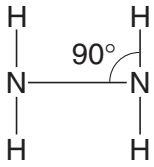
SHAPES OF MOLECULES WS 1

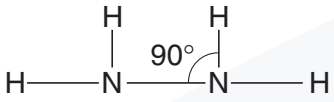
SECTION A

1 Which is the most likely shape of a molecule of hydrazine, N_2H_4?

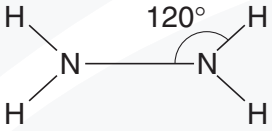
A



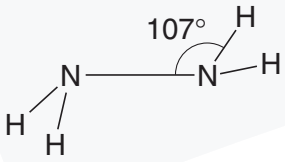
B



C



D



[W'02 Q6]

2 Chemists have been interested in the properties of hydrogen selenide, H_2Se, to compare it with 'bad egg' gas hydrogen sulphide, H_2S.

Which set of data would the hydrogen selenide molecule be expected to have?

	number of lone pairs on Se atom	bond angle
A	1	104°
B	2	104°
C	2	109°
D	2	180°

[W'03 Q7]

3 Which molecule is planar?

A NF_3

B C_2Cl_4

C C_3H_6

D C_3H_8

[S'04 Q20]

4 What are the bond angles in the PH_3 molecule likely to be?

A 90° **B** 104° **C** 109° **D** 120°

[W'04 Q7]

5 *Lycra*® is a polyurethane fibre used in the fashion industry. It is a polymer made from two monomers, one of which has the following formula.

$$O{=}C{=}N{-}(CH_2)_n{-}N{=}C{=}O$$

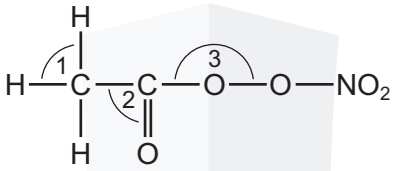
What is the O–C–N bond angle in this molecule?

A 90° **B** 109° **C** 120° **D** 180°

[W'07 Q6]

6 Organic nitrates in photochemical smog can cause breathing difficulties.

The diagram shows an example of an organic nitrate molecule.



What is the correct order of the bond angles shown in ascending order (smallest first)?

A 1 → 2 → 3 **B** 2 → 1 → 3 **C** 3 → 1 → 2 **D** 3 → 2 → 1

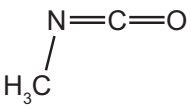
[W'10 Q7]

7 Methyl isocyanate, CH_3NCO, is a toxic liquid which is used in the manufacture of some pesticides.

In the methyl isocyanate molecule, the sequence of atoms is $H_3C—N=C=O$.

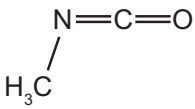
What is the approximate angle between the bonds formed by the N atom?

A



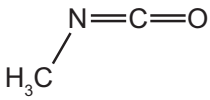
104°

B



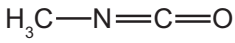
109°

C



120°

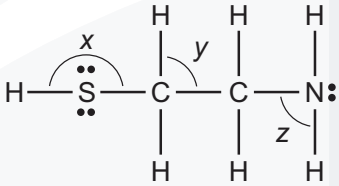
D



180°

[W'11 1 Q4]

8 The antidote molecule shown can help to prevent liver damage if someone takes too many paracetamol tablets.



: represents a lone pair

What is the order of **decreasing** size of the bond angles *x*, *y* and *z*?

	largest ⟶		smallest
A	*x*	*y*	*z*
B	*x*	*z*	*y*
C	*y*	*z*	*x*
D	*z*	*y*	*x*

[W'09 1 Q4]

9 Which molecule or structure does **not** contain three atoms bonded at an angle between 109° and 110°?

A ethanoic acid

B graphite

C propane

D silicon(IV) oxide

['1 Q]

10 In which pair do the molecules have the same shape as each other?

A H_2O and CO_2

B H_2O and SCl_2

C NH_3 and BH_3

D SCl_2 and $BeCl_2$

[W'12 1 Q12]

11 X is an element in Period 2.

In which fluoride is the F – X – F angle the largest?

A BF_3 **B** CF_4 **C** NF_3 **D** OF_2

12 Which series shows molecules in order of increasing bond angle?

A $CH_4 \rightarrow BF_3 \rightarrow NH_3$

B $H_2O \rightarrow CO_2 \rightarrow BF_3$

C $NH_3 \rightarrow CH_4 \rightarrow CO_2$

D $NH_3 \rightarrow CH_4 \rightarrow H_2O$

[M'16 Q6]

13 Which row of the table 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

14 Dicarbon monoxide, C_2O, is found in dust clouds in space. The structure of this molecule is C=C=O. The molecule contains no unpaired electrons.

How many lone pairs of electrons are present in a molecule of C_2O?

A 1 **B** 2 **C** 3 **D** 4

[S'13 2 Q9]

15 $AlCl_3$ vapour forms molecules with formula Al_2Cl_6 as it is cooled.

What happens to the bond angles during the change from $AlCl_3$ to Al_2Cl_6?

A Some decrease, some remain the same.

B Some increase, some remain the same.

C They all decrease.

D They all increase.

[S'14 1 Q6]

16 Which pair has species with different shapes?

A $BeCl_2$ and CO_2

B CH_4 and NH_4^+

C NH_3 and BF_3

D SCl_2 and H_2O

[S'15 3 Q4]

17 Each of the four species in this question are isolated and gaseous.

Which species is **not** planar?

A BF_3 **B** CH_3^+ **C** C_2H_4 **D** NH_3

[S'16 2 Q5]

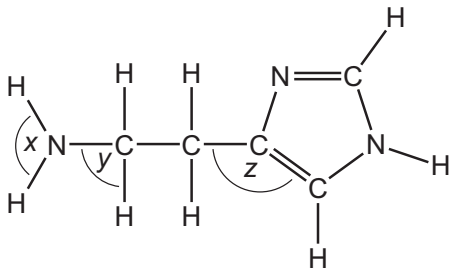
18 Sodium borohydride, $NaBH_4$, and boron trifluoride, BF_3, are compounds of boron.

What are the shapes around boron in the borohydride ion and in boron trifluoride?

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

[W'12 2 Q3]

19 Histamine is produced in the body to help fight infection. Its shape allows it to fit into receptors which expand blood vessels.



histamine

What are the bond angles *x*, *y* and *z* in histamine, from the smallest to the largest?

	smallest bond angle → largest bond angle		
A	*x*	*y*	*z*
B	*y*	*x*	*z*
C	*y*	*z*	*x*
D	*z*	*y*	*x*

[W'16 1 Q6]

20 Which molecule is planar?

A C_2Cl_4 **B** C_3H_6 **C** C_3H_8 **D** NF_3

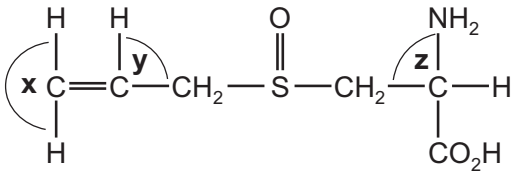
[S'04 Q20]

21 In which hydride is the H–X–H bond angle the smallest?

A BH_3 **B** CH_4 **C** C_2H_6 **D** NH_3

[W'16 2 Q7]

22 The characteristic smell of garlic is due to alliin.



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°

[M'17 Q5]

23 Which feature is present in both ethene and poly(ethene)?

A bond angles of 109°

B π covalent bonds

C σ covalent bonds

D sp^3 orbitals

[S'18 2 Q1]

24 Which statement describes the bond between carbon and hydrogen in an ethene molecule?

A a π bond between an s orbital and an sp^2 orbital

B a π bond between an s orbital and an sp^3 orbital

C a σ bond between an s orbital and an sp^2 orbital

D a σ bond between an s orbital and an sp^3 orbital

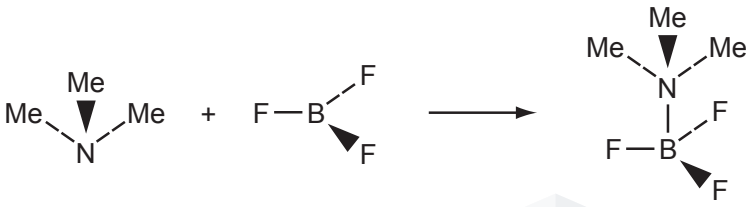
[S'18 3 Q4]

25 In this question, the methyl group, CH_3, is represented by Me.

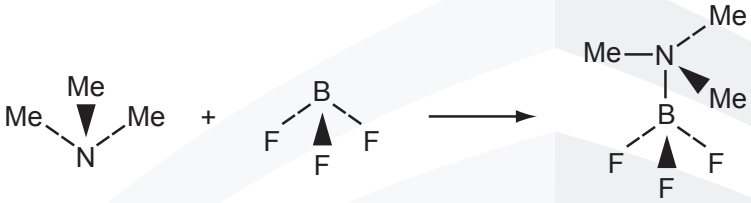
Trimethylamine, Me_3N, reacts with boron trifluoride, BF_3, to form a compound of formula $Me_3N.BF_3$.

How may this reaction be written in terms of the shapes of the reactants and products?

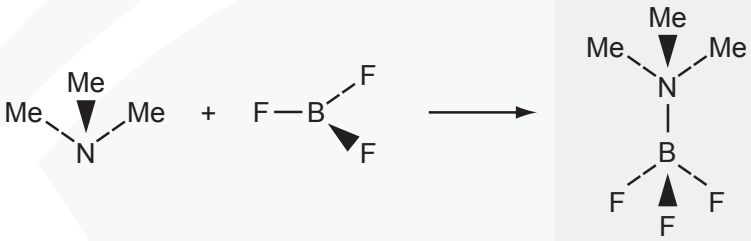
A



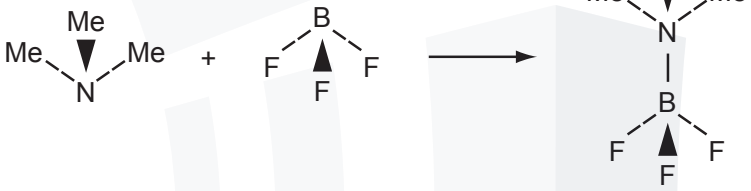
B



C



D



[S'08 Q5]

SECTION B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

1 Which of the following molecules and ions have a regular trigonal planar shape?

1 $AlCl_3$

2 CH_3^+

3 PH_3

[S'05 Q31]

2 Which molecules are planar?

1 BCl_3

2 NH_3

3 PH_3

[W'05 Q32]

3 In which sequences are the molecules quoted in order of increasing bond angle within the molecule?

1 H_2O NH_3 CH_4

2 H_2O SF_6 BF_3

3 CH_4 CO_2 SF_6

[S'02 Q32]

4 Which descriptions of the ammonium ion are correct?

1 It contains ten electrons.

2 It has a bond angle of 109.5°.

3 It has only three bonding pairs of electrons.

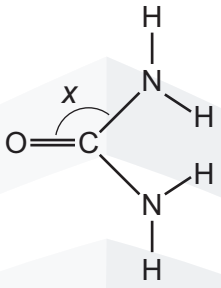
5 Which elements can form π bonds in their compounds?

1 carbon

2 oxygen

3 nitrogen

6 Urea is a product of animal metabolism. It can also be used as a fertiliser.



urea

The diagram shows angle *x* in this molecule.

Which statements about the structure of urea are correct?

1 Angle *x* is approximately 120°.

2 The molecule has two π bonds.

3 The molecule has only three lone pairs of electrons.

[S'15 1 Q32]

7 Which statements are correct?

1 The hydrogen bonds in ice are more regularly arranged than in water.

2 The solidification of water to form ice is exothermic.

3 Pure water is less dense than ice.

[S'18 1 Q32]