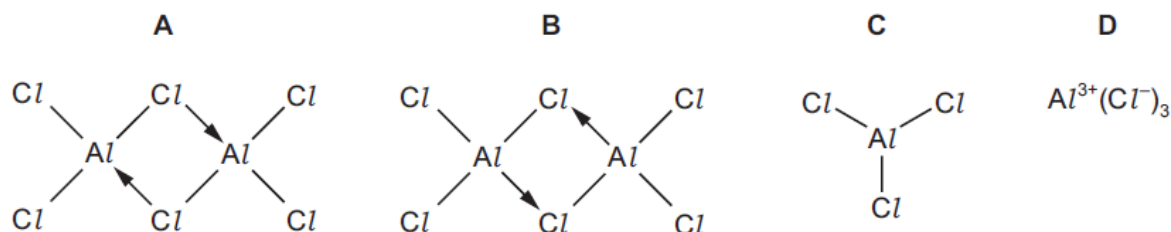


## Chemical bonding – 2023 AS Chemistry 9701

1. Nov/2023/Paper\_9701/11/No.5

Solid aluminium chloride sublimes at 178 °C.

Which structure best represents the species in the vapour at this temperature?



2. Nov/2023/Paper\_9701/11/No.6

Which row is correct?

	shape of $H_3O^+$	shape of $SCl_2$
A	pyramidal	non-linear
B	pyramidal	linear
C	trigonal planar	non-linear
D	trigonal planar	linear

3. Nov/2023/Paper\_9701/12/No.5

Ammonium ions,  $NH_4^+$ , are formed when ammonia gas reacts with hydrogen chloride gas.

Which statement about the changes that occur in this reaction is correct?

- A The dipole moment of an ammonium ion is greater than the dipole moment of an ammonia molecule.
- B The H–N–H bond angle decreases when an ammonium ion is formed.
- C The hybridisation of nitrogen does **not** change.
- D There is electron transfer from nitrogen to chlorine.

4. Nov/2023/Paper\_9701/12/No.7

Two compounds of boron are sodium borohydride,  $\text{NaBH}_4$ , and boron trifluoride,  $\text{BF}_3$ .

What are the shapes of the borohydride ion and the boron trifluoride molecule?

	borohydride ion	boron trifluoride
<b>A</b>	square planar	pyramidal
<b>B</b>	square planar	trigonal planar
<b>C</b>	tetrahedral	pyramidal
<b>D</b>	tetrahedral	trigonal planar

5. Nov/2023/Paper\_9701/21/No.1(c, d)

(c) A student does three tests on separate samples of  $\text{NaCl}(\text{aq})$ .

Complete Table 1.2 with the observations the student makes in each test.

Table 1.2

test	test	observations
1	addition of a few drops of $\text{Br}_2(\text{aq})$	
2	addition of a few drops of concentrated $\text{H}_2\text{SO}_4$	
3	addition of a few drops of dilute $\text{AgNO}_3(\text{aq})$	

[3]

(d)  $\text{POCl}_3$  shows similar chemical properties to  $\text{PCl}_5$ .

$\text{POCl}_3$  has a melting point of  $1^\circ\text{C}$  and a boiling point of  $106^\circ\text{C}$ .

$\text{POCl}_3$  reacts vigorously with water, forming misty fumes and an acidic solution.

(i) Explain how the information in (d) suggests the structure and bonding of  $\text{POCl}_3$  is simple covalent.

.....  
.....  
..... [2]

(ii) Construct an equation for the reaction of  $\text{POCl}_3$  with water.

$\text{POCl}_3 + \dots \rightarrow \dots$  [1]

(iii)  $\text{POCl}_3$  contains a double covalent bond between P and O.

Complete the dot-and-cross diagram, in Fig. 1.1, to show the bonding in  $\text{POCl}_3$ .

Show outer shell electrons only.

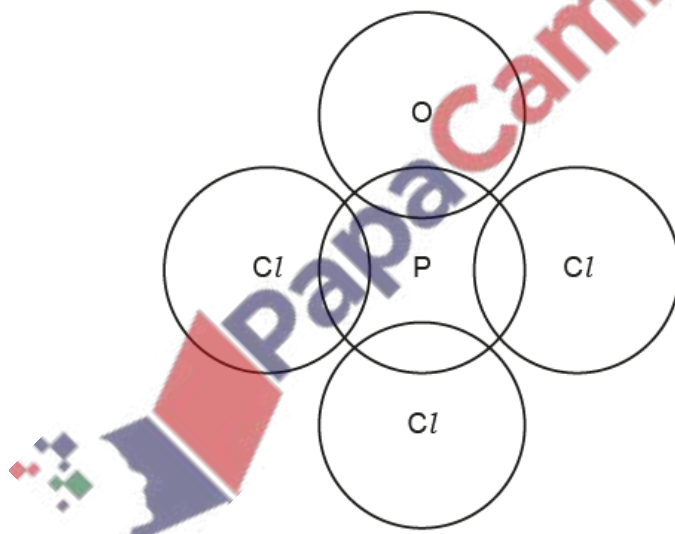
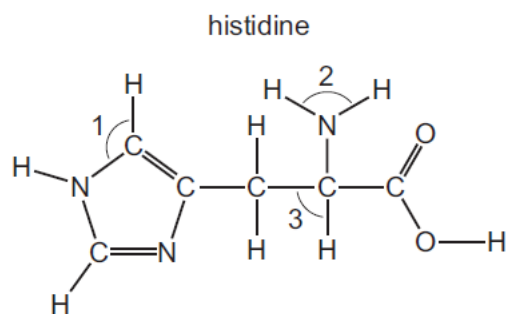


Fig. 1.1

[2]

6. June/2023/Paper\_9701/11/No.7

Histidine is an amino acid.



What are the approximate bond angles 1, 2, and 3?

	1	2	3
<b>A</b>	109.5°	107°	90°
<b>B</b>	120°	107°	109.5°
<b>C</b>	120°	120°	90°
<b>D</b>	120°	120°	109.5°

7. June/2023/Paper\_9701/12/No.6

Which statement about the  $Cl-N=O$  molecule is correct?

- A** Each molecule contains one  $\sigma$  and two  $\pi$  bonds.
- B** It is a non-polar molecule.
- C** It is a linear molecule.
- D** The nitrogen atom is  $sp^2$  hybridised .

8. June/2023/Paper\_9701/12/No.7

Which row is correct?

	molecule	shape	total number of pairs of electrons in the valence shell of the central atom
<b>A</b>	$CO_2$	linear	two
<b>B</b>	$BF_3$	trigonal planar	three
<b>C</b>	$NH_3$	regular tetrahedral	four
<b>D</b>	$PF_5$	octahedral	six

9. June/2023/Paper\_9701/13/No.4

L and M are elements in Period 3 of the Periodic Table. Neither element is argon.

Information about the Pauling electronegativity values of L and M is given.

element	Pauling electronegativity value
L	the highest of the seven elements Na to Cl
M	the lowest of the seven elements Na to Cl

Three statements about elements L and M are given.

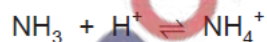
- 1 Element L contains covalent bonds.
- 2 Element L has a higher atomic number than element M.
- 3 A compound of L and M contains ionic bonds.

Which statements are correct?

- A** 1, 2 and 3      **B** 1 and 2 only      **C** 1 and 3 only      **D** 2 and 3 only

10. June/2023/Paper\_9701/13/No.5

Ammonia reacts with acids to form the ammonium ion.



Which row is correct?

	shape of $\text{NH}_4^+$	bond angle in $\text{NH}_4^+$ / °
<b>A</b>	pyramidal	107
<b>B</b>	pyramidal	109.5
<b>C</b>	tetrahedral	107
<b>D</b>	tetrahedral	109.5

The melting points of some solids are shown in Table 1.1.

**Table 1.1**

solid	melting point/K
magnesium	923
phosphorus	317
sodium chloride	1074
sulfur	392

(a) (i) State the type of bonding present in magnesium and in sodium chloride.

bonding in magnesium .....

bonding in sodium chloride .....

[1]

(ii) Explain the difference in the melting points of magnesium and sodium chloride.

.....  
 ..... [1]

(iii) Explain the difference in the melting points of phosphorus and sulfur in terms of structure and bonding.

.....  
 .....  
 ..... [2]

(b) (i) Define electronegativity.

.....  
 ..... [1]

(ii) Explain why electronegativity increases across a period.

.....  
 .....  
 ..... [2]

(iii) Name the strongest intermolecular force that exists between  $\text{NH}_3(\text{l})$  molecules.

..... [1]

(iv) Draw a diagram to show the formation of the strongest intermolecular force between **two** molecules of  $\text{NH}_3(\text{l})$ .

Include any relevant lone pairs of electrons and dipoles.

[2]

(v) The melting points of ice and ammonia are shown in Table 1.2.

Table 1.2

solid	melting point/K
ice	273
ammonia	195

Suggest **two** reasons for the difference in the melting points of ice and ammonia.

.....  
.....  
..... [2]

[Total: 12]

(a) The reaction of pure aluminium is only observed if the aluminium oxide layer is removed first. When pure aluminium is added to cold water, bubbles of gas are seen.

(i) State **one** property of aluminium oxide that explains why an aluminium object does **not** react with cold water until the aluminium oxide layer is removed.

..... [1]

(ii) Write an equation, with state symbols, for the reaction of aluminium oxide with an excess of NaOH(aq).

..... [2]

(iii) Name **one** other Period 3 element that also produces bubbles of gas when added to cold water.

..... [1]

(b) Aluminium nitrate is a white soluble salt. On heating aluminium nitrate, thermal decomposition occurs and a brown gas is seen.

State the formula of the salt of another element in Period 3 which also decomposes on heating to produce a brown gas.

..... [1]

(c) Aluminium chloride and phosphorus chloride are both white solids.

(i) State the maximum oxidation number of aluminium and of phosphorus in these solid chloride salts.

maximum oxidation number of aluminium .....

maximum oxidation number of phosphorus .....

[1]

(ii) State why the maximum oxidation number of aluminium is different from that of phosphorus.

.....

..... [1]

(iii) Write an equation for the reaction of solid phosphorus chloride and excess water.

..... [1]



(iv) Name the type of reaction that occurs when aluminium chloride is added to water.

..... [1]

(v) Explain why the solution produced after aluminium chloride is added to water has a pH of 1–2.

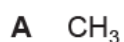
.....

..... [1]

[Total: 10]

13. March/2023/Paper\_9701/12/No.8

In which species is there a lone pair of electrons?



14. March/2023/Paper\_9701/12/No.14

In a sample of pure water, what is the maximum number of hydrogen bonds that one molecule of water can be involved in?

A 1

B 2

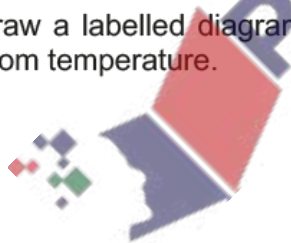
C 3

D 4

15. March/2023/Paper\_9701/22/No.2(a)

The Group 2 elements Mg to Ba are all silvery-white reactive metals.

(a) (i) Draw a labelled diagram to show the bonding and structure of the Group 2 metals at room temperature.



[2]

(ii) Explain why Mg has a higher electrical conductivity than Na.

.....

..... [1]