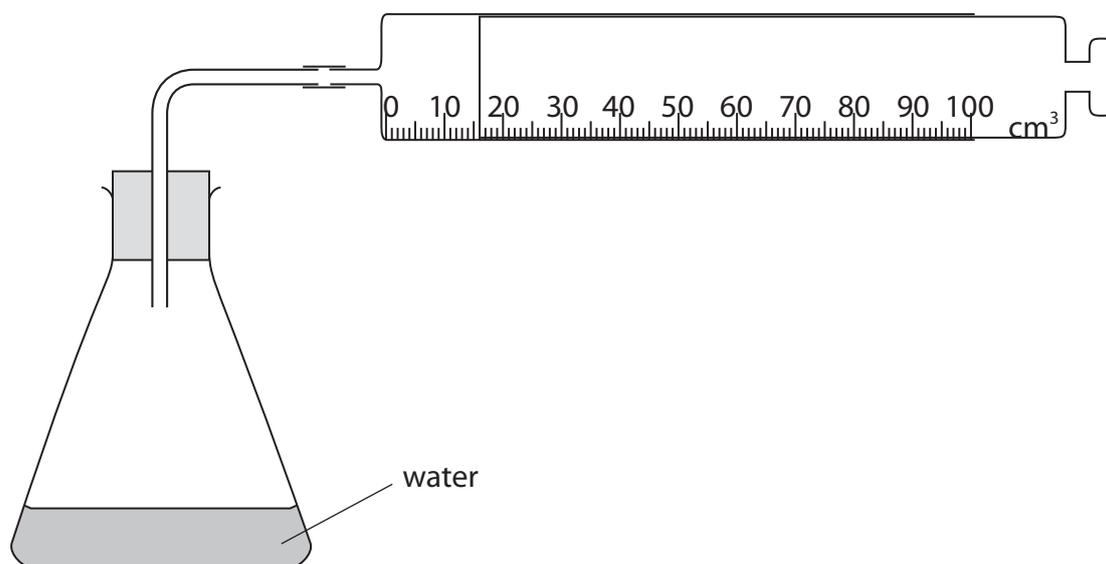
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(b) Calcium carbide is a reactive solid. When water is added to it, a gas (ethyne) is formed.

A teacher uses this apparatus to investigate the rate of reaction between calcium carbide and water.



This is the teacher's method.

- record the temperature of the water in the flask
- add a known mass of calcium carbide and replace the bung in the flask
- record the time taken to collect  $100\text{ cm}^3$  of gas in the syringe

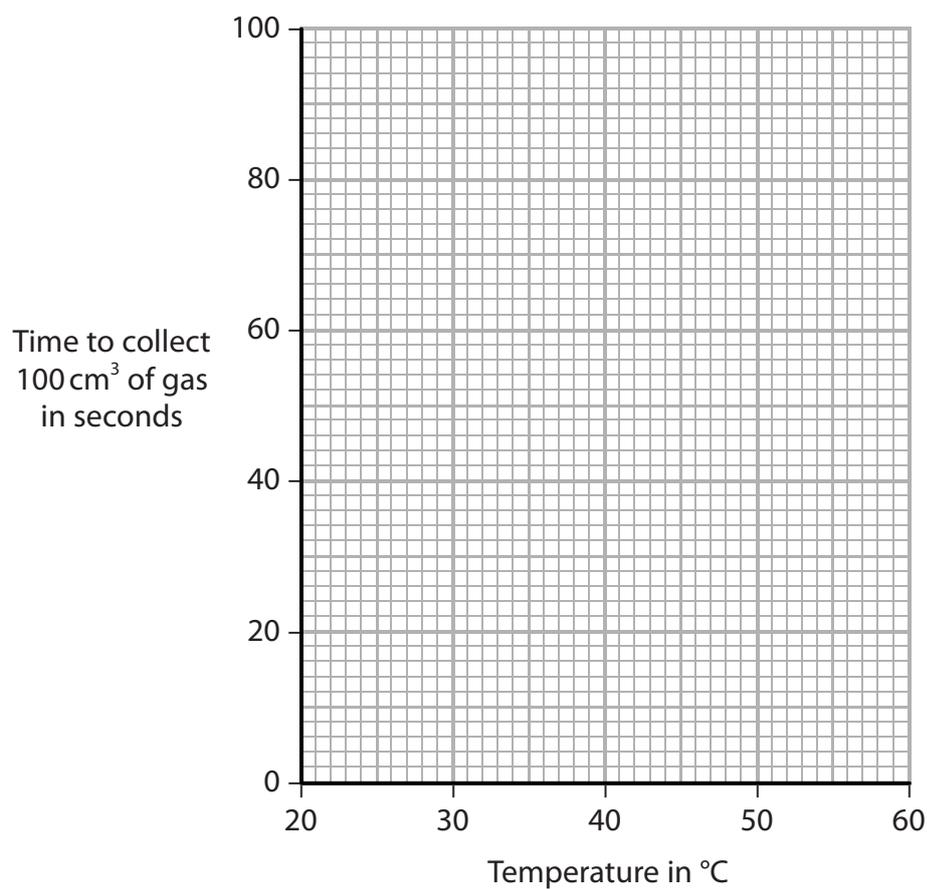
The teacher repeats the experiment using the same volume of water and the same mass of calcium carbide, but with the water at different temperatures.

The table shows the results for six different temperatures.

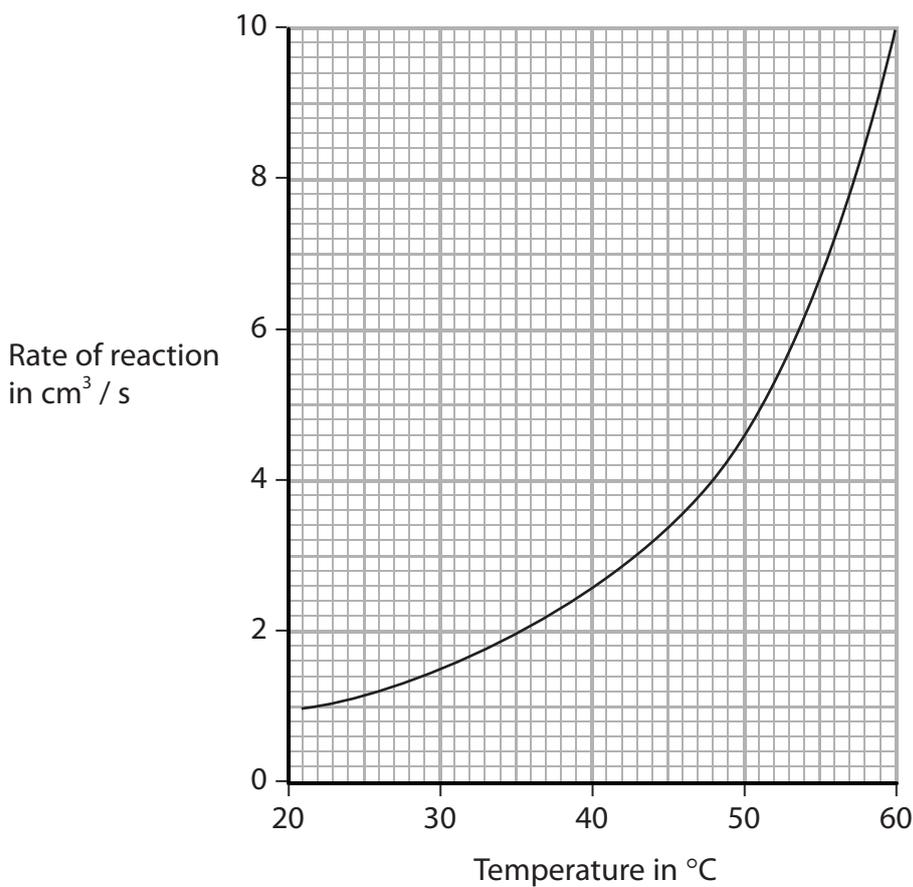
<b>Temperature of water in °C</b>	21	32	40	49	56	60
<b>Time to collect 100 cm<sup>3</sup> of gas in seconds</b>	100	59	38	24	14	10

Plot these results on the grid and draw a curve of best fit.

(3)



(c) The teacher plots this graph to show how the rate of reaction varies with temperature.



Her graph shows that the rate of reaction is not directly proportional to temperature.

There are two reasons why the rate of reaction increases as the temperature increases.

One reason is that the water molecules move more quickly and collide more frequently with calcium carbide particles.

Explain the other reason for the increase in the rate of reaction.

(3)

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

**TOTAL FOR PAPER = 120 MARKS**

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