Practice Test Questions 8
Lewis Diagrams and VSEPR Geometries

1. Complete the table below. Provide the best Lewis diagram for each compound, or one representative of the best set of Lewis diagrams for molecules with resonance structures. *Include any non-zero formal charges on the appropriate atom(s).*

Chemical Formula	**Lewis Diagram**	**Electron Group Geometry (name)**	**Molecular Geometry (name)**	**Drawing of Molecule's Geometry with Bond Angles Labeled**
ICl_5				
SO_2^{2-}				
BF_4^-				

2. Use enthalpies of bond dissociation to estimate the enthalpy change for the reaction below:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

$\Delta_{bd}H$(C-H) = 413 kJ/mol $\Delta_{bd}H$(O-H) = 467 kJ/mol

$\Delta_{bd}H$(O=O) = 498 kJ/mol $\Delta_{bd}H$(C=O) = 799 kJ/mol in CO_2

3. For each of the molecules/ions below:

- Draw the best Lewis diagram.
  Include any non-zero formal charges on the appropriate atoms.
- Name the electron group geometry.
- Name the molecular geometry.
- Redraw the molecule to show the molecular geometry. Label bond angles.

(a) SiH_2Cl_2 (b) XeH_2F_2

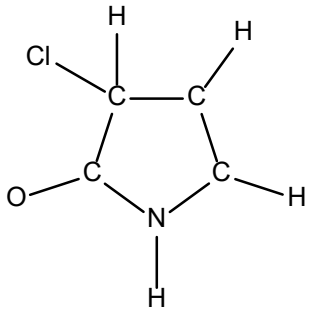
4.

(a) Draw **all** resonance structures for the carbonate ion (CO_3^{2-}).
Include any non-zero formal charges on the appropriate atom(s).

(b) What is the average C-O bond order in the carbonate ion?

(c) Draw **one** valid Lewis diagram for carbonic acid (H_2CO_3).
Include any non-zero formal charges on the appropriate atom(s).

5. The skeleton below shows which atoms are connected. Draw the best Lewis diagram for this molecule. *(You can draw directly on the skeleton if you like.)*



6. Using an argument based on formal charge and on other relevant concepts, explain why we don't normally see molecules containing X-F-Y, i.e. a fluorine atom bonded to two different atoms in a molecule. (X and Y could be any two atoms.)

7.

(a) Give an example of a diatomic molecule with a bond order of 1.

(b) Give an example of a diatomic molecule with a bond order of 2.

(c) Give an example of a diatomic molecule with a bond order of 3.

8.

(a) Give an example of a molecule with trigonal pyramidal molecular geometry.

(b) Give an example of a molecule with trigonal planar molecular geometry.

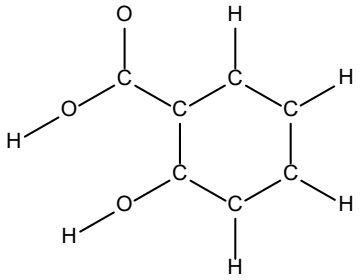
9. There are two valid resonance structures for an anion with the chemical formula CH_2NO^-. The connectivity for this anion is shown below.



(a) On the two skeletons above, draw each of the two valid resonance structures.
Include any non-zero formal charges on the appropriate atoms.

(b) Circle the better resonance structure (the resonance structure which more closely resembles the true/averaged structure of this anion) and explain your choice.
You will only obtain credit for part (b) if your answers to part (a) are correct.

10. Salicylic acid ($C_7H_6O_3$) is produced by willow trees. It is used to make aspirin. The skeleton for salicylic acid is shown below:



(a) Add electrons to the skeleton above to turn it into a valid Lewis diagram.
Include any non-zero formal charges on the appropriate atom(s).

(b) Including the one you drew above, how many valid resonance structures could you draw for this molecule?

(c) Which bond(s) do you expect to be the shortest in this molecule?

(d) Which bond(s) do you expect to be the longest in this molecule?

(e) On your structure above, circle/highlight one of the carbon atoms and one of the oxygen atoms (one that is attached to an H).

(i) What is the electron group geometry of the circled/highlighted carbon atom?

(ii) What is the molecular geometry of the circled/highlighted carbon atom?

(iii) What is the electron group geometry of the circled/highlighted oxygen atom?

(iv) What is the molecular geometry of the circled/highlighted oxygen atom?

11. The cyanate ion has the formula OCN^-. Carbon is the central atom. There are two good resonance structures for this anion.

(a) Draw both resonance structures for OCN^-.

(b) Which of these two resonance structures would you expect to be the major resonance structure? Why?

(c) Based on your answers to parts (a) and (b), what can you conclude about the bond orders and charge distribution in OCN^-?

12. Draw one valid Lewis diagram for each of the molecules/ions listed below.

Include any non-zero formal charges on the appropriate atoms.

(a) NO_3^- (b) HNO_3

(c) PO_4^{3-} (d) HPO_4^{2-}

(d) $H_2PO_4^-$ (e) H_3PO_4

13. Redraw each of the molecules/ions in Question 11 to show geometry. List or label bond angles. *If you choose to list, it must be clear which angle goes with which three atoms.*

- *Angles should be accurate to the number of sig. fig. shown. (e.g. 109.5˚)*
- *Use the ~ symbol to indicate approximate angles. (e.g. ~109.5˚)*
- *Use the < symbol to indicate that an angle is close to – but definitely smaller than – a given value. (e.g. <109.5˚)*
- *Use the > symbol to indicate that an angle is close to – but definitely larger than – a given value. (e.g. >109.5˚)*

14. The thiocyanate ion consists of a carbon atom, a nitrogen atom and a sulfur atom. It has an overall charge of -1.

Include any non-zero formal charges on the appropriate atom(s).

Not all central atom choices will lead to reasonable Lewis diagrams – but at least one will!

(a) Draw the best Lewis diagram you can if the central atom is carbon.

(b) Draw the best Lewis diagram you can if the central atom is nitrogen.

(c) Draw the best Lewis diagram you can if the central atom is sulfur.

(d) Based on your answers to parts (a), (b) and (c), which of the three atoms is most likely to be the central atom in the thiocyanate ion?