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CHEMISTRY

Physical Chemistry

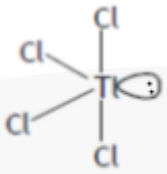
Level & Board	AQA (A-LEVEL)
TOPIC:	BONDING
PAPER TYPE:	SOLUTION -4
TOTAL QUESTIONS	10
TOTAL MARKS	49

Bonding

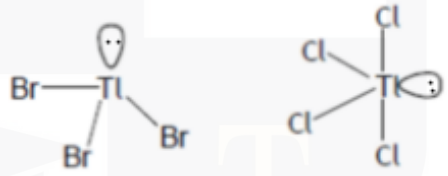
1.

(a)

$TlCl_4^{3-}$



$TlBr_3^{2-}$
Shape: trigonal planar shape /trigonal pyramid
Angle: 107°



(4)

(b)

Thallium(I) bromide (TlBr) has ionic bonding.
Ionic bonding occurs between a metal (thallium, Tl) and a non-metal (bromine, Br) in this compound.
The high melting point of thallium(I) bromide is due to the strong ionic bonds present in the crystal lattice structure.
These ionic bonds require a large amount of energy to overcome, leading to a high melting point.

(3)

(c)

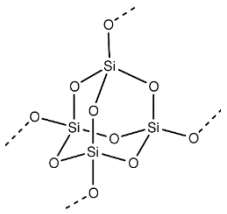
$2Tl_{(s)} + Br_{2\ (g)} \rightarrow 2TlBr_{(s)}$

(1)

2.

(a)

Silicon dioxide, commonly known as silica, has a crystal structure known as a tetrahedral coordination / giant or "three-dimensional network covalent bonding."



(1)

(b)

In molten state, silicon dioxide does not conduct electricity because it do not have mobile ions or free electrons required for electrical conduction. The absence of charged particles capable of carrying an electric current prevents silicon dioxide from conducting electricity, whether in its solid or molten state.

(1)

(c)

The balanced chemical equation for this reaction is as follows:

$SiO_{2(s)} + 6HF_{(aq)} \rightarrow H_2SiF_{6(aq)} + 2H_2O_{(l)}$

(1)

3. (D)

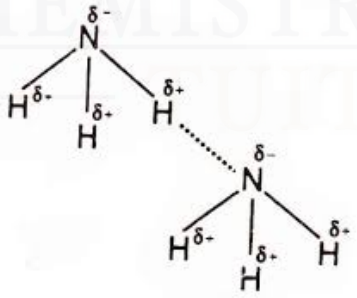
(Total 1 mark)

4. (A)

(Total 1 mark)

5.

(a) Diagram showing the strongest type of interaction between two molecules of NH_3 is Hydrogen bonding.



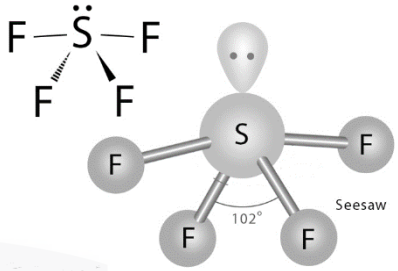
(3)

(b)

SF_4

Shape: distorted tetrahedral / see-saw/ trigonal bipyramidal

Angle: 102°



In SF_4, sulfur (S) has six valence electrons four from the four fluorine (F) atoms and two from its lone pair of electrons.

The molecular shape is a see-saw or distorted tetrahedral shape.

The lone pair of electrons occupies more space around the central sulfur atom compared to the bonding pairs, resulting in a distortion from the ideal tetrahedral angle of 109.5°.

The presence of the lone pair repels the bonding pairs, slightly decreasing the bond angles.

So, the bond angle for SF_4 is approximately 102°.

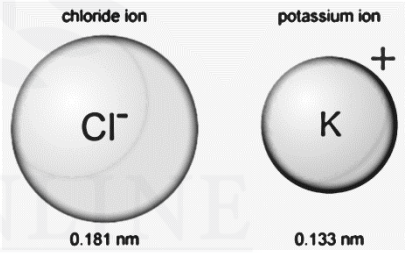
(5)

6.

(a)

Both K^+ and Cl^- ions have the same number of electrons, the difference in their ionic sizes is due to the difference in nuclear charges.

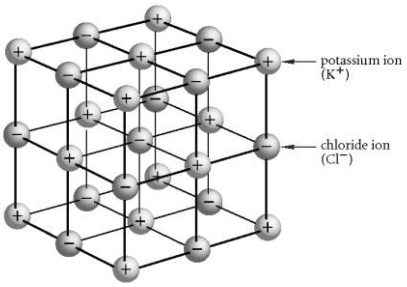
K^+ has a higher effective nuclear charge due to its 19 protons, also lost its shell by removing an electron resulting in a smaller ionic size, while Cl^- has a lower effective nuclear charge due to its 17 protons, resulting in a larger ionic size. Cl^- also have electron repulsion resulting in a larger ionic size.



(2)

(b)

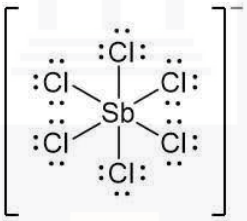
The ionic lattice structure of potassium chloride is held together by strong electrostatic forces, requiring a significant amount of energy to overcome these bonds and break apart the crystal lattice.
Therefore, a lot of amount of heat energy is needed to raise the temperature of potassium chloride to its melting point, resulting in its high melting point. It has melting of 770 °C.



(2)

(c)

$SbCl_6^-$
Shape: **Octahedral**
Angle: 90°



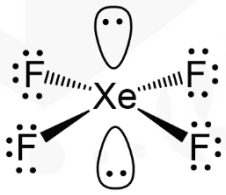
(3)

7. (B)

(Total 1 mark)

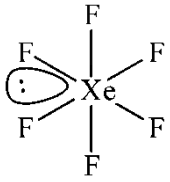
8.

XeF_4
Shape: square planar.



XeF_6
Shape: distorted octahedral
Angle: 90° to 72°.

In an octahedral arrangement, the bond angles between the ligands (fluorine atoms) are expected to be 90°.
However, due to the presence of lone pairs on the xenon atom, these lone pairs exert greater repulsion compared to bonded electron pairs.

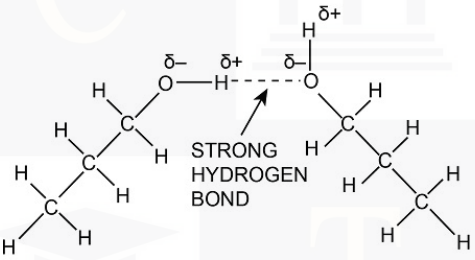


The lone pairs of electrons tend to occupy more space compared to bonding pairs, causing greater repulsion and influencing the bond angles.
The actual bond angles in XeF_6 are observed to be around 90^o, although due to the repulsive effects, they might be slightly smaller than 90^o.

(Total 5 marks)

9.

Propanal (CH_3CH_2CHO) is an aldehyde with a molecular structure that includes a polar carbonyl group (C=O) as well as a longer carbon chain. The polar carbonyl group in propanal molecules helps to form dipole-dipole interactions and hydrogen bonding between molecules. Hydrogen bonding in propanol as :



Ethene molecules do not have the polarity. The main intermolecular forces in ethene are weak London dispersion forces (van der Waals forces) which are generally weaker than dipole-dipole interactions and hydrogen bonding.
That is why propanal has a higher boiling point than ethene.

(3)

10. (D)

(Total 1 mark)

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