Recitation Worksheet Eleven

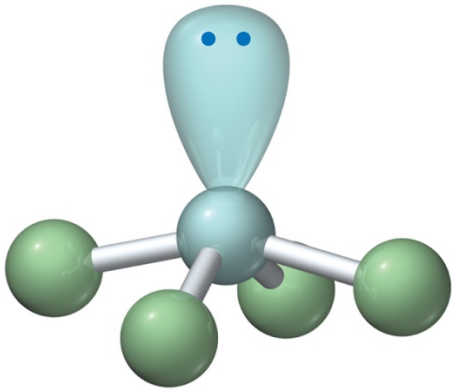
Name: | UGA ID:

Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname that is not reflected in eLC).
- Your UGA myID is a combination of letters and numbers (example: mine is jmj81738). Do *not* enter your 81x number.
- Download this worksheet and print it if you have a printer. Write the answers in the answer boxes and show your work when appropriate. Using the instructions in the Welcome module on eLC, convert your worksheet to a PDF and then upload it to Gradescope. If you have an iPhone or Android device, you can scan and upload directly through the Gradescope app. The pages must be in the correct order or Gradescope will not be able to read it.
- If you do not have a printer, download the worksheet and type your answers in the answer boxes and upload it to Gradescope. Write your work on separate sheets of paper, convert these pages to a PDF using the instructions in the Welcome module on eLC, then upload them to the dropbox on eLC for this worksheet.
- If you are using an app to annotate the worksheet, make sure the pages are in the correct order and have the same layout as the original or Gradescope will not be able to read it.
- Answers must be written in the corresponding answer box or no credit will be awarded.
- This worksheet is due no later than **11:59 PM on the Friday of the recitation week.**
- The instructions for uploading worksheets to Gradescope can be found in the Content area of eLC in the Welcome Module.
- **You must show your work to receive credit.**

1. Consider a hypothetical molecule, MX_4, which has a square planar molecular geometry. How many lone pairs are on this molecule? Answer with an integer (e.g. 7).

2. Which of the following statements below are **true** regarding the molecule below which is illustrated **incorrectly**? Select all that apply. Hint: the molecular geometry shown below is not a standard geometry you have learned.



A. The correct molecular geometry should be square planar
B. The correct electron geometry should be square planar
C. The correct molecular geometry should be seesaw
D. The correct electron geometry should be seesaw
E. The lone pair should be in the axial position
F. The lone pair should be in the equatorial position
G. The lone pair may be in the axial or equatorial position because electron pair repulsions are minimized in either case

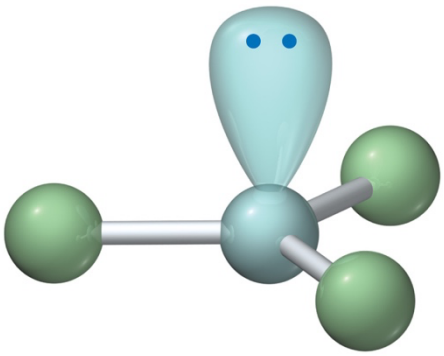
Use the following options below to answer all parts of questions 3-4.

<u>Electron/molecular geometries</u>
A. Linear
B. Trigonal planar
C. Tetrahedral
D. Trigonal bipyramidal
E. Octahedral
F. Bent
G. Seesaw
H. T-shaped
I. Square pyramidal
J. Square planar
K. Trigonal pyramidal

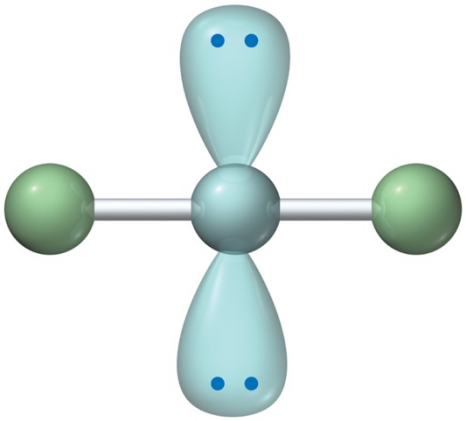
<u>Bond angles</u>
A. 90°
B. <109.5°
C. 109.5°
D. <120°
E. 120°
F. 180°

3. Consider the molecules below, all of which are illustrated **incorrectly**. Determine the correct molecular geometry for each, and provide the **corresponding letter** in the boxes below using the options on page 2.

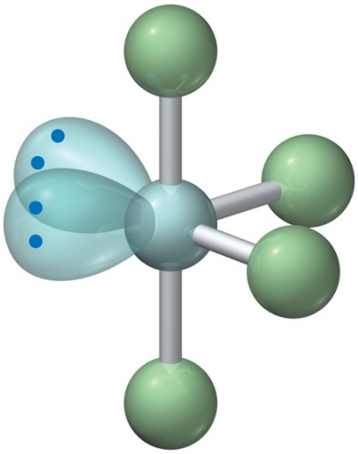
I. ☐



II. ☐



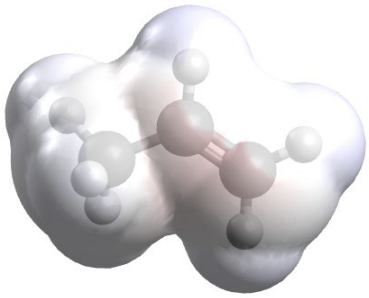
III. ☐



4. Determine the electron and molecular geometries of the compounds below, then determine the bond angle(s). Write the **corresponding letters** in the boxes below using the options on page 2.

	Compound	Electron Geometry?	Molecular Geometry?	Bond Angle(s)?
I	Phosphorus trihydride			
II	Sulfur difluoride			
III	BF_2^{1-}			
IV	ICl_3			
V	BrF_5			
VI	HCN			
VII	TeF_4			
VIII	PF_6^{1-}			
IX	$XeCl_2F_2$			

5. The following electrostatic potential map has very little to no color difference. It shows a _____ molecule.



A. Polar
B. Nonpolar
C. Ionic
D. Stoichiometric

6. Which of the following bonds would best be considered non-polar covalent?

A. C-F
B. O-H
C. C-C
D. C-N

7. Which of the following has the bonds correctly arranged in order of **decreasing** polarity (i.e. most polar bond written first)?

A. Sr-I > P-S > Si-Cl > F-F
B. Sr-I > Si-Cl > P-S > F-F
C. F-F > Si-Cl > P-S > Sr-I
D. F-F > P-S > Si-Cl > Sr-I
E. P-S > Sr-I > Si-Cl > F-F
F. Si-Cl > Sr-I > P-S > F-F

8. Which of the following has the partial charges correctly assigned?

A. $Cl^{\delta-}$ - $C^{\delta+}$
B. $Cl^{\delta-}$ - $F^{\delta+}$
C. $C^{\delta-}$ - $F^{\delta+}$
D. $N^{\delta-}$ - $O^{\delta+}$

9. Label the following molecules as (P) polar or (NP) nonpolar. Write the **corresponding letters** in the boxes below.

I. CH_3COOH ☐

II. SF_4 ☐

III. SCl_6 ☐

IV. SCl_5Br ☐

V. AsH_3 ☐

VI. CO_2 ☐

VII. SbF_5 ☐

10. What is **true** of hybridization and hybrid orbitals? Select all that apply.

A. Non-hybrid orbitals could not form the bond angles predicted in VSEPR
B. sp^2 hybrid orbitals are formed from the mixing of one s and two p orbitals
C. Hybrid orbitals retain the same shapes as the original orbitals
D. Pi bonds do not involve hybrid orbitals
E. An sp orbital is degenerate with the two remaining p orbitals

11. What is false about bonding according to Valence Bond Theory?

A. Bonds are formed by the overlap of atomic orbitals
B. Orbitals hybridize to achieve a favorable geometry
C. Orbitals hybridize to create degenerate orbitals they can use for bonding
D. Two different types of covalent bonds can be formed: sigma and pi
E. None of the above are false

12. What is true about a pi bond? Select all that apply.

A. They are formed by the head-to-head overlap of p orbitals
B. They are formed by the side-to-side overlap of p orbitals
C. They are stronger than sigma bonds
D. They do not involve hybrid orbitals
E. They are the first type of bonds to form between atoms

13. Determine whether the hybridization around the central atoms on the following molecules below are (A) sp, (B) sp^2, (C) sp^3, (D) sp^3d, or (E) sp^3d^2. Write the **corresponding letters** in the boxes below.

I. XeF_4 ☐

II. CO_3^{2-} ☐

III. CO ☐

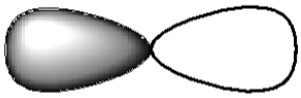
IV. NF_3 ☐

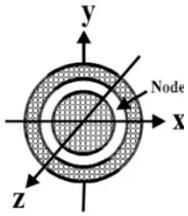
V. IF_3 ☐

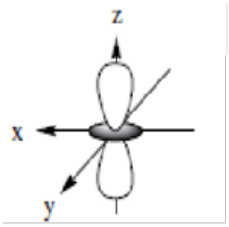
VI. IF_5 ☐

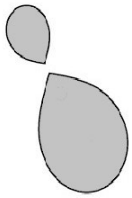
VII. AsF_5 ☐

14. Which of the following is a hybrid orbital?

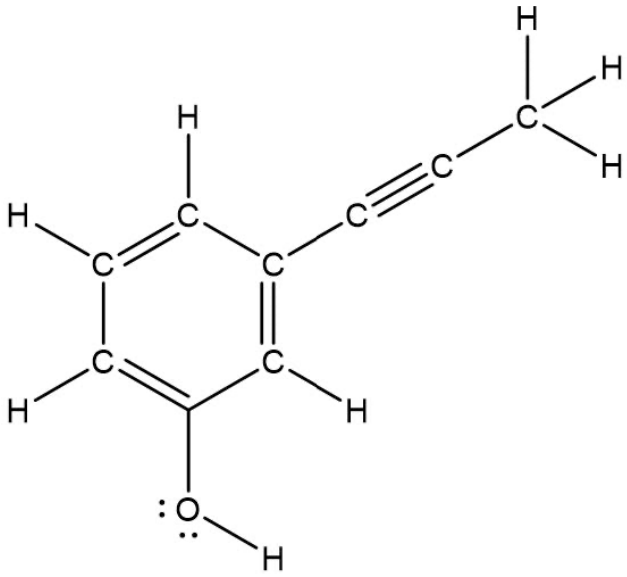
A. 

C. 

B. 

D. 

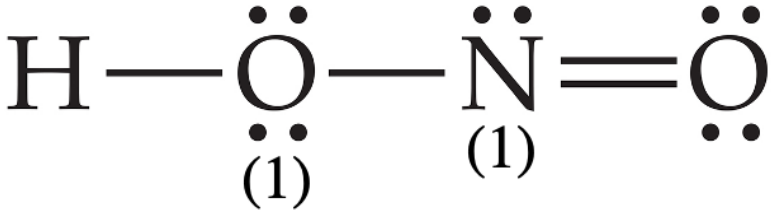
15. How many sigma and pi bonds are in the molecule below? Answer with integers (e.g. 6).



I. Sigma:

II. Pi:

Answer questions 16-19 using the Lewis structure provided below.



16. What is the bond angle around the O(1) atom?

	A. 90°	D. <120°
	B. <109.5°	E. 120°
	C. 109.5°	F. 180°

17. What is the hybridization around the O(1) atom?

	A. sp	D. sp^3d
	B. sp^2	E. sp^3d^2
	C. sp^3	F. None of the above

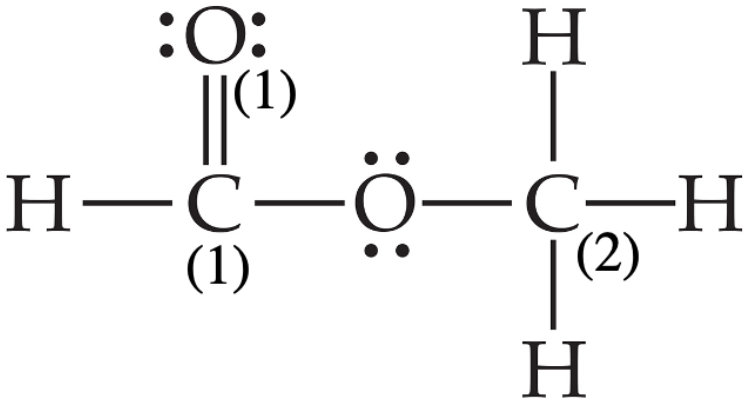
18. What is the bond angle around the N(1) atom?

	A. 90°	D. <120°
	B. <109.5°	E. 120°
	C. 109.5°	F. 180°

19. What is the hybridization around the N(1) atom?

	A. sp	D. sp^3d
	B. sp^2	E. sp^3d^2
	C. sp^3	F. None of the above

Answer questions 20-24 using the Lewis structure provided below.



20. What is the bond angle around the C(1) atom?

A. 90°	D. <120°
B. <109.5°	E. 120°
C. 109.5°	F. 180°

21. What is the hybridization around the C(1) atom?

A. sp	D. sp^3d
B. sp^2	E. sp^3d^2
C. sp^3	F. None of the above

22. What is the bond angle around the C(2) atom?

A. 90°	D. <120°
B. <109.5°	E. 120°
C. 109.5°	F. 180°

23. What is the hybridization around the C(2) atom?

A. sp	D. sp^3d
B. sp^2	E. sp^3d^2
C. sp^3	F. None of the above

24. What is the hybridization around the O(1) atom?

	A. sp	D. sp^3d
	B. sp^2	E. sp^3d^2
	C. sp^3	F. None of the above

Answer questions 25-26 using the Lewis structure provided below.

25. What is the bond angle around the C(1) atom?

	A. 90°	D. <120°
	B. <109.5°	E. 120°
	C. 109.5°	F. 180°

26. What is the hybridization around the C(1) atom?

	A. sp	D. sp^3d
	B. sp^2	E. sp^3d^2
	C. sp^3	F. None of the above

Extra Practice Questions: these questions will not be graded.

1. Which of the following molecules would have a trigonal planar *electron* geometry? Select all that apply.

	A. O_3	D. SCl_2
	B. NH_3	E. ClF_3
	C. BH_3	F. None of the above

2. What is the expected bond angle in the sulfite ion, SO_3^{2-}?

	A. 90°	D. <120°
	B. <109.5°	E. 120°
	C. 109.5°	F. 180°

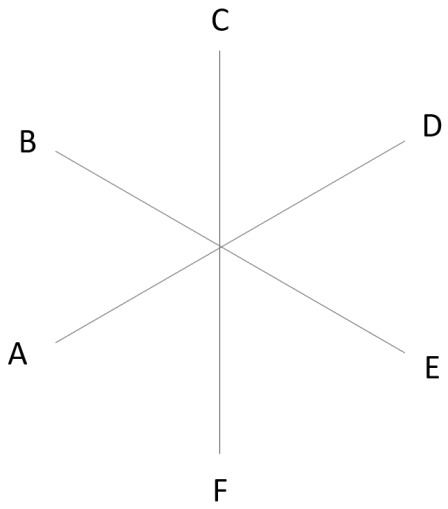
3. What is **true** about the trigonal bipyramidal electron geometry and associated molecular shapes?

A. Lone pairs occupy the equatorial position to minimize electron repulsion
B. Lone pairs occupy the axial position to minimize electron repulsion
C. Lone pairs are equally likely to occupy either an axial or equatorial position
D. Three lone pairs will occupy both axial and one equatorial position, resulting in a bent molecular shape
E. One lone pair will result in a trigonal pyramidal molecular shape

4. The phosphorus-chlorine bonds in phosphorus trichloride are…

A. Ionic
B. Polar covalent
C. Covalent
D. Cannot tell based on electronegativity values

5. In the alternate universe of Flatland, there are only two dimensions. An atom with six electron groups has a hexagonal planar structure (see diagram).



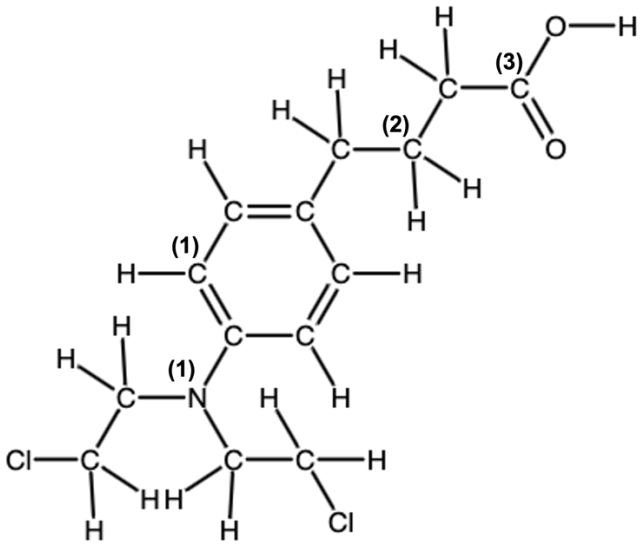
I. What are the bond angles in the hexagonal planar structure?

degrees

II. Which pair of spaces could two lone pairs occupy?

A. A and B
B. F and D
C. B and E
D. D and B
E. More than one of the above

6. The Lewis structure of Chlorambucil, a common chemotherapy drug used for leukemia and various lymphomas, is provided below. Answer the remainder of this worksheet using the given Lewis structure (note: lone pairs have been omitted).



I. What is the bond angle around the N(1) atom?

A. 90°	D. <120°
B. <109.5°	E. 120°
C. 109.5°	F. 180°

II. What is the bond angle around the C(1) atom?

A. 90°	D. <120°
B. <109.5°	E. 120°
C. 109.5°	F. 180°

III. What is the bond angle around the C(2) atom?

A. 90°	D. <120°
B. <109.5°	E. 120°
C. 109.5°	F. 180°

IV. What is the bond angle around the C(3) atom?

	A. 90°	D. <120°
	B. <109.5°	E. 120°
	C. 109.5°	F. 180°

V. What is the hybridization around the N(1) atom?

	A. sp	D. sp^3d
	B. sp^2	E. sp^3d^2
	C. sp^3	F. None of the above

VI. What is the hybridization around the C(1) atom?

	A. sp	D. sp^3d
	B. sp^2	E. sp^3d^2
	C. sp^3	F. None of the above

VII. What is the hybridization around the C(2) atom?

	A. sp	D. sp^3d
	B. sp^2	E. sp^3d^2
	C. sp^3	F. None of the above

VIII. What is the hybridization around the C(3) atom?

	A. sp	D. sp^3d
	B. sp^2	E. sp^3d^2
	C. sp^3	F. None of the above

IX. What orbitals are involved in the bonding of the COOH group? Select all that apply to the carbon, two oxygens, and hydrogen.

	A. s
	B. p
	C. sp
	D. sp^2
	E. sp^3
	F. sp^3d
	G. sp^3d^2