2 Radium, Ra, is an element found in Group 2 of the Periodic Table. It is a crystalline solid at room temperature and conducts electricity.

Radium chloride, $RaCl_2$, has a melting point of 900 °C and is soluble in water.

(a) Predict the lattice structure of $RaCl_2(s)$ based on the properties described.

..... [1]

(b) Draw a dot-and-cross diagram to show the arrangement of outer electrons in $RaCl_2$.

[1]

(c) Solid Ra and Ca show similar reactions with H_2O, but the reactions occur at different rates.

Separate samples, each containing a single piece of solid Ra or Ca, are added to equal volumes of cold water.

Each sample contains equal numbers of moles of solid and the H_2O is in excess.

(i) Construct an equation for the reaction of Ra with H_2O.

..... [1]

(ii) Identify which element, Ra or Ca, reacts with H_2O at a faster rate. Suggest how the observations of each reaction would differ.

.....

..... [1]

(iii) Suggest why these reactions occur at different rates.

.....

.....

..... [2]

(iv) One of the solutions is cloudy when the reaction has finished.

At the end of each reaction, universal indicator is added to each reaction mixture.

Suggest pH values of the solutions made in both reactions. Explain your answer.

.....

.....

..... [2]

(d) A sample of aqueous calcium halide, $CaX_2(aq)$, contains either chloride, bromide or iodide ions.

Complete Table 2.1 to describe a two-step process that could be used to identify the halide ion present.

Table 2.1

step	method	observation with $CaCl_2$	observation with $CaBr_2$	observation with CaI_2
step **1**				
step **2**				

[3]

[Total: 11]

1 **(a)** Complete Table 1.1 using relevant information from the Periodic Table.

Table 1.1

	nucleon number	proton number	number of electrons
Mg^{2+}	24		
Al^{3+}	27		

[2]

(b) State and explain the difference in the ionic radius of Al^{3+} compared to Mg^{2+}.

.....

.....

.....

..... [3]

(c) Draw a labelled diagram to show the structure and bonding in sodium.

[1]

(d) Fig. 1.1 shows the variation in melting point of some Period 3 elements in their standard states at room temperature and pressure.

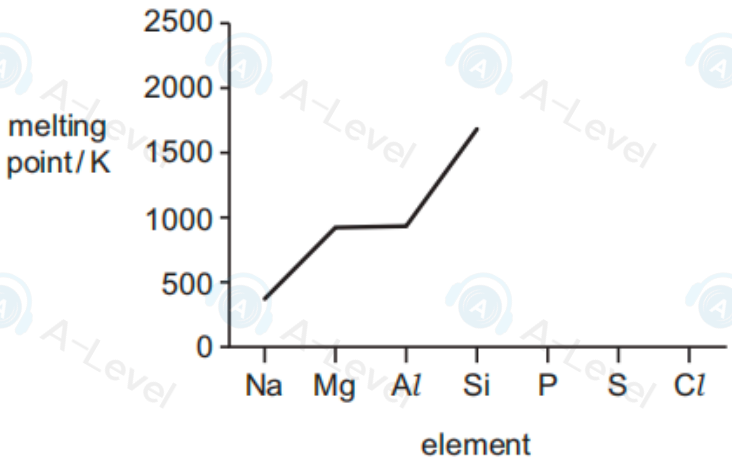

Fig. 1.1

(i) Explain why Si has a high melting point.

.....

.....

..... [1]

(ii) Complete Fig. 1.1 to show the variation in the melting points of the elements P, S and Cl.
[2]

(e) Two Period 3 elements react with an excess of oxygen at room pressure.

(i) Complete Table 1.2.

Table 1.2

1	2	3
Period 3 element	state of oxide at room temperature and pressure	approximate pH of solution made when oxide is added to water
Na		
S		

[2]

(ii) The solutions made in column 3 of Table 1.2 are mixed together.
Name the type of reaction that occurs.

..... [1]

(iii) Write an equation to describe the reaction between P_4O_{10} and an excess of water.

..... [1]

(f) Aluminium hydroxide is amphoteric.

(i) Explain what is meant by amphoteric.

.....

..... [1]

(ii) Write an equation to describe the reaction that occurs when aluminium hydroxide, $Al(OH)_3$, reacts with NaOH(aq).

..... [1]

[Total: 15]

(c) Element **E** is in Period 3 of the Periodic Table.
The first eight ionisation energy values of **E** are shown in Table 1.1.

Table 1.1

ionisation	1st	2nd	3rd	4th	5th	6th	7th	8th
ionisation energy / kJ mol^{-1}	577	1820	2740	11600	14800	18400	23400	27500

Deduce the full electronic configuration of **E**.
Explain your answer.

full electronic configuration of **E** = ...

explanation .....

.....

.....

[3]

[Total: 9]

1 Fig. 1.1 shows how **first** ionisation energies vary across Period 2.

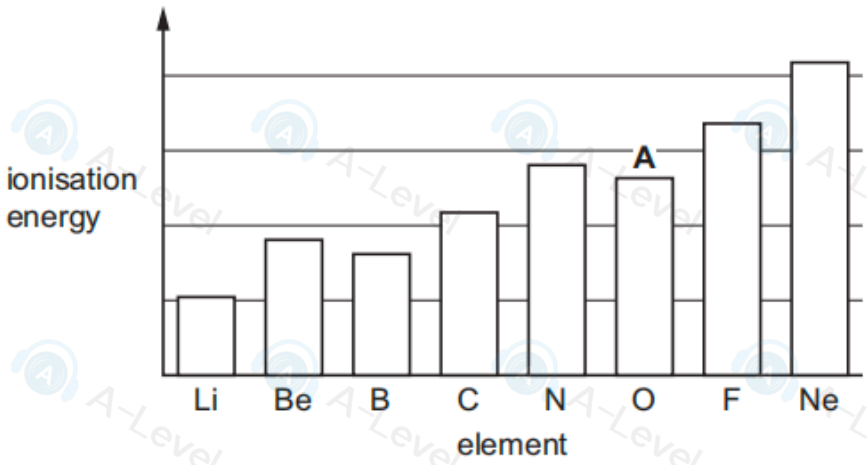

Fig. 1.1

(a) Construct an equation to represent the **first** ionisation energy of oxygen. Include state symbols.

..... [1]

(b) (i) State and explain the general trend in first ionisation energies across Period 2.

.....

.....

.....

.....

..... [3]

(ii) Explain why ionisation energy **A** in Fig. 1.1 does **not** follow the general trend in first ionisation energies across Period 2.

.....

.....

.....

..... [2]