3. Chemical bonding

3.5 Shapes of molecules

Paper 1

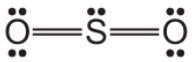
Question Paper

1 An ion contains 1 nitrogen atom and 2 hydrogen atoms. It has an H–N–H bond angle of approximately 105°.

Which row is correct?

	number of lone pairs around N in ion	overall charge on ion
A	1	+1
B	2	+1
C	1	–1
D	2	–1

2 The structure of the sulfur dioxide molecule is shown.



What is the shape of the sulfur dioxide molecule?

A linear

B non-linear

C pyramidal

D tetrahedral

3 What is the bond angle in the ammonium ion?

A 90° **B** 107° **C** 109.5° **D** 120°

4 Which shape is correctly predicted by VSEPR theory?

	number of bonded electron pairs	number of lone pairs	shape
A	2	2	linear
B	2	2	tetrahedral
C	3	1	pyramidal
D	3	1	trigonal planar

5 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

6 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.

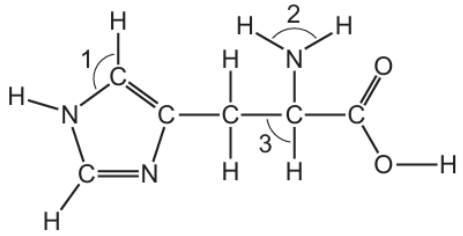
7 Two compounds of boron are sodium borohydride, $NaBH_4$, and boron trifluoride, BF_3.

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

	borohydride ion	boron trifluoride
A	square planar	pyramidal
B	square planar	trigonal planar
C	tetrahedral	pyramidal
D	tetrahedral	trigonal planar

8 Histidine is an amino acid.

histidine



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

	1	2	3
A	109.5°	107°	90°
B	120°	107°	109.5°
C	120°	120°	90°
D	120°	120°	109.5°

9 Which statement about the C*l*–N=O molecule is correct?

A Each molecule contains one σ and two π bonds.

B It is a non-polar molecule.

C It is a linear molecule.

D The nitrogen atom is sp^2 hybridised .

10 Which row is correct?

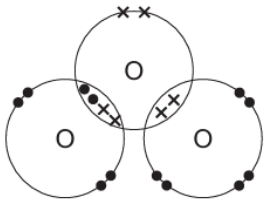
	molecule	shape	total number of pairs of electrons in the valence shell of the central atom
A	CO_2	linear	two
B	BF_3	trigonal planar	three
C	NH_3	regular tetrahedral	four
D	PF_5	octahedral	six

11 Which molecule has an equal number of bonding electrons and lone-pair electrons?

A BH_3 **B** CO_2 **C** F_2O **D** SO_2

12 VSEPR theory should be used in answering this question.

The dot-and-cross diagram for an ozone, O_3, molecule is shown.



What is the predicted bond angle in this molecule?

A 107° **B** 109.5° **C** 117° **D** 120°

13 In which structure are three atoms bonded together in a straight line?

A poly(ethene), $-(CH_2CH_2)_n-$

B propane, C_3H_8

C silicon tetrachloride, $SiCl_4$

D sulfur hexafluoride, SF_6

14 Which row is correct?

	shape		bonds present	
	ammonia molecule	ammonium ion	ammonia molecule	ammonium ion
A	pyramidal	regular tetrahedral	σ	σ
B	pyramidal	regular tetrahedral	σ	π
C	regular tetrahedral	pyramidal	σ	σ
D	regular tetrahedral	pyramidal	π	σ

15 Atom X is the central atom in a molecule.

In this molecule, atom X has four pairs of valence electrons in its outer shell.

The four pairs of valence electrons include at least one bond pair and at least one lone pair.

What could be a possible shape for the molecule?

A linear

B non-linear

C trigonal bipyramidal

D trigonal planar

16 Phosphorus forms two chlorides. Phosphorus(III) chloride, PCl_3, is a covalent liquid.

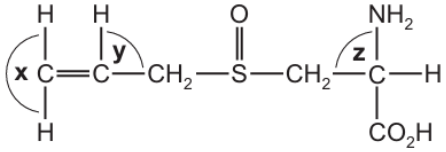
Phosphorus(V) chloride is an ionic solid. One of the ions present is $[PCl_4]^+$.

What is the shape of the PCl_3 molecule and the $[PCl_4]^+$ ion?

	PCl_3	$[PCl_4]^+$
A	pyramidal	square planar
B	pyramidal	tetrahedral
C	tetrahedral	square planar
D	trigonal planar	tetrahedral

17 The structural formula of alliin is shown.

alliin



What are the approximate bond angles **x**, **y** and **z** in a molecule of alliin?

	x	**y**	**z**
A	90°	90°	109°
B	120°	109°	90°
C	120°	120°	109°
D	180°	109°	109°

18 Which molecule or ion contains the smallest bond angle?

A C_2H_4 **B** CH_3COCH_3 **C** NH_4^+ **D** NH_3

19 In which set do all the molecules have all their atoms arranged in one plane?

A $AlCl_3$, BF_3, PH_3

B $AlCl_3$, CO_2, NH_3

C BF_3, C_2H_4, C_3H_6

D C_2H_4, CO_2, H_2O