1 (a) Chlorine reacts with potassium bromide in solution to form bromine and potassium chloride.

(i) What type of reaction is taking place?

Put a cross (☒) in the box next to your answer.

(1)

☐ **A** displacement

☐ **B** distillation

☐ **C** neutralisation

☐ **D** precipitation

(ii) State the colour of the mixture at the end of the reaction.

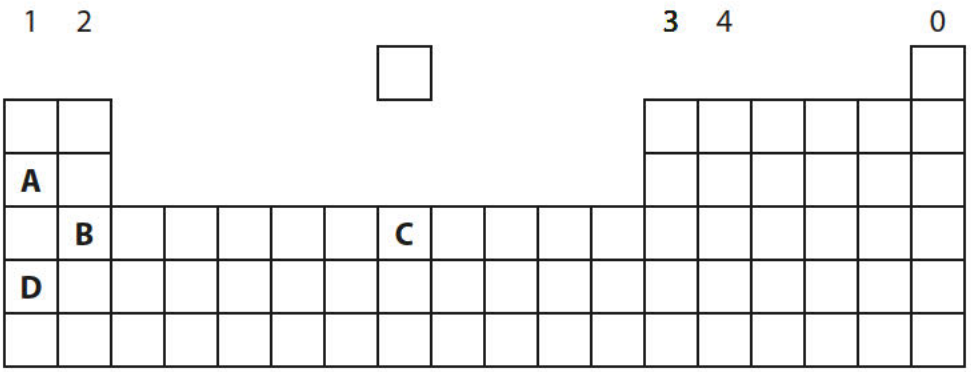
(1)

.....

(b) Chlorine reacts with an element X to form a solid chloride.

The solid chloride is dark red.

Which is the most likely position of the element X in the periodic table?



Put a cross (☒) in the box next to your answer.

(1)

☐ **A**

☐ **B**

☐ **C**

☐ **D**

(c) The halogens react with hydrogen to form hydrogen halides.

Complete the balanced equation for the reaction between hydrogen and bromine forming hydrogen bromide.

(2)

$H_2 + Br_2 \rightarrow$ .....

(**d**) alculate the relative formula mass of magnesium chloride, $MgCl_2$.
(relative atomic masses: Mg = 24.0; Cl = 35.5)

(1)

.....

relative formula mass = ...

(e) Calculate the percentage by mass of fluorine in sodium fluoride, NaF.
(relative atomic masses: F = 19; Na = 23)

(2)

.....

.....

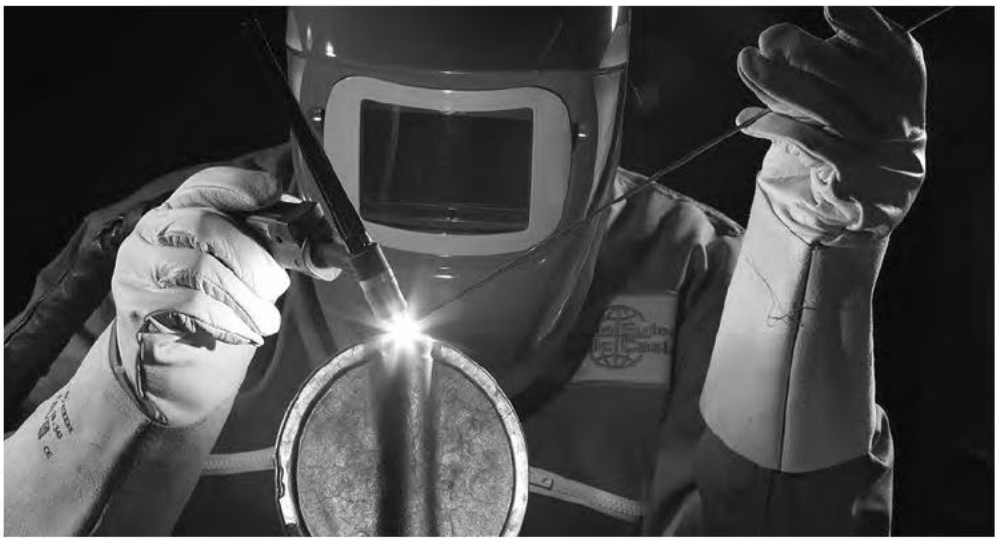
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percentage by mass of fluorine = ... %

(Total for Question 1 = 8 marks)

2 (a) Two pieces of metal can be joined by welding them together.



(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

The structure of a metal is a lattice of

(1)

☐ **A** anions

☐ **B** anions and cations

☐ **C** cations in a sea of electrons

☐ **D** molecules in a sea of electrons

(ii) To join two pieces of metal by welding, they must be melted together.

State why a high temperature has to be used.

(1)

.....

.....

(iii) The pieces of metal are welded together in an atmosphere of argon.

Explain why an atmosphere of argon is used.

(2)

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.....

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.....

(b) Some metals react with halogens.

Iron reacts with bromine, Br_2, to form iron(III) bromide, $FeBr_3$.

Write the balanced equation for this reaction.

(2)

.....

(c) Complete the sentence by putting a cross (☒) in the box next to your answer.

At room temperature, iodine is a

(1)

☒ **A** brown gas

☒ **B** brown liquid

☒ **C** grey solid

☒ **D** purple gas

(d) When a halogen is added to a solution containing halide ions a displacement reaction may occur.

In the table

✓ shows a displacement reaction occurs

✗ shows a displacement reaction does not occur

halogen added	halide ion in solution		
	chloride ion	bromide ion	iodide ion
chlorine		✓	✓
bromine	✗		✓
iodine	✗	✗	

Use the information in the table to explain the order of reactivity of the three halogens.

(2)

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(Total for Question 2 = 9 marks)

3 The elements chlorine, bromine and iodine are part of group 7 in the periodic table.

(a) The appearances of chlorine, bromine and iodine at room temperature are shown in Figure 10.

halogen	appearance
chlorine	green gas
bromine	red-brown liquid
iodine	grey solid

Figure 10

Astatine is the element below iodine in group 7.

Predict the appearance of astatine.

(1)

.....

*(b) The order of reactivity of chlorine, bromine and iodine can be determined by carrying out displacement reactions.

Explain how displacement reactions can be used to show the reactivity of these three elements.

(6)

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(c) When iron wool is heated in bromine vapour, it reacts to form iron bromide.

(i) In an experiment, 5.60 g of iron reacted exactly with 24.0 g of bromine, Br_2.

[relative atomic masses: Fe = 56.0, Br = 80.0]

Determine, using this information, the balanced equation for the reaction between iron and bromine.
You must show your working.

(4)

(ii) When iron reacts with bromine, bromide ions are formed.

Explain the type of reaction bromine atoms undergo when they are converted to bromide ions.

(2)

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.....

(Total for Question 3 = 13 marks)

4 (a) A compound of iron and chlorine was formed by reacting 2.80 g of iron with 3.55 g of chlorine.

Calculate the empirical formula of the compound.
(relative atomic masses: Cl = 35.5, Fe = 56.0)

(3)

empirical formula .....

(b) Sodium reacts with chlorine to form sodium chloride.

$$2Na + Cl_2 \rightarrow 2NaCl$$

Calculate the maximum mass of sodium chloride that could be formed by reacting 9.20 g of sodium with excess chlorine.
(relative atomic masses: Na = 23.0, Cl = 35.5)

(3)

mass of sodium chloride ..... g

*(c) Chlorine, bromine and iodine are in group 7 of the periodic table.

The order of reactivity of these three elements can be shown by carrying out displacement experiments.

You are provided with

potassium bromide solution
potassium chloride solution
potassium iodide solution
bromine solution
chlorine solution
iodine solution

Describe how these solutions could be used to carry out experiments to show the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.
You may use equations if you wish.

(6)

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(Total for Question 4 = 12 marks)

5 Electrolysis occurs when solutions of some compounds are decomposed by passing direct electric current through them.

(a) Sodium chloride solution was electrolysed.
The reaction produced chlorine and hydrogen.
The remaining solution contained sodium hydroxide, NaOH.

(i) State a hazard associated with chlorine gas.

(1)

.....

(ii) Describe a test that can be used to identify a sample of gas as chlorine.

(2)

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.....

.....

(iii) State a use of chlorine.

(1)

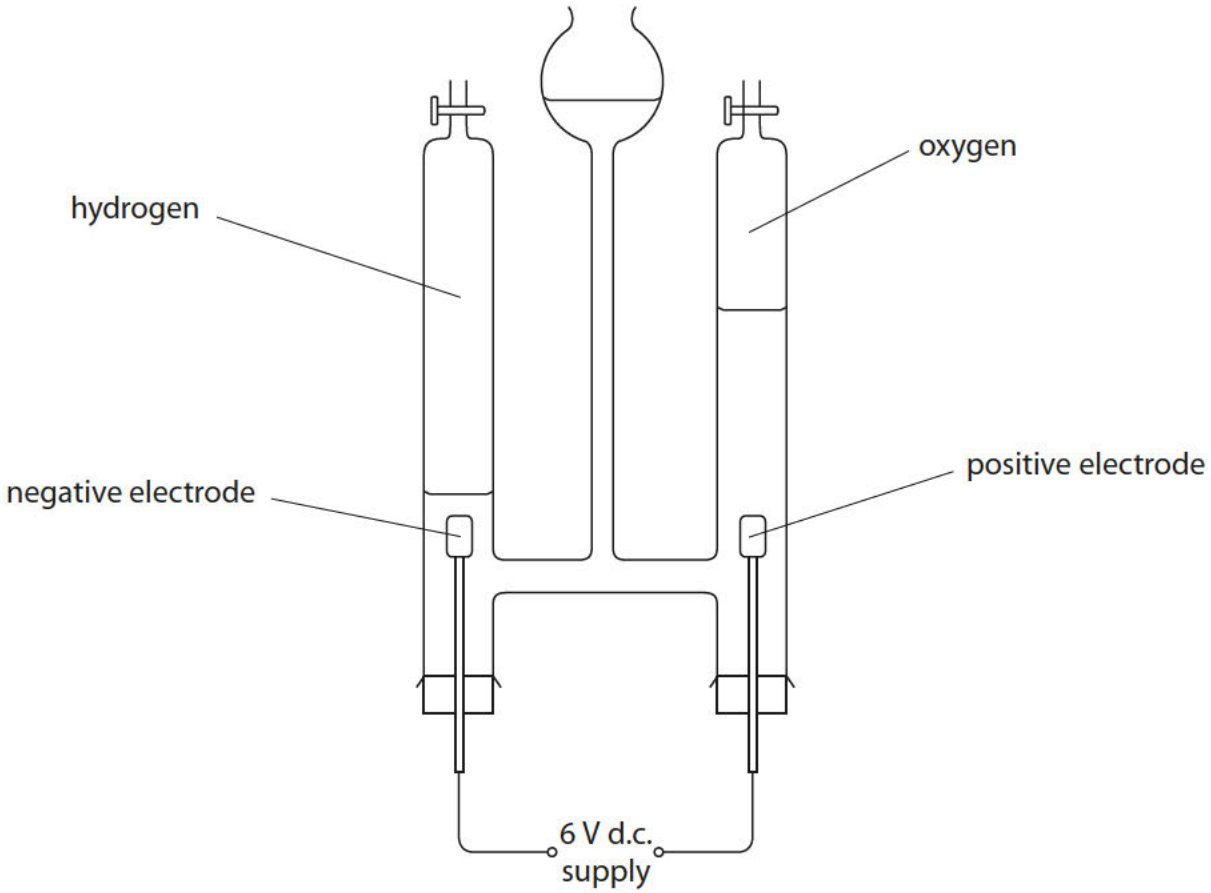
.....

(iv) Complete and balance the equation for the overall reaction taking place when sodium chloride solution is electrolysed.

(2)

..... NaCl + ... H_2O → ..... + ... + ...

*(b) Water was decomposed by electrolysis in the apparatus shown.



The water decomposed into hydrogen and oxygen.
After five minutes, the volumes of hydrogen and oxygen in the tubes were measured.

Two further experiments were carried out changing only one factor in each experiment. All other factors were kept the same.

The table shows the conditions and results of all three experiments.

experiment	time / minutes	current / amps	volume of hydrogen / cm^3	volume of oxygen / cm^3
1	5	0.50	20.0	10.0
2	10	0.50	40.0	20.0
3	5	0.75	30.0	15.0

Use these results of electrolysis to compare the volumes of hydrogen and oxygen formed and to show the effect of changing the time and the current on the volumes of these gases.

(6)

(Total for Question 5 = 12 marks)