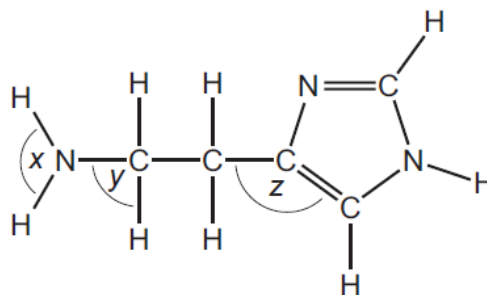


## Chemical Bonding – 2016

1. 9701/11/O/N/16/6

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 |
|----------|---------------------|---|--------------------|
| <b>A</b> | $x$                 |   | $z$                |
| <b>B</b> | $y$                 |   | $z$                |
| <b>C</b> | $y$                 |   | $x$                |
| <b>D</b> | $z$                 |   | $x$                |

2. 9701/11/O/N/16/32

Which elements can form  $\pi$  bonds in their compounds?

- 1 carbon
- 2 oxygen
- 3 nitrogen

3. 9701/12/O/N/16/6

When solid aluminium chloride is heated,  $Al_2Cl_6$  is formed.

Which bonding is present in  $Al_2Cl_6$ ?

- A** covalent and co-ordinate (dative covalent)
- B** covalent only
- C** ionic and co-ordinate (dative covalent)
- D** ionic only

4. 9701/12/O/N/16/7

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

- A**  $\text{BH}_3$                       **B**  $\text{CH}_4$                       **C**  $\text{C}_2\text{H}_6$                       **D**  $\text{NH}_3$

5. 9701/12/O/N/16/13

Which element shows the greatest tendency to form covalent compounds?

- A** boron  
**B** magnesium  
**C** neon  
**D** potassium

6. 9701/12/F/M/16/6

Which series shows molecules in order of increasing bond angle?

- A**  $\text{CH}_4 \rightarrow \text{BF}_3 \rightarrow \text{NH}_3$   
**B**  $\text{H}_2\text{O} \rightarrow \text{CO}_2 \rightarrow \text{BF}_3$   
**C**  $\text{NH}_3 \rightarrow \text{CH}_4 \rightarrow \text{CO}_2$   
**D**  $\text{NH}_3 \rightarrow \text{CH}_4 \rightarrow \text{H}_2\text{O}$

7. 9701/12/F/M/16/15

Which row of the table is correct?

|          | shape               |                     | bonds present    |              |
|----------|---------------------|---------------------|------------------|--------------|
|          | ammonia molecule    | ammonium ion        | ammonia molecule | ammonium ion |
| <b>A</b> | pyramidal           | regular tetrahedral | $\sigma$         | $\sigma$     |
| <b>B</b> | pyramidal           | regular tetrahedral | $\sigma$         | $\pi$        |
| <b>C</b> | regular tetrahedral | pyramidal           | $\sigma$         | $\sigma$     |
| <b>D</b> | regular tetrahedral | pyramidal           | $\pi$            | $\sigma$     |

8. 9701/12/F/M/16/16

Hydrogen chloride gas and hydrogen iodide gas have different thermal stabilities. The difference is due to a difference in the energies of some of the covalent bonds that are involved in the decomposition.

Which row identifies the more stable of the two compounds, and gives the correct explanation?

|          | identity of the more thermally stable compound | explanation for the difference in stability      |
|----------|--|--|
| <b>A</b> | hydrogen chloride                              | the $Cl-Cl$ bond is stronger than the $I-I$ bond |
| <b>B</b> | hydrogen chloride                              | the $H-Cl$ bond is stronger than the $H-I$ bond  |
| <b>C</b> | hydrogen iodide                                | the $Cl-Cl$ bond is stronger than the $I-I$ bond |
| <b>D</b> | hydrogen iodide                                | the $H-Cl$ bond is stronger than the $H-I$ bond  |

9. 9701/12/F/M/16/31

Which molecules have an overall dipole moment?

- 1 carbon monoxide,  $CO$
- 2 phosphine,  $PH_3$
- 3 carbon dioxide,  $CO_2$

10. 9701/11/M/J/16/2

What is the correct number of bonds of each type in the  $Al_2Cl_6$  molecule?

|          | covalent | co-ordinate (dative covalent) |
|----------|----------|-------------------------------|
| <b>A</b> | 6        | 1                             |
| <b>B</b> | 6        | 2                             |
| <b>C</b> | 7        | 0                             |
| <b>D</b> | 7        | 1                             |

11. 9701/11/M/J/16/5

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

12. 9701/11/M/J/16/7

At room temperature and pressure,  $\text{H}_2\text{O}$  is a liquid and  $\text{H}_2\text{S}$  is a gas.

What is the reason for this difference?

- A O has higher first and second ionisation energies than S.
- B The covalent bond between O and H is stronger than the covalent bond between S and H.
- C There is significant hydrogen bonding between  $\text{H}_2\text{O}$  molecules but not between  $\text{H}_2\text{S}$  molecules.
- D The instantaneous dipole-induced dipole forces between  $\text{H}_2\text{O}$  molecules are stronger than the instantaneous dipole-induced dipole forces between  $\text{H}_2\text{S}$  molecules.

13. 9701/12/M/J/16/5

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

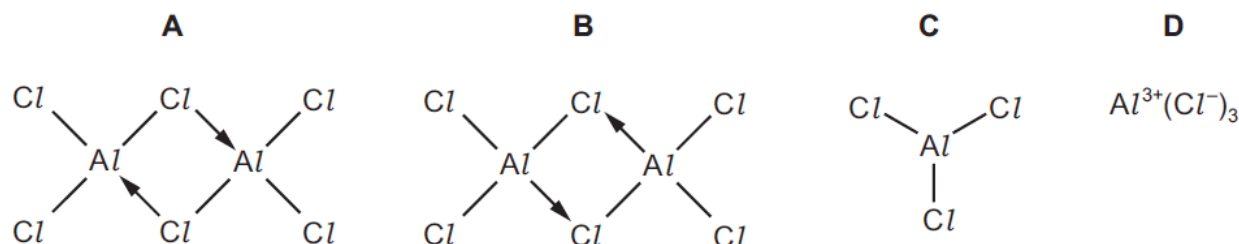
Which species is **not** planar?

- A  $\text{BF}_3$
- B  $\text{CH}_3^+$
- C  $\text{C}_2\text{H}_4$
- D  $\text{NH}_3$

14. 9701/12/M/J/16/13

Solid aluminium chloride sublimes at  $178^\circ\text{C}$ .

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



15. 9701/13/M/J/16/6

Carbon and silicon have the same outer electronic structure.

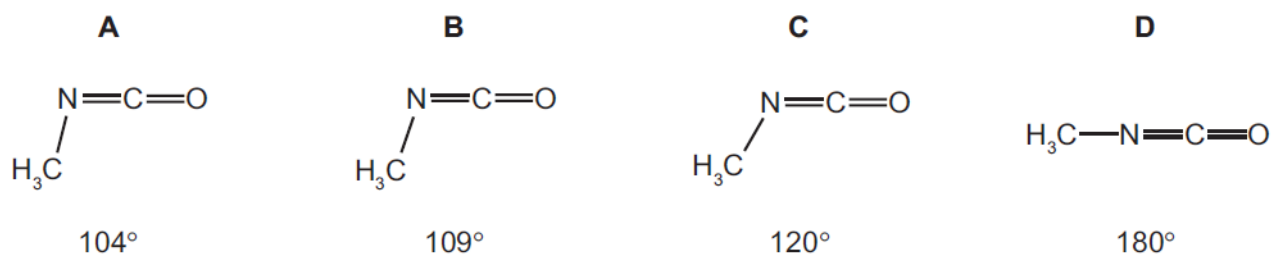
Why is a Si–Si bond weaker than a C–C bond?

- A Silicon atoms have a larger atomic radius than carbon atoms.
- B Silicon has a greater nuclear charge than carbon.
- C Silicon has a smaller first ionisation energy than carbon.
- D Silicon is more metallic than carbon.

16. 9701/13/M/J/16/7

Methyl isocyanate,  $\text{CH}_3\text{NCO}$ , is a toxic liquid which is used in the manufacture of some pesticides.

What is the approximate angle between the bonds formed by the N atom in a molecule of methyl isocyanate?



17. 9701/13/M/J/16/13

Each pair below consists of a sample of two separate elements. Each element is in its standard state at room temperature and pressure.

Which pair of elements has chemical bonds of the same type between their atoms?

- A aluminium and phosphorus
- B chlorine and argon
- C magnesium and silicon
- D sulfur and chlorine

18. 9701/13/M/J/16/32

Water has some unusual physical properties compared to other hydrides of Group 16 elements. Some of these properties are due to hydrogen bonds. These intermolecular forces are much stronger in water than they are in  $\text{H}_2\text{S}$ , for example.

Which statements are correct?

- 1 Hydrogen bonds cause the melting point of ice to be higher than expected.
- 2 Hydrogen bonds cause the surface tension of water to be higher than expected.
- 3 Hydrogen bonds cause the viscosity of water to be higher than expected.