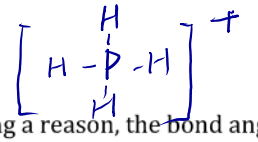
1.

(i) Deduce the Lewis structure of $PH_4^+$ .



(ii) Predict, giving a reason, the bond angle around the phosphorus atom in $PH_4^+$ .

The bond angle is 109.5° because there are 4 electron domain and all of them are bonding pairs, so the shape is tetrahedral

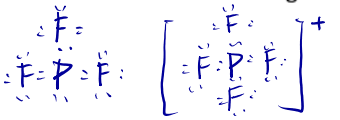
(iii) Predict whether or not the P–H bond is polar, giving a reason for your choice.

P-H bond is nonpolar, because P and H have nearly the same electronegativity.

2.

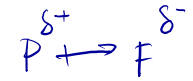
Lewis (electron dot) structures are useful models.

Draw the Lewis (electron dot) structures of $PF_3$ and $PF_4^+$ and use the VSEPR theory to deduce the molecular geometry of each species.



| | Electron Domain | bonding pair | molecular geometry |
|---|---|---|---|
| $PF_3$ | 4 | 3 | trigonal pyramidal |
| $PF_4^+$ | 4 | 4 | tetrahedral |

Predict with a reason, whether the molecule $PF_3$ is polar or non-polar.

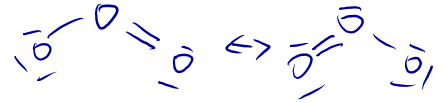


$PF_3$ is polar, because the shape of $PF_3$ is trigonal paramydal and is not symmetric. so the dipoles cannot cancel out

3.

**a.** Draw the Lewis structures of oxygen, $O_2$, and ozone, $O_3$.

**b.** State the different bond lengths and strengths between the oxygen atoms in $O_2$ and $O_3$ in the ozone layer affect radiation reaching the Earth's surface.

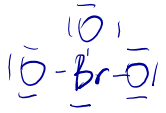
The resonance structure of $O_3$ is 

the bond length in $O_3$ is between single bond and double bond, longer than that of $O_2$, so the bond strength in $O_3$ is smaller than that of $O_2$

4.

78 18 26/2 = 13

**a.** Draw the Lewis (electron dot) structure for $BrO_3^-$ that obeys the octet rule.



**b.** Predict, using the VSEPR theory, the geometry of the $BrO_3^-$ ion and the O–Br– O bond angles.

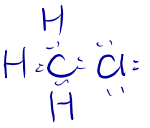
Geometry: trigonal pyramidal

Reason: 4 electron domain, 3 bonding pairs

O-Br-O angle: 107°

5.

**a.** Draw the Lewis (electron dot) structure of chloromethane CH3Cl.



**b.** Predict the shape of the chloromethane molecule and the H–C–H bond angle.

Shape: tetrahedral

Bond angle: 109.5°

**c.** Explain why chloromethane is a polar molecule.

Because the dipoles in C-H and C-Cl bonds are different, the dipoles cannot be canceled, thus $CH_3Cl$ is a polar molecule.

6.

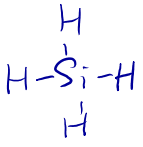
**(a)** Sketch and state the names of the shapes of the following molecules.

**(i)** $SiH_4$

**(ii)** $PH_3$ (4)

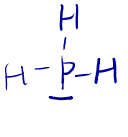
**(b)** State the bond angle in $SiH_4$ and explain why it is greater than that in $PH_3$. (2)

(a) (i)

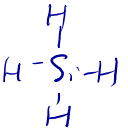


tetrahedral

(ii)



trigonal pyramidal



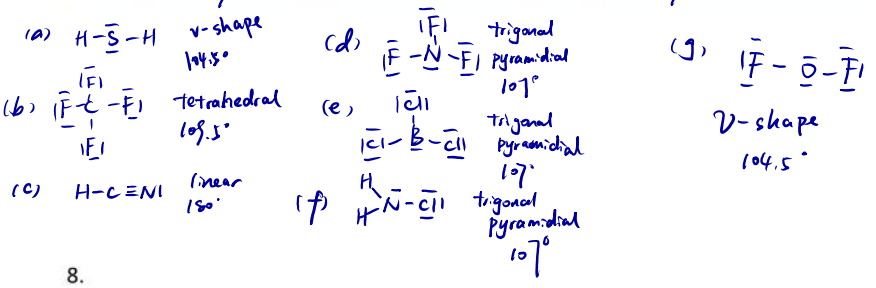
| | $SiH_4$ | $PH_3$ |
|---|---|---|
| Electron Domain | 4 | 4 |
| bonding pair | 4 | 3 |
| bond angle | 109.5° | 107 |

(b) Bond angle of $SiH_4$ is bigger than $PH_3$ because

7.

Predict the shape and bond angles of the following molecules:

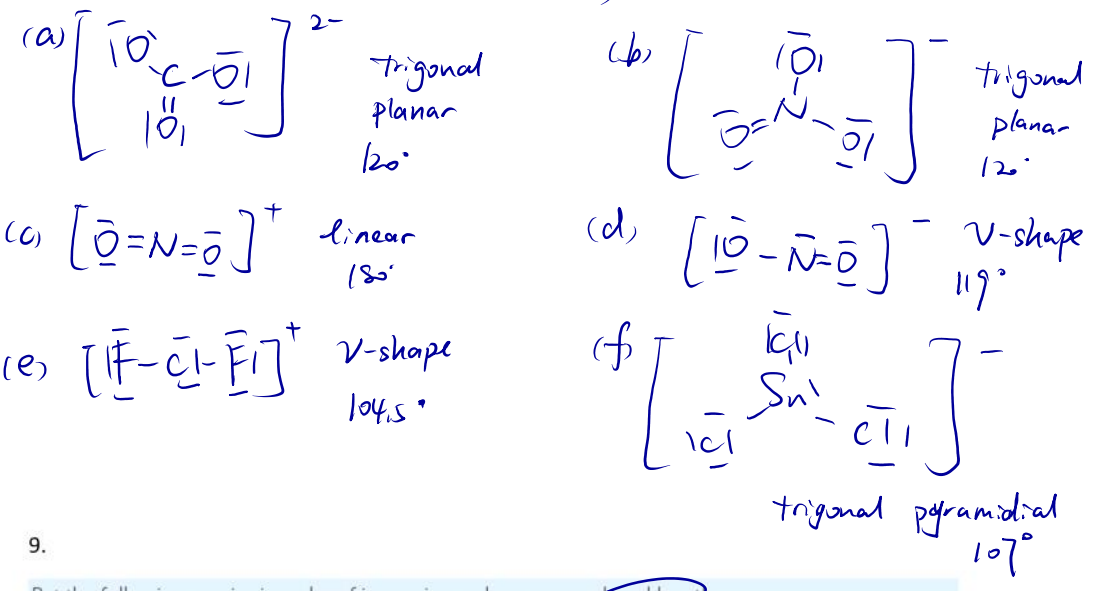
**(a)** $H_2S$ **(b)** $CF_4$ **(c)** HCN **(d)** $NF_3$
**(e)** $BCl_3$ **(f)** $NH_2Cl$ **(g)** $OF_2$




8.

Predict the shape and bond angles of the following ions:

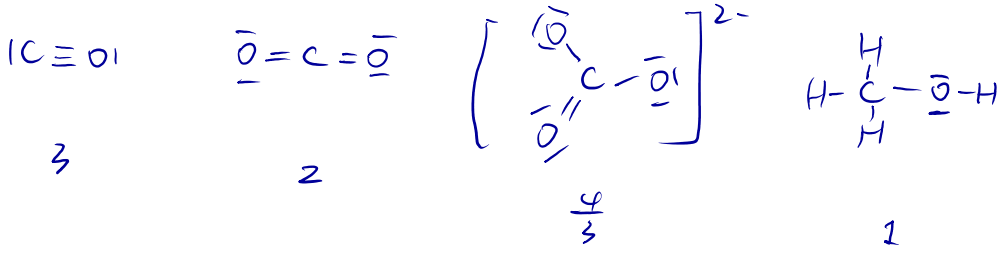
**(a)** $CO_3^{2-}$ **(b)** $NO_3^-$ **(c)** $NO_2^+$ **(d)** $NO_2^-$
**(e)** $ClF_2^+$ **(f)** $SnCl_3^-$




9.

Put the following species in order of increasing carbon–oxygen bond length:

CO $CO_2$ $CO_3^{2-}$ $CH_3OH$




$CH_3OH > CO_3^{2-} > CO_2 > CO$