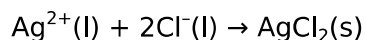# Covalent Bonding - Questions by Topic

Q1.

This question is about compounds containing chlorine.

(a) A precipitate of silver chloride is formed when silver nitrate solution reacts with sodium chloride solution.

A student wrote an ionic equation for the reaction.

$$Ag^{2+}(l) + 2Cl^-(l) \rightarrow AgCl_2(s)$$

Explain why this equation is incorrect, even though it is balanced.

(2)

....

....

....

....

....

....

(b) A sample of a compound is analysed and found to contain **only** 3.09 g carbon, 0.26 g hydrogen and 9.15 g chlorine.

The molar mass of the compound is 97.0 g mol^{-1}.

Calculate the molecular formula of this compound.

You **must** show your working.

(3)

(c) Nitrogen trichloride has the formula NCl_3.

(i) A sample of nitrogen trichloride contained only nitrogen atoms with mass number 14, and chlorine atoms with mass numbers 35 and 37.

Give the formula and mass/charge ratio for each of the **four** ions responsible for the molecular ion peaks in the mass spectrum of nitrogen trichloride.

(2)

(ii) Complete the table to predict the shape and Cl—N—Cl bond angle in nitrogen trichloride.

(3)

Number of bonding pairs of electrons on nitrogen	
Number of lone pairs of electrons on nitrogen	
Shape of molecule	
Cl—N—Cl bond angle	

(d) Aluminium chloride exists as an ionic lattice in the solid state and as a covalent dimer, Al_2Cl_6, in the gas phase, just above its boiling temperature.

(i) Explain why aluminium chloride in the solid state has significant covalent character.

(2)

....

....

....

....

....

....

....

....

(ii) Describe how two $AlCl_3$ molecules are joined together in the dimer.

Include a diagram in your answer.

(2)

....

....

....

....

(Total for question = 14 marks)

Q2.

This question is about nitrogen.

(a) The table shows the successive ionisation energies of nitrogen.

Ionisation number	Ionisation energy / kJ mol^{-1}	log (ionisation energy)
1	1402	3.15
2	2856	3.46
3	4578	3.66
4	7475	3.87
5	9445	3.98
6	53268	
7	64362	

(i) Complete the table.

(1)

(ii) Plot a graph of log (ionisation energy) against ionisation number.

(3)
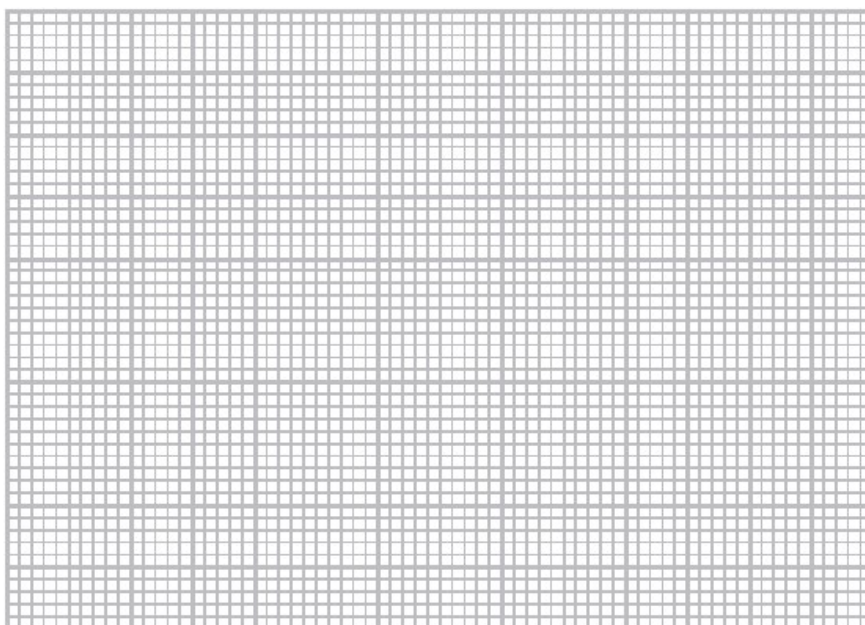
(iii) Give a reason why the logarithm of the ionisation energy, rather than just the ionisation energy, is used to plot this graph.

(1)

....

....

....

(iv) Explain what can be deduced from the graph about the electronic structure of nitrogen.

(3)

....

....

....

....

....

....

....

....

(v) Explain why the first ionisation energy of oxygen is lower than that of nitrogen.

(3)

....

....

....

....

....

....

....

....

(b) Nitrogen gas consists of nitrogen molecules.

(i) Draw a dot-and-cross diagram to show the bonding in a molecule of nitrogen.

(1)

(ii) Calculate the number of nitrogen **atoms** in 5.60 g of nitrogen gas.

[Avogadro constant = 6.02×10^{23} mol^{-1}]

(iii) A sample of nitrogen gas occupied 108 cm^3 at a temperature of 25 °C and a pressure of 1.36 × 10^5 Pa.

Using the ideal gas equation, calculate the number of moles of nitrogen gas in this sample.

[$pV = nRT$ $R = 8.31$ J mol^{-1} K^{-1}]

(4)

(Total for question = 18 marks)

Q3.

Water reacts with H$^+$ ions to form H$_3$O$^+$ ions.

Identify the bonding **within** the H$_3$O$^+$ ion.

(1)

☒ **A**   covalent bonding only

☒ **B**   covalent and dative covalent bonding only

☒ **C**   covalent, dative covalent and ionic bonding

☒ **D**   ionic bonding only

(Total for question = 1 mark)

Q4.

Which describes the polarity of the C—Cl bond and the polarity of the CCl$_4$ molecule?

	Polarity of C—Cl bond	Polarity of CCl$_4$ molecule
☒ **A**	non-polar	non-polar
☒ **B**	non-polar	polar
☒ **C**	polar	polar
☒ **D**	polar	non-polar

(Total for question = 1 mark)