

1 Chlorine and bromine are elements in Group 7 of the Periodic Table.

(a) Chlorine is used in water treatment.

State **one** advantage and **one** disadvantage of using chlorine in water treatment.

advantage:

.....

disadvantage:

..... [2]

(b) The electron configuration of bromine contains outermost electrons in the 4th shell.

Using your knowledge of Group 7 elements, complete the electron configuration of bromine.

$1s^2 2s^2 2p^6 3s^2 3p^6$ [1]

(c) Displacement reactions can be used to detect bromide ions in solution.

A student has a solution that contains bromide ions. The student carries out the following experiment.

Step 1

- She bubbles some chlorine gas through a sample of the solution.
- The mixture changes colour.

Step 2

- The student then adds an organic solvent, cyclohexane, to the mixture.
- She shakes the contents and allows the layers to separate.

(i) Write the **ionic** equation for the reaction that takes place in **step 1**.

..... [1]

(ii) What colour does the cyclohexane layer turn in **step 2**?

..... [1]

(d) Chlorine reacts differently with dilute and concentrated aqueous solutions of sodium hydroxide.

- When chlorine reacts with dilute sodium hydroxide, one of the products is sodium chlorate(I). This is the reaction that is used to manufacture bleach.
- When chlorine is reacted with hot concentrated sodium hydroxide, a different reaction takes place. One of the products is NaClO_3 , used as a weedkiller.

In each reaction, chlorine has been both oxidised and reduced.

(i) What term is used to describe a redox reaction in which an element is both oxidised and reduced?

..... [1]

(ii) Write equations for these two reactions of chlorine with sodium hydroxide:

equation for reaction with **dilute** sodium hydroxide,

.....

equation for reaction with **hot concentrated** sodium hydroxide.

..... [3]

(iii) Chlorine forms another chlorate called sodium chlorate(VII), used in the manufacture of matches.

Suggest the formula of sodium chlorate(VII).

..... [1]

[Total: 10]

2 Chemists use the Periodic Table to predict the behaviour of elements.

(a) Early attempts at developing a Periodic Table arranged elements in order of increasing atomic mass.

(i) State which two elements from the **first twenty** elements of the modern Periodic Table are not arranged in order of increasing atomic mass.

..... [1]

(ii) Why does the modern Periodic Table **not** arrange some elements, such as those in **a(i)**, in order of increasing atomic mass?

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.....
..... [1]

(b) Magnesium and strontium are in Group 2 of the Periodic Table.

(i) When reacted with oxygen, magnesium forms a white powder called magnesium oxide.

Write the equation for the reaction of magnesium with oxygen.

..... [1]

(ii) Magnesium reacts with dilute acids.

Describe what you would expect to see when magnesium ribbon is added to an excess of dilute hydrochloric acid.

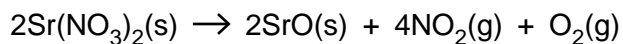
.....
..... [2]

(iii) Strontium reacts in a similar way to magnesium.

Describe **one** difference you might observe if strontium, instead of magnesium, was reacted with dilute hydrochloric acid.

..... [1]

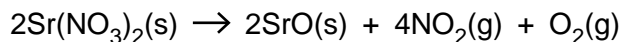
- (d) The element strontium forms a nitrate, $\text{Sr}(\text{NO}_3)_2$, which decomposes on heating as shown below.



- (i) Using oxidation numbers, explain why the reaction involves both oxidation and reduction.

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..... [3]

- (ii) A student heats 5.29 g of $\text{Sr}(\text{NO}_3)_2$ and collects the gas at room temperature and pressure, RTP.



Calculate the volume of gas, in dm^3 , obtained by the student at RTP.

Molar mass of $\text{Sr}(\text{NO}_3)_2 = 211.6 \text{ g mol}^{-1}$.

answer = dm^3 [3]

[Total: 18]

3 The table below shows the melting points and atomic radii of the elements in Period 3, Na to Cl.

element	Na	Mg	Al	Si	P	S	Cl
melting point/°C	98	639	660	1410	44	113	-101
atomic radius/pm	186	160	143	118	110	102	99

1 pm = 1×10^{-12} m

(a) (i) Explain the difference in melting point for the elements Na and Mg.

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.....
.....
.....
.....
..... [3]

(ii) Sulfur exists as S₈ molecules and chlorine as Cl₂ molecules. Use this information to explain the difference in their melting points.

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.....
.....
..... [2]

(b) Explain the decrease in the atomic radii across the period from Na to Cl.



In your answer, you should use appropriate technical terms, spelt correctly.

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.....
.....
..... [3]

[Total: 8]

4 This question is about a model of the structure of the atom.

(a) A model used by chemists includes the relative charges, the relative masses and the distribution of the sub-atomic particles making up the atom.

Complete the table below.

particle	relative charge	relative mass	position within the atom
proton			
neutron			
electron		1/2000	shell

[1]

(b) Early studies of ionisation energies helped scientists to develop a model for the electron structure of the atom.

Define the term *first ionisation energy*.

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[3]

(c) A modern model of the atom arranges electrons into orbitals, sub-shells and shells.

Complete the following table showing the maximum number of electrons which can be found within each region.

region	number of electrons
a 2p orbital	
the 3s sub-shell	
the 4th shell	

[3]

- (d) The modern Periodic Table arranges the elements in order of their atomic number. When arranged in this order the elements show periodicity.

Explain what is meant by the term *periodicity*.

.....
.....
..... [1]

- (e) In this part, you need to refer to the *Periodic Table of the Elements* in the *Data Sheet for Chemistry A*.

From the first 18 elements **only**, choose an element which fits the following descriptions.

- (i) An element with an isotope that can be represented as $^{14}_6\text{X}$ [1]
(ii) The element which has the strongest metallic bonding in Period 3. [1]
(iii) The element which forms a 3- ion with the same electron structure as Ne. [1]
(iv) The element which has the smallest third ionisation energy. [1]
(v) The element with the first six successive ionisation energies shown below, in kJ mol^{-1} .

738 1 541 629 995

..... [1]

[Total: 13]