1 **(a)** For each of the following, give the name of an element from Period 2 (lithium to neon), which matches the description.
Elements may be used once, more than once or not at all.

(i) an element which is gaseous at room temperature and pressure

..... [1]

(ii) an element which forms an oxide that is a reactant in photosynthesis

..... [1]

(iii) an element that is a product of photosynthesis

..... [1]

(iv) an element that makes up approximately 78% by volume of the air

..... [1]

(v) an element which has atoms with a full outer shell of electrons

..... [1]

(vi) an element which exists as both diamond and graphite

..... [1]

(vii) an element that reacts vigorously with cold water

..... [1]

(viii) a soft metallic element which is stored in oil

..... [1]

(b) Give the formula of a compound that contains

(i) only boron and oxygen, ... [1]

(ii) only lithium and nitrogen. ..... [1]

[Total: 10]

2 Rubidium, Rb, is a Group I element. It has similar physical and chemical properties to the other elements in Group I.

(a) Predict how many electrons there are in the outer shell of a rubidium atom.

..... [1]

(b) Predict **one** physical property of rubidium which is the same as that of a transition element such as iron.

..... [1]

(c) Predict **two** physical properties of rubidium which are different to those of a transition element such as iron.

.....

..... [2]

(d) When rubidium is added to cold water a reaction occurs.

(i) Suggest **two** observations that would be made when rubidium is added to cold water.

.....

..... [2]

(ii) What would be the colour of the solution if methyl orange was added to it after the reaction?

..... [1]

(iii) Write a chemical equation for the reaction between rubidium and water.

..... [2]

(iv) Put the Group I elements, caesium, lithium, potassium, rubidium and sodium in their order of reactivity with water

most reactive ⟶ least reactive

[1]

(v) Suggest **one** safety measure that should be used when rubidium is added to cold water.

..... [1]

(e) The phosphate ion has the formula PO_4^{3-}.

Deduce the formula of rubidium phosphate.

..... [1]

3 The table below shows the elements in the third period of the Periodic Table, the number of electrons in their outer energy level, their oxidation state in their common compounds and their melting points.

element	Na	Mg	A*l*	Si	P	S	C*l*	Ar
number of outer electrons	1	2						
oxidation state	+1	+2	+3	+4/–4	–3	–2	–1	0
melting point/°C	98	650	660	1414	317	115	–101	–189

(a) Describe and explain the variation in oxidation state across the period.

.....

.....

.....

[3]

(b) The first three elements, Na, Mg and A*l*, are metals.

Describe the structure of a typical metal.

.....

.....

.....

[3]

(c) Explain why Na, Mg and Al are good conductors of electricity.

..... [1]

(d) Which element exists as diatomic molecules of the type X_2?

..... [1]

(e) Silicon has a similar structure to diamond.

Explain why silicon has the highest melting point in the period.

.....

..... [2]

(f) Sodium chloride is a crystalline solid with a high melting point. It dissolves in water to give a neutral solution. Phosphorus trichloride is a liquid at room temperature. It reacts with water to form an acidic solution.

Suggest an explanation for these differences in properties.

.....

.....

..... [2]

(g) Describe how you could show that magnesium oxide is a basic oxide and not an amphoteric oxide.

.....

..... [2]

(h) Draw a dot-and-cross diagram showing the bonding in magnesium oxide. Show outer electrons only.

[3]

[Total: 17]

4 Choose from the following list of gases. A gas may be chosen once, more than once or not at all.

sulfur dioxide **hydrogen** **methane** **carbon monoxide**

argon **ethene** **butane**

(a) It is used to bleach wood pulp. ..... [1]

(b) When burned in oxygen, the only product is water. ..... [1]

(c) It can polymerise. ..... [1]

(d) It is used to provide an inert atmosphere for welding. ..... [1]

(e) When reacted with oxygen, the only product is carbon dioxide. ..... [1]

(f) It is produced by the decay of vegetation in the absence of oxygen. ..... [1]

[Total: 6]

5 The halogens are a group of non-metals in Group VII of the Periodic Table.

(a) The reactivity of the halogens decreases down the group.

Describe an experiment which shows that chlorine is more reactive than iodine. Include an equation in your answer.

.....

.....

.....

..... [3]

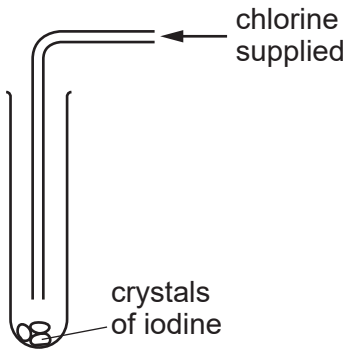
(b) The halogens form interhalogen compounds. These are compounds which contain two different halogens.

Deduce the formula of the compound which has the composition 0.013 moles of iodine atoms and 0.065 moles of fluorine atoms.

.....

..... [2]

(c) Iodine reacts with chlorine to form a dark brown liquid, iodine monochloride.



$$I_2(s) + Cl_2(g) \rightarrow \underset{\text{dark brown}}{2ICl(l)}$$

When more chlorine is added and the tube is sealed, a reversible reaction occurs and the reaction comes to equilibrium.

$$\underset{\text{dark brown}}{ICl(l)} + Cl_2(g) \rightleftharpoons \underset{\text{yellow}}{ICl_3(s)}$$

(i) Give another example of a reversible reaction.

..... [1]

(ii) Explain the term *equilibrium*.

.....

..... [2]

(d) Chlorine is removed from the tube and a new equilibrium is formed.

Explain why there is less of the yellow solid and more dark brown liquid in the new equilibrium mixture.

.....

.....

..... [2]

(e) A sealed tube containing the equilibrium mixture is placed in ice-cold water. There is an increase in the amount of yellow solid in the equilibrium mixture.

What can you deduce about the forward reaction in this equilibrium?

$$\mathrm{IC}l(\mathrm{l}) + \mathrm{C}l_2(\mathrm{g}) \rightleftharpoons \mathrm{IC}l_3(\mathrm{s})$$

Explain your deduction.

.....

.....

.....

..... [3]

[Total: 13]

6 The table shows the melting points, boiling points and electrical properties of five substances, **A** to **E**.

substance	melting point / °C	boiling point / °C	electrical conductivity of solid	electrical conductivity of liquid
A	–7	59	poor	poor
B	1083	2567	good	good
C	755	1387	poor	good
D	43	181	poor	poor
E	1607	2227	poor	poor

Choose a substance from the table above to match each of the following descriptions. A substance may be used once, more than once or not at all. Justify each choice with evidence from the table.

One has been completed as an example.

This substance is covalent and is a solid at room temperature (25 °C). .....**D**.....

evidence *Its melting point is above room temperature. It has a low melting point and it does not conduct as a liquid, so it is covalent*.

(a) This substance has a giant covalent structure. .....

evidence .....

..... [3]

(b) This substance is a metal. .....

evidence .....

..... [2]

(c) This substance is a liquid at room temperature (25 °C). .....

evidence .....

..... [3]

(d) This substance is an ionic solid. .....

evidence .....

..... [3]

[Total: 11]