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.

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..... **[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]**

(c) The third period of the Periodic Table features the elements magnesium and chlorine. The table below shows the melting points of these elements.

element	**melting point / °C**
magnesium	650
chlorine	–101

Describe the structure and bonding shown by these elements. Use your answer to explain the difference in melting points.

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

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..... **[6]**

(d) The element strontium forms a nitrate, $Sr(NO_3)_2$, which decomposes on heating as shown below.

$$2Sr(NO_3)_2(s) \rightarrow 2SrO(s) + 4NO_2(g) + O_2(g)$$

(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 $Sr(NO_3)_2$ and collects the gas at room temperature and pressure, RTP.

$$2Sr(NO_3)_2(s) \rightarrow 2SrO(s) + 4NO_2(g) + O_2(g)$$

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

Molar mass of $Sr(NO_3)_2$ = 211.6 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 C*l*.

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

$1\,pm = 1 \times 10^{-12}\,m$

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

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

(ii) Sulfur exists as S_8 molecules and chlorine as Cl_2 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 C*l*.

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*.

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..... **[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 $^{14}_{6}X$. ..... **[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]