1. (a) (i) Complete the electronic configuration of calcium.

$1s^2$ .....

(1)

(ii) State the number of electrons in the outer shell of an atom of chlorine.

……..

(1)

(b) (i) Write the equation for the reaction of calcium with chlorine to produce calcium chloride.

……..

(1)

(ii) Name the type of bonding in calcium chloride.

……..

(1)

(iii) Draw a dot and cross diagram for calcium chloride showing all the outer electrons.

(3)
(Total 7 marks)

2. (a) Describe a chemical test for chlorine.

……..…….

……..…….

……..…….

(2)

(b) Chlorine gas reacts with hydrogen to form hydrogen chloride gas, HCl.

(i) Name the type of bonding in hydrogen chloride gas.

……..

(1)

(ii) Explain why hydrogen chloride gas is soluble in water.

……..

……..

……..

……..

(2)

(c) A solution of hydrogen chloride reacts with solid calcium carbonate.
Write the equation for this reaction. Include the state symbols.

……..…….

(2)
(Total 7 marks)

3. (a) (i) Write the equation for the reaction of lithium with water.

……..

(2)

(ii) Describe what you would expect to see during the reaction.

……..

……..

(2)

(b) State the number of protons, neutrons and electrons in a $^{7}_{3}Li^{+}$ ion.

protons: …… neutrons: …… electrons: ……

(3)

(c) The mass spectrum of lithium shows two peaks. Their mass/charge ratios and percentage abundance are shown below.

Mass/charge	% Abundance
6.02	7.39
7.02	92.61

Calculate the relative atomic mass of lithium, giving your answer to three significant figures.

(2)

(d) Describe a test that you would do to distinguish between solid lithium chloride and solid sodium chloride. Clearly state what you would do and what you would see with both substances.

……

……

……

……

(3)

(Total 12 marks)

4. Both magnesium metal and molten magnesium chloride conduct electricity, but solid magnesium chloride does not.

(a) Describe the structure of magnesium metal and explain why the solid conducts electricity.

……

……

……

……

(3)

(b) Describe, in terms of the position and motion of the particles, what happens when some solid magnesium chloride, M_gCl_2, is heated from room temperature to just above its melting temperature.

……

……

……

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……

……

(4)

(c) Explain why magnesium chloride can conduct electricity when molten, but not when solid.

…….

…….

…….

…….

(2)

(Total 9 marks)

5. Nitrogen and phosphorus are in the same group of the Periodic Table. Phosphorus and hydrogen form the compound phosphine, PH_3, and nitrogen and hydrogen form ammonia, NH_3.

(a) (i) State the number of bond pairs and lone pairs of electrons in a molecule of phosphine.

Bond pairs of electrons: ..... Lone pairs of electrons: .....

(2)

(ii) Use your answer to (i) to draw the shape of the molecule and indicate on your diagram the approximate HPH bond angle that you would expect.

(2)

(b) The boiling temperature of ammonia is –33 °C and that of phosphine –88°C.

(i) List all the intermolecular forces that exist between molecules of ammonia.

……..

……..

……..

……..

(2)

(ii) Explain why the boiling temperature of phosphine is lower than that for ammonia.

……..……..……..

……..……..……..

……..……..……..

……..……..……..

(2)

(c) Ammonia forms a dative covalent bond with H^+ ions to form the ammonium ion, NH_4^+.

(i) Explain what is meant by the term **dative covalent bond**.

……..……..……..

……..……..……..

(2)

(ii) What part of the ammonia molecule enables it to form such a bond?

……..……..……..

(1)

(iii) State and explain the shape of the ammonium ion, NH_4^+.

……..……..……..

(3)

(Total 14 marks)

6. (a) Bromine is a *p*-block element Define the term ***p*-block element**.

……..……..

……..……..

(1)

(b) (i) Give the colour and physical state of bromine at room temperature,

Colour …… Physical state ……..…….

(2)

(ii) State what you would see when aqueous bromine is added to a solution of potassium iodide.

……..……..……..

……..……..……..

(1)

(c) Aqueous bromine will oxidise Fe^{2+} ions to Fe^{3+} ions.

(i) Write the ionic half-equation for the reduction of bromine to bromide ions.

……..……..……..

(1)

(ii) Write the ionic half-equation for the oxidation of Fe^{2+} ions to Fe^{3+} ions.

……..……..……..

(1)

(iii) Hence write the overall ionic equation for the reaction of Fe^{2+} ions with bromine.

……..……..……..

(1)

(d) Chlorine and bromine react with aqueous sodium hydroxide in a similar way at room temperature.

(i) Write the equation for the reaction of bromine with aqueous sodium hydroxide.

……..……..……..

(2)

(ii) What **type** of reaction is this?

……..……..……..

(1)

(e) Potassium bromide, KBr, reacts with potassium bromate, $KBrO_3$, in the presence of dilute sulphuric acid to form bromine, potassium sulphate and water.

$$5KBr + KBrO_3 + 3H_2SO_4 \rightarrow 3Br_2 + 3K_2SO_4 + 3H_2O$$

(i) Give the oxidation numbers of bromine in

KBr …….. $KBrO_3$ ……..... Br_2 .....……

(3)

(ii) Which substance in this reaction is the oxidising agent? Give a reason for your choice.

Substance: …….

Reason: ……..

……..……..……..

(2)

(Total 15 marks)

7. (a) The first ionisation energy of potassium is +419 kJ mol^{-1} and that of sodium is +496 kJ mol^{-1}.

(i) Define the term **first ionisation energy**.

……..……..……..

……..……..……..

……..……..……..

(3)

(ii) Explain why the first ionisation energy of potassium is only a little less than the first ionisation energy of sodium.

……..……..……..

……..……..……..

……..……..……..

……..……..……..

……..……..……..

(3)

(b) Potassium forms a superoxide, KO_2. This reacts with carbon dioxide according to the equation:

$$4KO_2(s) + 2CO_2(g) \rightarrow 2K_2CO_3(s) + 3O_2(g)$$

Carbon dioxide gas was reacted with 4.56 g of potassium superoxide.

(i) Calculate the amount, in moles, of KO_2 in 4.56 g of potassium superoxide.

(2)

(ii) Calculate the amount, in moles, of carbon dioxide that would react with 4.56 g of potassium superoxide.

(1)

(iii) Calculate the volume of carbon dioxide, in dm^3, that would react with 4.56 g of potassium superoxide. Assume that 1.00 mol of a gas occupies 24 dm^3 under the conditions of the experiment.

(1)

(iv) What volume of oxygen gas, in dm^3, measured under the same conditions of pressure and temperature, would be released?

(1)
(Total 11 marks)