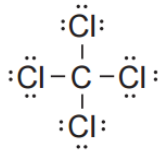
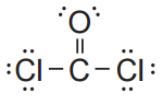
QUESTION (2015:1)

(a) Draw the Lewis structure for each of the following molecules.

Molecule	O_2	OCl_2	CH_2O
Lewis structure			

(b) Carbon atoms can bond with different atoms to form many different compounds. The following table shows the Lewis structure for two molecules containing carbon as the central atom, CCl_4 and $COCl_2$. These molecules have different bond angles and shapes.

Molecule	CCl_4	$COCl_2$
Lewis structure		

Evaluate the Lewis structure of each molecule to determine why they have different bond angles and shapes. In your answer, you should include:

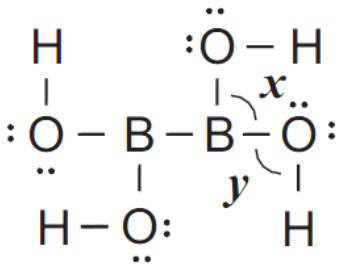
- the approximate bond angle in each molecule
- the shape of each molecule
- factors that determine the shape and bond angle for each molecule.

QUESTION (2014:1)

(a) Draw the Lewis structure for each of the following molecules.

Molecule	HCN	CH_2Br_2	AsH_3
Lewis structure			

(b) The Lewis structure for a molecule containing atoms of boron, oxygen, and hydrogen, is shown below.



(i) The following table describes the shapes around two of the atoms in the molecule above. Complete the table with the approximate bond angles x and y.

Central atom	Shape formed by bonds around the central atom	Approximate bond angle
B	Trigonal planar	*x* =
O	bent	*y* =

(ii) The bond angles x and y in the molecule above are different.

Elaborate on why the bond angles are different.

In your answer you should include:

- factors which determine the shape around the:

  B atom for bond angle *x*

  O atom for bond angle *y*

- reference to the arrangement of electrons around the B and O atoms.

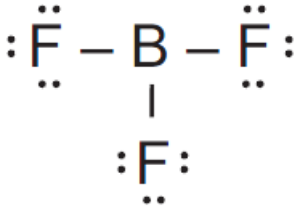
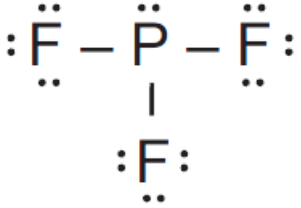
QUESTION (2013:1)

(a) Draw the Lewis structure for each of the following molecules.

Molecule	CH_4	H_2O	N_2
Lewis structure			

(b) Boron and phosphorus both bond with three fluorine atoms to form BF_3 and PF_3. However, the molecules have different shapes and bond angles.

The following table shows the Lewis structures for the molecules BF_3 and PF_3.

Molecule	BF_3	PF_3
Lewis structure		

Explain why these molecules have different shapes and bond angles.

In your answer include:

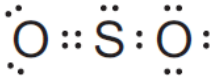
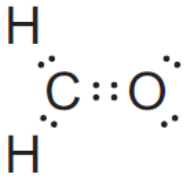
- the shapes of BF_3 and PF_3
- factors that determine the shape of each molecule
- the approximate bond angle in BF_3 and PF_3
- justification of your chosen bond angles for each molecule.

QUESTION (2012:1)

(a) Draw the Lewis structure (electron dot diagram) for each of the following molecules.

Molecule	PCl_3	CO_2	H_2S
Lewis structure			

(b) The following table shows the Lewis structures and bond angles for the molecules SO2 and H_2CO.

Molecule	SO_2	H_2CO
Lewis structure		
Approximate bond angle around the central atom	120°	120°

Explain why these molecules have different shapes, but have the same approximate bond angle.

In your answer you should include:

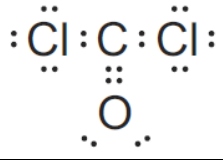
- the shapes of SO_2 and H_2CO
- factors which determine the shape of each molecule
- an explanation of why the approximate bond angle is the same by referring to the arrangement of electrons for each molecule.

QUESTION (2011:1)

(a) Draw the Lewis structure (electron dot diagram) for each of the following molecules.

Molecule	OCl_2	O_2	CH_3Br
Lewis structure			

(b) Lewis structures for two molecules are given below.

Molecule	HCN	$COCl_2$
Lewis structure		

For each molecule, name the shape of the molecule and give a reason for your answer.

(i) HCN Shape:

Reason:

(ii) $COCl_2$ Shape:

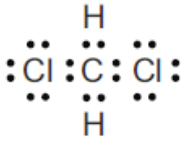
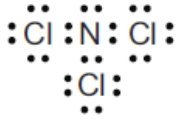
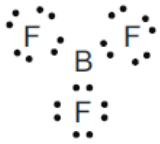
Reason:

QUESTION (2010:1)

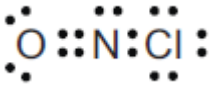
(a) Draw the Lewis structure (electron dot diagram) for each of the following molecules.

Molecule	**Lewis Structure**
O_2	
SO_2	
$SiCl_4$	

(b) Lewis structures for three molecules are given below. Complete the table by giving the name of the shape of each molecule.

Molecule	**Lewis Structure**	**Name of shape**
CH_2Cl_2		
NCl_3		
BF_3		

(c) The following table shows the Lewis structure and the shape of the molecules for NOCl and H_2S.

	NOCl	H_2S
Lewis Structure		
Name of shape	bent	bent

The shape of both molecules can be described as bent. However, these molecules do not have the same bond angle.

Discuss why these molecules have different bond angles.

Your answer must include:

- factors which determine the shape of each molecule
- the approximate bond angle for each molecule.

QUESTION (2009:1)

(a) Complete the table below by:

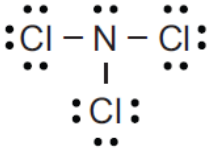
(i) Drawing the Lewis structure (electron dot diagram) for each molecule.

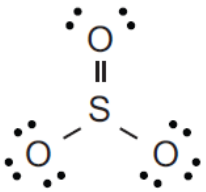
(ii) Drawing a diagram to show the shape of the molecule.

(iii) Naming the shape of the molecule.

Molecule	**Lewis Structure**	**Diagram of shape**	**Name of shape**
H_2O			
CO_2			
CH_2Br_2			

(b) The Lewis structures of the molecules NCl_3 and SO_3 are given below.





Discuss the shapes and bond angles of these two molecules. For each molecule:

- name the shape
- determine the bond angle
- justify your answers.

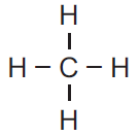
QUESTION (2008:1)

(a) Draw a Lewis structure (electron dot diagram) for each of the following molecules :

Molecule	Lewis structure
Cl_2O	
CS_2	
HCN	

(b) Lewis structures for TWO molecules are given below. For each molecule :

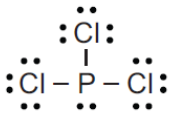
- name the shape
- justify your answer.



(i)

Shape

Justification



(ii)

Shape

Justification

QUESTION (2008:3)

An element, X, has four valence electrons. Another element, Y, has six valence electrons. These elements both combine with oxygen. The molecules formed are XO_2 and YO_2.

(a) Draw the Lewis structures of these two molecules. XO_2 & YO_2

(b) Determine the bond angle in each of these molecules using the Lewis structures from (a). Justify your answer.

QUESTION (2007:1)

(a) Complete the table below by:

(i) drawing the Lewis structure (electron dot diagram) for each molecule

(ii) naming the shape of the molecule.

Molecule	(i) Lewis diagram	(ii) Name of shape

CH_3Cl		
NCl_3		
CH_2O		

(b) For each of the molecules in the table, explain why it has the shape you have identified.
(i) CH_3Cl (ii) NCl_3 (iii) CH_2O

QUESTION (2006:1)

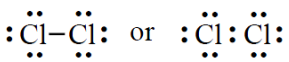
Complete the table below by:
(a) drawing a Lewis structure (electron dot diagram) for each molecule
(b) drawing a diagram to show the shape of the molecule
(c) naming the shape of the molecule.

Formula of molecule	Lewis structure	Diagram of shape	Name of shape
SF_2			
CO_2			
PBr_3			

QUESTION (2006:4)

Molecules of water (H_2O) and ozone (O_3) each contain 3 atoms and both the molecules are bent. However, the bond angle in H_2O is significantly smaller than the bond angle in O_3.
Using Lewis structures, discuss the reasons for the difference in **bond angles** of these two molecules.

QUESTION (2005:1)

The Lewis structure for chlorine, Cl_2, is  or

Complete the table below by:
(a) drawing a Lewis structure for each molecule,
(b) naming the shape of each molecule.

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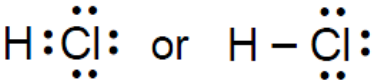
Molecule	Lewis structure	Name of shape
H_2S		
PCl_3		
CH_3Br		
$COCl_2$ Note C is central atom		

QUESTION (2004:1)

The Lewis structure for hydrogen chloride, HCl, is  or

Complete the table below by:

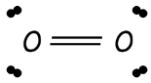
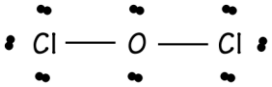
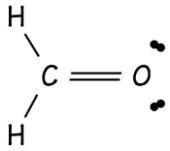
(a) drawing a Lewis structure for each molecule,

Molecule	Lewis structure
CO_2	
PH_3	
CH_2Cl_2	
H_2CO	
F_2O	

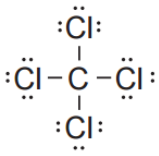
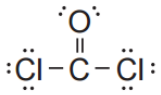
ANSWERS

QUESTION (2015:1)

(a) Draw the Lewis structure for each of the following molecules.

Molecule	O_2	OCl_2	CH_2O
Lewis structure			

(b) Carbon atoms can bond with different atoms to form many different compounds. The following table shows the Lewis structure for two molecules containing carbon as the central atom, CCl_4 and $COCl_2$. These molecules have different bond angles and shapes.

Molecule	CCl_4	$COCl_2$
Lewis structure		

Evaluate the Lewis structure of each molecule to determine why they have different bond angles and shapes. In your answer, you should include:

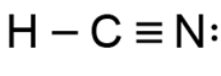
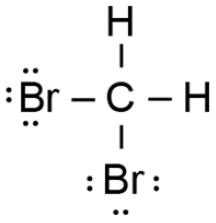
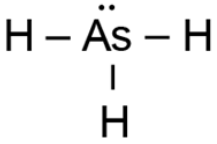
- the approximate bond angle in each molecule
- the shape of each molecule
- factors that determine the shape and bond angle for each molecule.

In each CCl_4 molecule, there are four negative / electron : densities / clouds / regions around the central C atom. These repel each other / are positioned as far away from each other as possible in a tetrahedral (base) arrangement, resulting in a 109.5° bond angle. All of these regions of electrons / electron densities are bonding, without any non-bonding regions, so the shape of the molecule is tetrahedral.

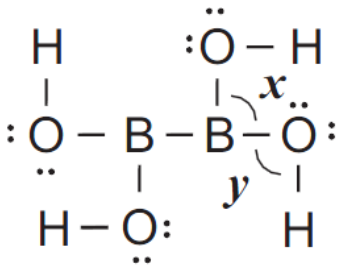
In each $COCl_2$ molecule, there are three negative / electron : densities / clouds / regions around the central C atom. These repel / are positioned as far away from each other as possible in a triangular / trigonal planar (base) shape, resulting in a 120° bond angle. All of these regions of electrons / electron densities are bonding, without any non-bonding regions, so the shape of the molecule is trigonal planar.

QUESTION (2014:1)

(a) Draw the Lewis structure for each of the following molecules.

Molecule	HCN	CH_2Br_2	AsH_3
Lewis structure			

(b) The Lewis structure for a molecule containing atoms of boron, oxygen, and hydrogen, is shown below.



(i) The following table describes the shapes around two of the atoms in the molecule above. Complete the table with the approximate bond angles x and y.

Central atom	Shape formed by bonds around the central atom	Approximate bond angle
B	Trigonal planar	x = 120°
O	bent	y = 109.5°

(ii) The bond angles x and y in the molecule above are different.

Elaborate on why the bond angles are different.

In your answer you should include:

- factors which determine the shape around the:

  B atom for bond angle *x*

  O atom for bond angle *y*

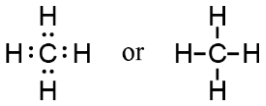
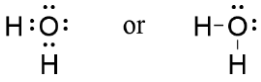
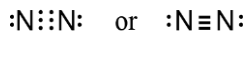
- reference to the arrangement of electrons around the B and O atoms.

The B atom has three regions of electron density around it. These are all bonding regions. The regions of electron density are arranged to minimise repulsion / are arranged as far apart as possible from each other. (This is why the bond angle is 120°.)

The O atom has four regions of electron density around it. The regions of electron density are arranged to minimise repulsion / are arranged as far apart as possible from each other in a tetrahedral arrangement / two of these are bonding (and two are non-bonding). This is why the bond angle is 109.5°.

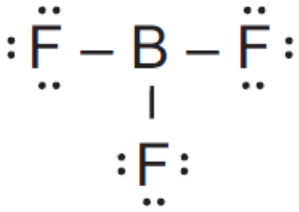
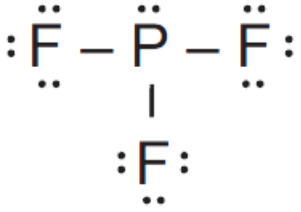
QUESTION (2013:1)

(a) Draw the Lewis structure for each of the following molecules.

Molecule	CH_4	H_2O	N_2
Lewis structure	 or		

(b) Boron and phosphorus both bond with three fluorine atoms to form BF_3 and PF_3. However, the molecules have different shapes and bond angles.

The following table shows the Lewis structures for the molecules BF_3 and PF_3.

Molecule	BF_3	PF_3
Lewis structure		

Explain why these molecules have different shapes and bond angles.

In your answer include:

- the shapes of BF_3 and PF_3
- factors that determine the shape of each molecule
- the approximate bond angle in BF_3 and PF_3
- justification of your chosen bond angles for each molecule.

BF_3: trigonal planar: 120° bond angles

PF_3: trigonal pyramidal; ≈ / < 109.5° (107°) bond angle

Shape is determined by the number of regions of electron density / electron clouds and whether they are bonding / non-bonding.

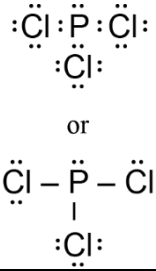
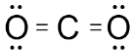
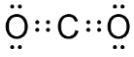
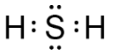
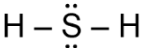
BF_3 has three regions of electron density / electron clouds around the central B atom. The regions of electrons are arranged as far apart as possible from each other / to minimise repulsion, which results in a trigonal planar arrangement with a bond angle of 120°. All three regions of electrons are bonding, so the overall shape is trigonal planar.

PF_3 has four regions of electron density / electron clouds around the central P atom. The regions of electrons make a tetrahedral arrangement with a bond angle of 109.5°. Only three regions of electrons are bonding and one is non-bonding, so the overall shape is trigonal pyramidal.

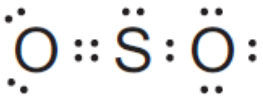
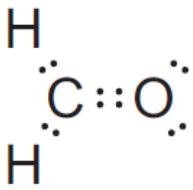
The non-bonding electrons have increased repulsion, therefore decreasing the bond angle to < 109.5°

QUESTION (2012:1)

(a) Draw the Lewis structure (electron dot diagram) for each of the following molecules.

Molecule	PCl_3	CO_2	H_2S
Lewis structure	 or	 or 	 or 

(b) The following table shows the Lewis structures and bond angles for the molecules SO2 and H_2CO.

Molecule	SO_2	H_2CO
Lewis structure		
Approximate bond angle around the central atom	120°	120°

Explain why these molecules have different shapes, but have the same approximate bond angle.

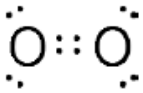
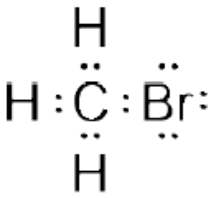
In your answer you should include:

- the shapes of SO_2 and H_2CO
- factors which determine the shape of each molecule
- an explanation of why the approximate bond angle is the same by referring to the arrangement of electrons for each molecule.

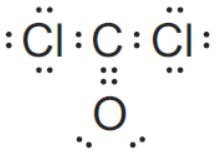
The central atom in SO_2 has three regions of electron density/electron clouds around it. The regions of electrons are arranged as far apart as possible from each other (in order to minimise repulsion) making a trigonal planar shape. This gives a bond angle of 120°. Only two of these regions of electrons are bonding and one is non-bonding so the shape of the molecule is **V-shaped (bent).**
The central atom of H_2CO, has three regions of electron density around it. The regions of electrons making a trigonal planar shape, giving a bond angle of 120°. All three of these regions of electrons are bonding so the arrangement of the bonds/molecular shape is **trigonal planar**.

QUESTION (2011:1)

(c) Draw the Lewis structure (electron dot diagram) for each of the following molecules.

Molecule	OCl_2	O_2	CH_3Br
Lewis structure			

(d) Lewis structures for two molecules are given below.

Molecule	HCN	$COCl_2$
Lewis structure		

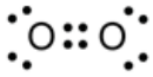
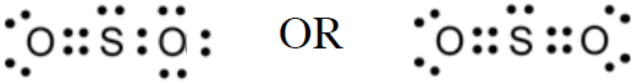
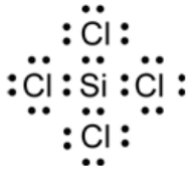
For each molecule, name the shape of the molecule and give a reason for your answer.

(i) HCN Shape: Linear
Reason: There are two regions of electron repulsion / bonding regions around the C atom. These are as far apart as possible, so the molecule is linear.

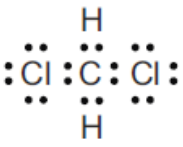
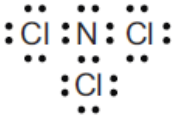
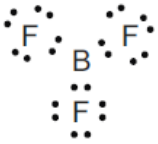
(ii) $COCl_2$ Shape: Trigonal planar.
Reason: There are three regions of electron repulsion / bonding regions around the C atom. These are as far apart as possible, so the molecule is trigonal planar.

QUESTION (2010:1)

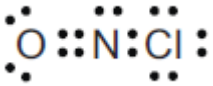
(b) Draw the Lewis structure (electron dot diagram) for each of the following molecules.

Molecule	**Lewis Structure**
O_2	
SO_2	 OR
$SiCl_4$	

(b) Lewis structures for three molecules are given below. Complete the table by giving the name of the shape of each molecule.

Molecule	**Lewis Structure**	**Name of shape**
CH_2Cl_2		Tetrahedral
NCl_3		Trigonal pyramidal
BF_3		Trigonal planar

(c) The following table shows the Lewis structure and the shape of the molecules for NOCl and H_2S.

	NOCl	H_2S
Lewis Structure		
Name of shape	bent	bent

The shape of both molecules can be described as bent. However, these molecules do not have the same bond angle.

Discuss why these molecules have different bond angles.

Your answer must include:

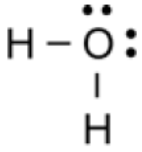
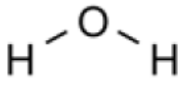
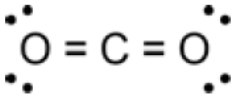
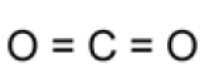
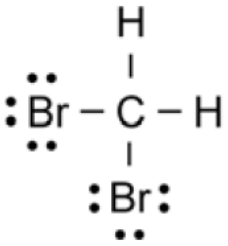
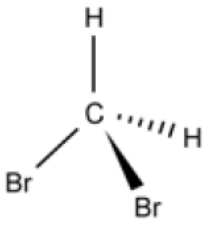
- factors which determine the shape of each molecule
- the approximate bond angle for each molecule.

The shape of a molecule is determined by the regions of negative charge surrounding the central atom and the number of bonding atoms.
NOCl: The bond angle is approximately 120°. There are three regions of negative charge around the central N atom which repel to give maximum separation. There are two bonding electrons / negative regions to the N atom and one lone pair of electrons, therefore the overall shape is bent. H_2S: The bond angle is approximately 109°. There are four regions of negative charge around the central S atom which repel to give maximum separation. There are two bonding electrons / negative regions to the S atom and two lone pairs of electrons, therefore the overall shape is bent.

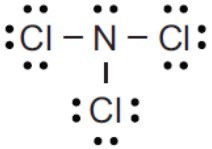
QUESTION (2009:1)

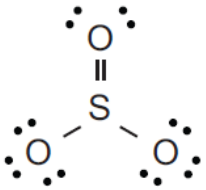
(a) Complete the table below by:

(i) Drawing the Lewis structure (electron dot diagram) for each molecule.
(ii) Drawing a diagram to show the shape of the molecule.
(iii) Naming the shape of the molecule.

Molecule	Lewis Structure	Diagram of Shape	Name of Shape
H_2O			bent / V-shape / angular
CO_2			linear
CH_2Br_2			tetrahedral

(b) The Lewis structures of the molecules NCl_3 and SO_3 are given below.





Discuss the shapes and bond angles of these two molecules. For each molecule:

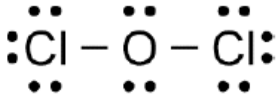
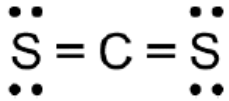
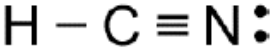
- name the shape
- determine the bond angle
- justify your answers.

NCl_3 trigonal pyramid 109.5° (105°–110°). The central atom has 4 areas of electron repulsion around it. Three of these are bonding and one is nonbonding. These 4 regions repel each other as far apart as possible (maximum separation to achieve minimum repulsion). The non-bonding pair contributes to the shape, but is not considered part of the shape; therefore the shape is trigonal pyramid. The four areas of electron repulsion give the molecule a tetrahedral shape so the bond angle is 109°.

SO_3 trigonal planar 120°. There are three areas of electron repulsion around the central atom, all three are bonding sets. These 3 regions repel each other as far apart as possible, therefore giving a trigonal planar shape with a bond angle of 120°.

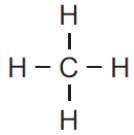
QUESTION (2008:1)

(b) Draw a Lewis structure (electron dot diagram) for each of the following molecules :

Molecule	Lewis structure
Cl_2O	
CS_2	
HCN	

(b) Lewis structures for TWO molecules are given below. For each molecule :

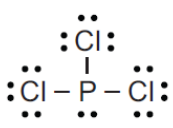
- name the shape
- justify your answer.



(i)

Shape: Tetrahedral

Justification: The central atom has 4 areas of electron repulsion around it. These 4 regions repel each other as far as possible / maximum distance, (therefore giving a tetrahedral shape.)



(ii)

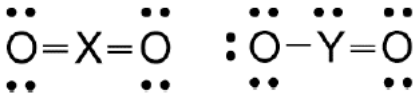
Shape: Trigonal pyramid

Justification: The central atom has 4 areas of electron repulsion around it. Three of these are bonding and one is non-bonding. These 4 regions repel each other as far as possible. The non-bonding pair contributes to the shape, but is not considered part of the shape, (therefore the shape is trigonal pyramid).

QUESTION (2008:3)

An element, X, has four valence electrons. Another element, Y, has six valence electrons. These elements both combine with oxygen. The molecules formed are XO_2 and YO_2.

(a) Draw the Lewis structures of these two molecules. XO_2 & YO_2

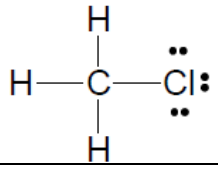
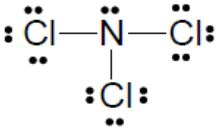
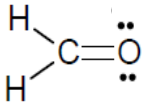


(b) Determine the bond angle in each of these molecules using the Lewis structures from (a). Justify your answer.

XO_2 has 2 areas of electron repulsion / regions of electrons / negative centres about the central atom. This leads to a bond angle of linear shape, which has a bond angle of 180°.
YO_2 has three areas of electron repulsion / regions of electrons / negative centres about the central atom. This leads to a trigonal planar arrangement of electron clouds / bent shape, which has a bond angle of 120°.

QUESTION (2007:1)

(a) Complete the table below by:
(i) drawing the Lewis structure (electron dot diagram) for each molecule
(ii) naming the shape of the molecule.

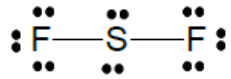
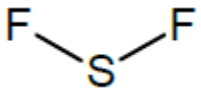
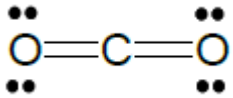
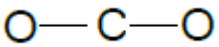
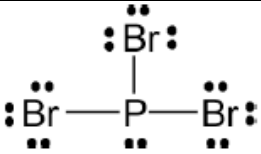
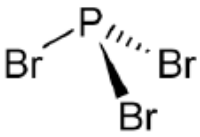
Molecule	(i) Lewis diagram	(ii) Name of shape
CH_3Cl		Tetrahedral
NCl_3		Trigonal pyramid
CH_2O		Trigonal planar

(b) For each of the molecules in the table, explain why it has the shape you have identified.
(iv) CH_3Cl (ii) NCl_3 (iii) CH_2O

There are 4 electron repulsions about the central C atom and no lone pairs on the C. Therefore, the molecule is a tetrahedral shape.
There are 4 electron repulsions about the central N atom (tetrahedral) and one lone pair on the N. Therefore, the molecule is a trigonal pyramid shape.
There are 3 electron repulsions around the central C atom and no lone pairs on the C. Therefore, the shape is trigonal planar.

QUESTION (2006:1)

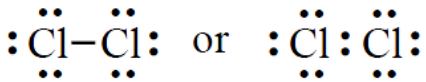
Complete the table below by:
(a) drawing a Lewis structure (electron dot diagram) for each molecule
(b) drawing a diagram to show the shape of the molecule
(c) naming the shape of the molecule.

Formula of molecule	Lewis structure	Diagram of shape	Name of shape
SF_2			bent or v-shaped
CO_2			linear or straight
PBr_3			trigonal or triangular pyramid

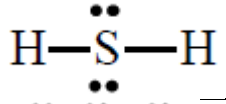
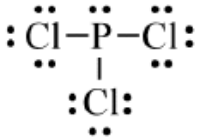
QUESTION (2006:4)

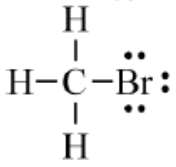
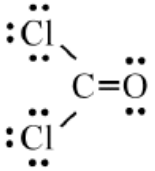
Molecules of water (H_2O) and ozone (O_3) each contain 3 atoms and both the molecules are bent. However, the bond angle in H_2O is significantly smaller than the bond angle in O_3.
Using Lewis structures, discuss the reasons for the difference in **bond angles** of these two molecules.

QUESTION (2005:1)

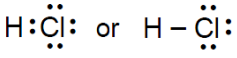
The Lewis structure for chlorine, Cl_2, is 

Complete the table below by:
(a) drawing a Lewis structure for each molecule,
(b) naming the shape of each molecule.

Molecule	Lewis structure	Name of shape
H_2S		Bent / v-shape / angular
PCl_3		Trigonal / triangular pyramid

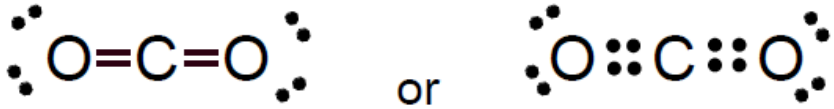
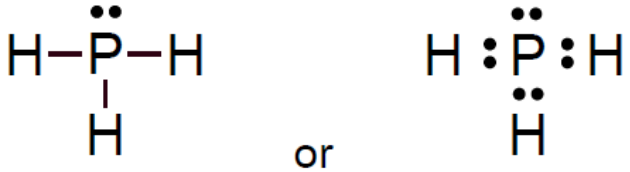
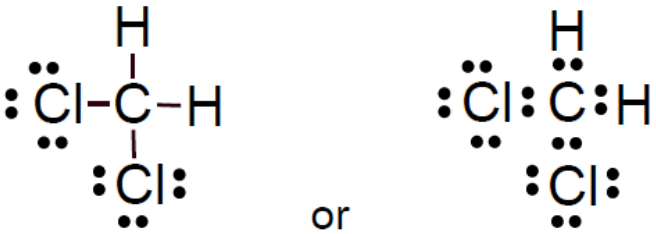
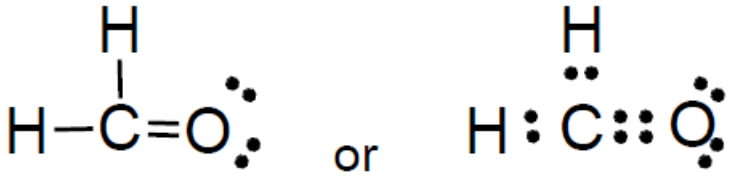
CH_3Br		Tetrahedral
$COCl_2$ Note C is central atom		Trigonal planar

QUESTION (2004:1)

The Lewis structure for hydrogen chloride, HCl, is  or

Complete the table below by:

(a) drawing a Lewis structure for each molecule,

Molecule	Lewis structure
CO_2	
PH_3	
CH_2Cl_2	
H_2CO	
F_2O