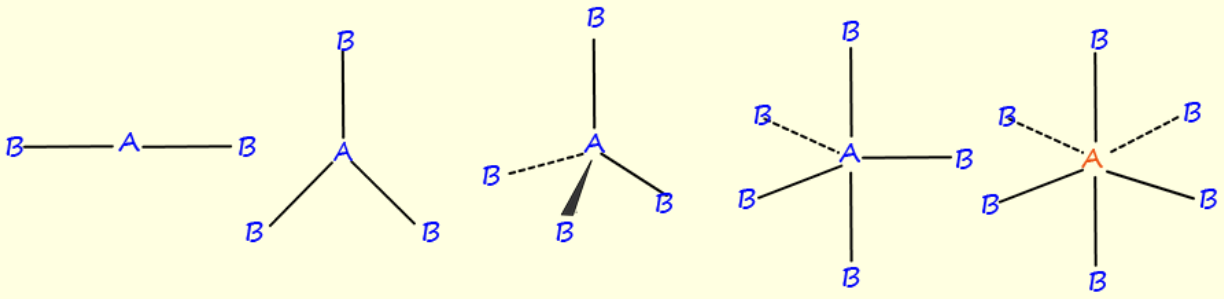
Shapes of molecules

1. The diagram below shows the 5 basic shapes of molecules that VSEPR theory predicts. Underneath each shape write the name of the molecular shape and identify and label all bond angles in the molecules.



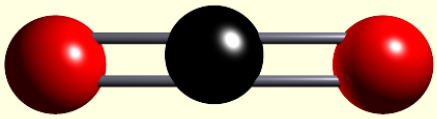
b. For each molecule above how many bonding pairs of electrons are present?

c. Which molecules above have an expanded valance shell of electrons? How many electrons are in this expanded valance shell?

d. What do the solid, dotted and arrow lines coming out of the central atom in each of the molecules above represent?

e. In a short sentence or two explain what VSEPR theory is.

2. The molecule shown opposite is carbon dioxide.

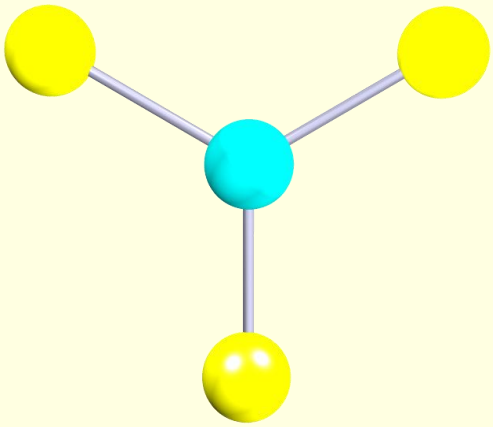


a. How many valance electrons are shown in the covalent bonds in this molecule?

b. What shape is this molecule?

c. What are the bond angles in this molecule?

3. The molecule shown opposite is boron trifluoride.



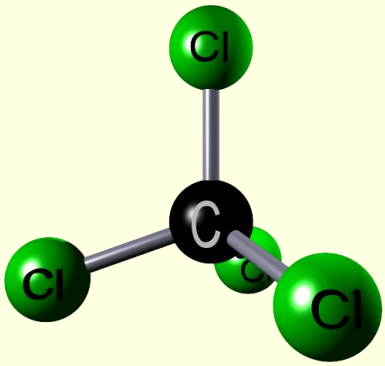
a. What is its formula?

b. How many electrons are round the central boron atom? What is unusual about this number of electrons?

c. What shape is this molecule?

d. What are the bond angles in this molecule?

4. The molecule shown opposite is carbon tetrachloride.



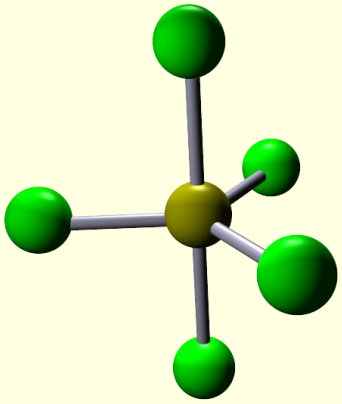
a. What is the formula for this molecule?

b. What shape is carbon tetrachloride?

c. What are the bond angles in this molecule?

d. Is this molecule symmetrical?

5. The molecule shown opposite has the formula PCl_5.



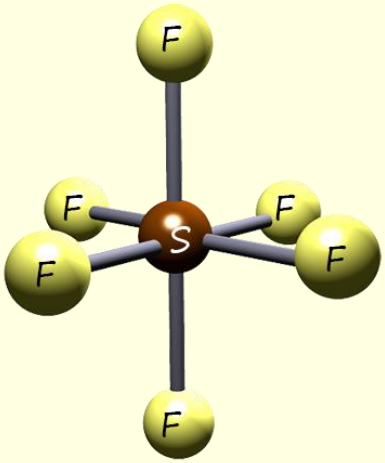
a. Name the molecule.

b. Clearly label the axial and equatorial chlorine atoms in this molecule.

c. What are the two different bond angles present in this molecule?

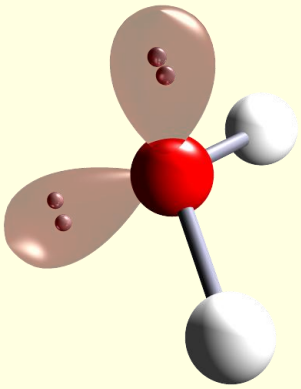
d. What shape is PCl_5?

6. Name the molecule shown opposite and write down its molecular formula.



a. What shape is this molecule and what are the bond angles in this molecule?

7. The molecule opposite is water. The white spheres represent the two hydrogen atoms present in water.



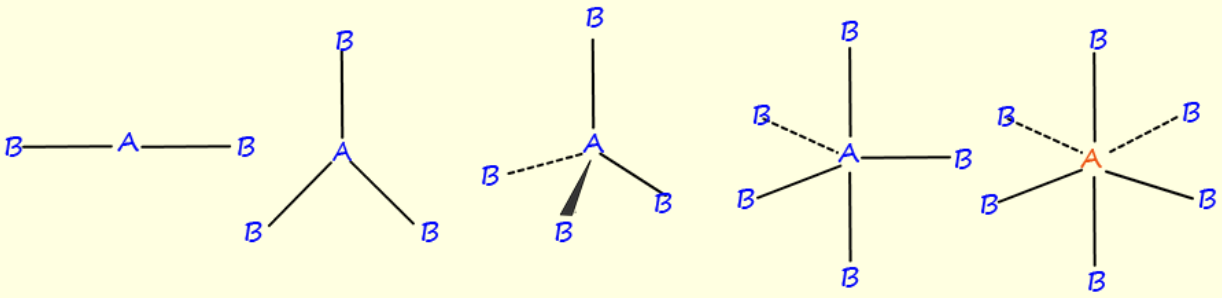
a. How many valance electrons are present in this molecule?

b. What do the two ear like structures sticking out of the oxygen atom represent?

Shapes of molecules

Answers

1. The diagram below shows the 5 basic shapes of molecules that VSEPR theory predicts. Underneath each shape write the name of the molecular shape and identify and label all bond angles in the molecules.



Linear	Trigonal planar	tetrahedral	Trigonal bipyramidal	octahedral
All bond angles are 180°	All bond angles are 120°	All bond angles are 109.5°	bond angles are 120° and 90°	All bond angles are 90°
2 bonding pairs of electrons present	3 bonding pairs of electrons present	4 bonding pairs of electrons present	5 bonding pairs of electrons present	6 bonding pairs of electrons present

b. For each molecule above how many bonding pairs of electrons are present?

Answers in table above

c. Which molecules above have an expanded valence shell of electrons? How many electrons are in this expanded valence shell?

The trigonal bipyramidal molecule has 10 electrons in its valence shell and the octahedral molecule has 12 electrons in its valence shell. Recall that in gcse chemsitry we limited the number of electrons in the last or valence shell to 8 (an octet of electrons). However it is possible to have more than 8 electrons in the outer shell. It is common when we have non-metal elements in or above period 3 in the periodic table to have expanded valence shells.

d. What do the solid, dotted and arrow lines coming out of the central atom in each of the molecules above represent?

Solid lines represent bonds in the plane of the paper

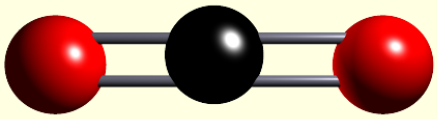
Dotted lines represent bonds behind the plane of the paper

Arrows represent bonds stucking out of the plane of the paper.

e. In a short sentence or two explain what VSEPR theory is.

VSEPR uses the idea that electrons in bonding and non-bonding pairs of electrons repel each other and try to get as far apart as possible in 3d space.

2. The molecule shown opposite is carbon dioxide.



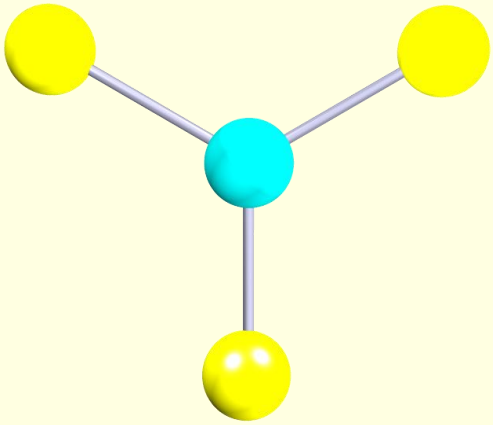
a. How many valance electrons are shown in the covalent bonds in this molecule?

4 covalent bonds are shown with 2 electrons in each bond. So total is 10 electrons.

b. What shape is this molecule? linear

c. What are the bond angles in this molecule? 180°

3. The molecule shown opposite is boron trifluoride.



a. What is its formula? BF_3

b. How many electrons are round the central boron atom? What is unusual about this number of electrons?

3 covalent bonds, so total of 6 electrons.

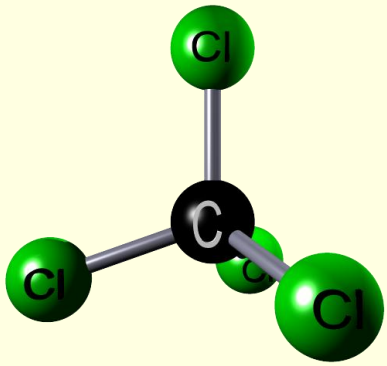
This molecule is electron deficient; we learned in gcse that minimum is 8 electrons in last or valence shell.

c. What shape is this molecule? Trigonal planar

d. What are the bond angles in this molecule?

120°

4. The molecule shown opposite is carbon tetrachloride.



a. What is the formula for this molecule? CCl_4

b. What shape is carbon tetrachloride?

tetrahedral

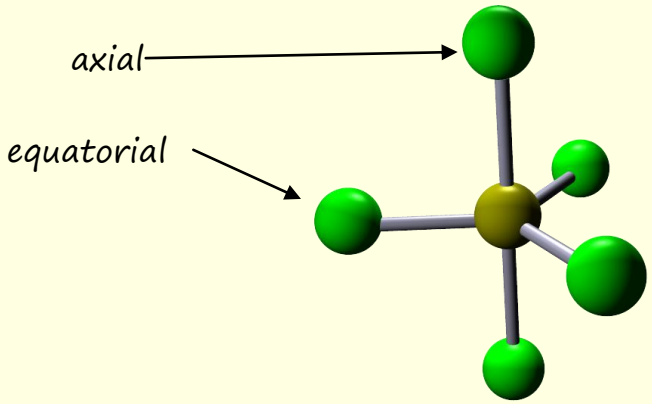
c. What are the bond angles in this molecule? 109.5°

d. Is this molecule symmetrical? Highly symmetrical, build it and see for yourself!

5. The molecule shown opposite has the formula PCl_5.

a. Name the molecule. Phosphorus pentachloride (pent=5)

b. Clearly label the axial and equatorial chlorine atoms in this molecule.

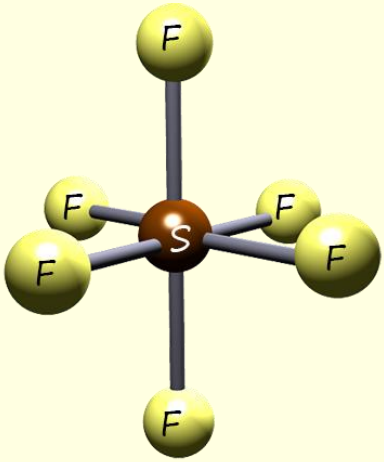


c. What are the two different bond angles present in this molecule? Around the equatorial position the 4 chlorine atoms are at 120° to each other. The angle between the axial and equatorial chlorine atoms is 90°

d. What shape is PCl_5? trigonal bipyramidal

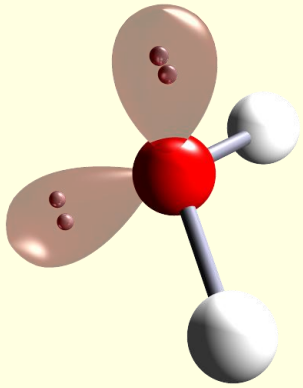
6. Name the molecule shown opposite and write down its molecular formula.

Sulfur hexafluoride , hex= 6



a. What shape is this molecule and what are the bond angles in this molecule? octahedral

7. The molecule opposite is water. The white spheres represent the two hydrogen atoms present in water.



a. How many valance electrons are present in this molecule?

2 covalent bonds = 4e

2 lone pairs = 4e

Total of 8e in valence shell of water.

b. What do the two ear like structures sticking out of the oxygen atom represent?

lone pairs or non-bonding pairs of electrons