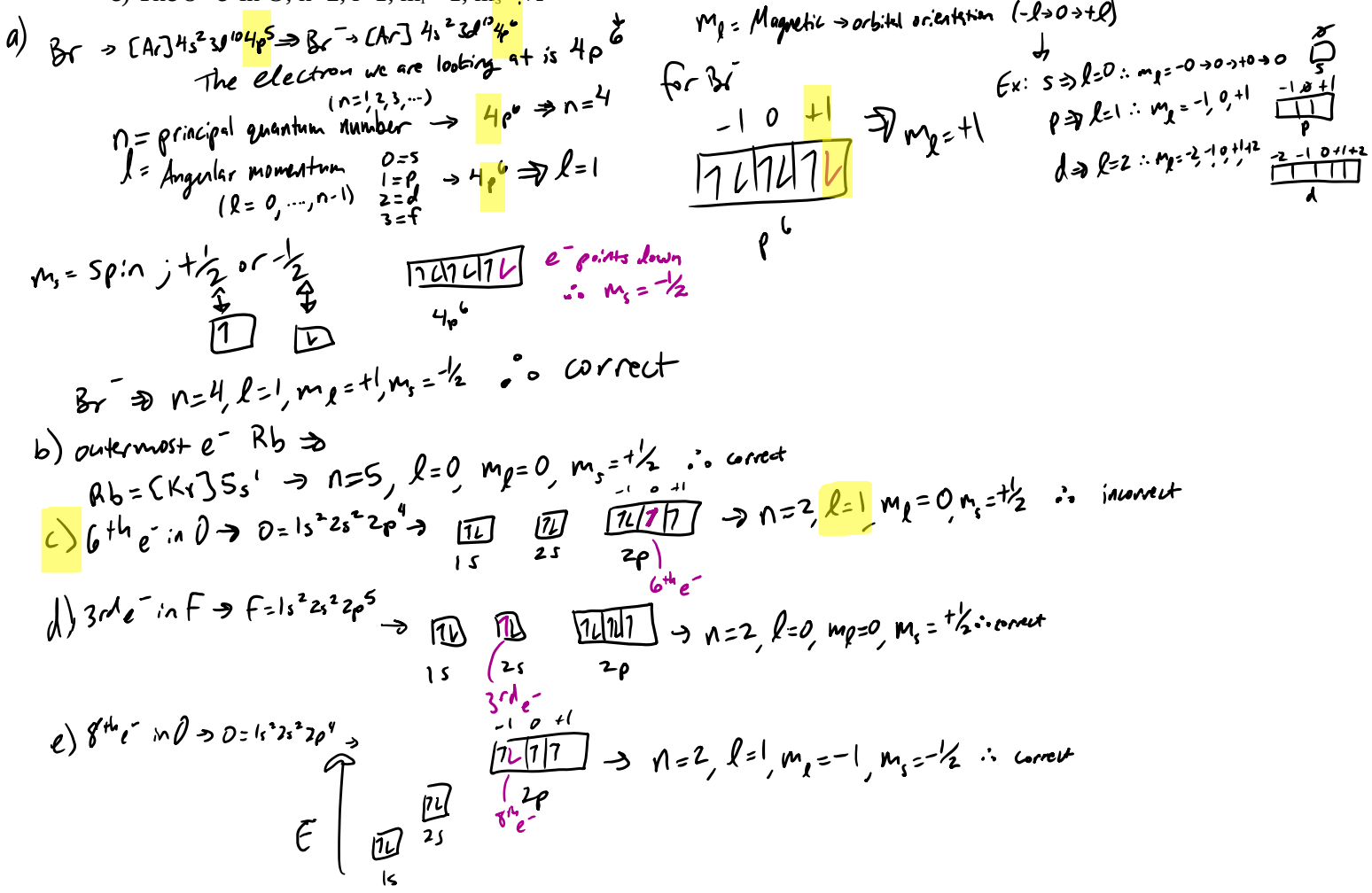
CHM 2045 Exam 3 Review UF Academic Resources

ANSWER KEY WITH SOLUTIONS (Zoom in for clarity)

Chapter 8: Electron Configuration and Periodic Trends

1. Which of the following full sets of quantum numbers is incorrect?

a) The e^- gained from Br → Br^-; n=4, l=1, m_l=+1, m_s=-½
b) The outermost e- in Rb; n=5, l=0, m_l=0, m_s=+½
c) The 6th e^- in O; n=2, l=0, m_l=0, m_s=+½
d) The 3rd e^- in F; n=2, l=0, m_l=0, m_s=+½
e) The 8th e^- in O; n=2, l=1, m_l=-1, m_s=-½



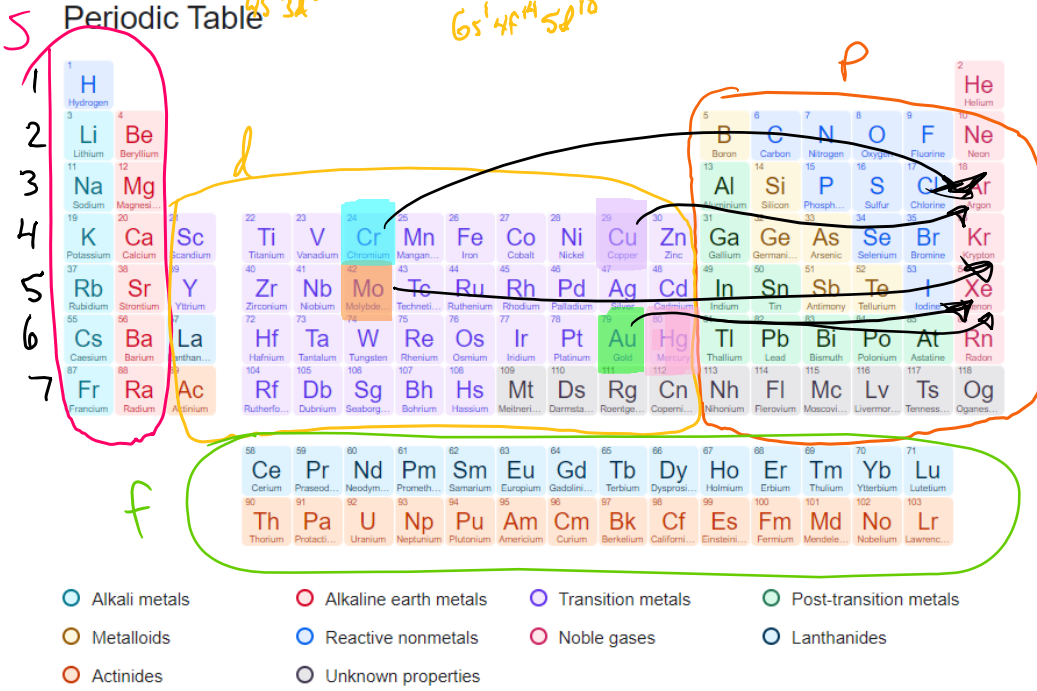
2. Which of the following electron configurations are correct?

I. Hg: [Xe] $6s^2 4f^{14} 5d^{10}$ II. Mo: [Kr] $5s^1 4d^5$ III. Cr: [Ar] $4s^2 3d^4$ IV. Au: [Xe] $6s^2 4f^{14} 5d^9$ V. Cu: [Ar] $4s^1 3d^{10}$

a) I, III, V
b) II, IV
c) I, II, V
d) None
e) All

n = s = p
n − 1 = d
n − 2 = f
∴
n = 5 → 5s, 4d, 5p
n = 6 → 6s, 4f, 5d, 6p

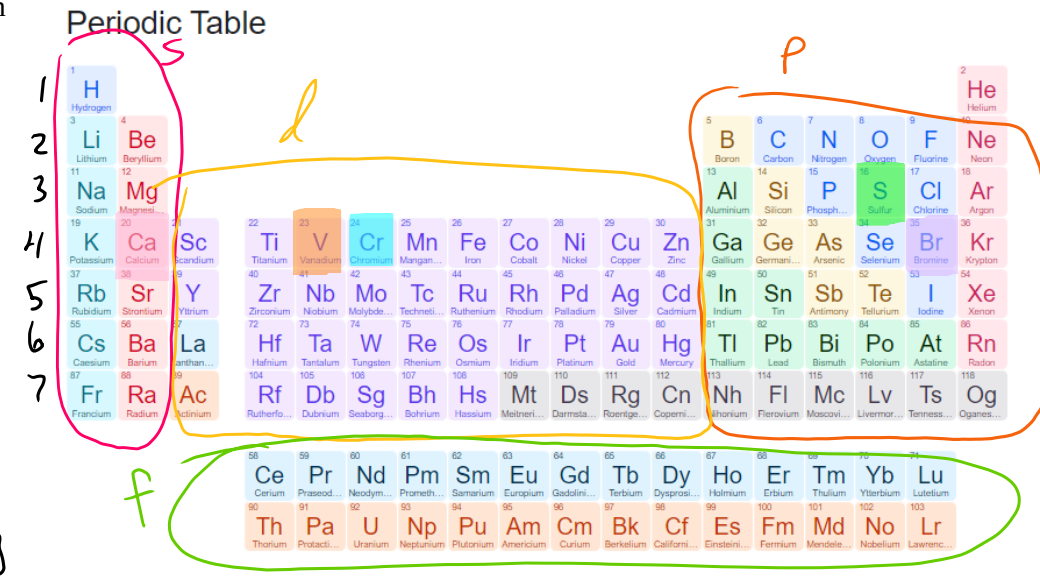
Hg: [Xe] $6s^2 4f^{14} 5d^{10}$ ✓
Mo: [Kr] $5s^1 4d^5$ exception ✓
Cr: [Ar] $4s^1 3d^5$ exception X
Au: [Xe] $6s^1 4f^{14} 5d^{10}$ exception X
Cu: [Ar] $4s^1 3d^{10}$ exception ✓



3. Which of the following electron configurations for these ions are correct?

I. Ca^{2+}: [Ar] $4s^2$ II. V^{3+}: [Ar] $3d^2$
III. S^{2-}: [Ne] $3s^2 3p^6$
IV. Cr^{3+}: [Ar] $3d^3$
V. Br^-: [Ar] $5s^2 4d^{10} 5p^6$

a) All
b) I, V
c) II, IV, V
d) III, V
e) II, III, IV



Ca: [Ar] $4s^2 \xrightarrow{-2e^-} Ca^{2+}$; [Ar]

V: [Ar] $4s^2 3d^3 \xrightarrow{-3e^-} V^{3+}$; [Ar] $3d^2$

S: [Ne] $3s^2 3p^6 \xrightarrow{+2e^-} S^{2-}$; [Ne] $3s^2 3p^6$

Cr: [Ar] $4s^1 3d^5 \xrightarrow{-3e^-} Cr^{3+}$; [Ar] $3d^3$

Br: [Ar] $4s^2 3d^{10} 4p^5 \xrightarrow{+1e^-} Br^-$; [Ar] $4s^2 3d^{10} 4p^6$

4. Rank these elements by their increasing atomic size.

a) Sr < Ca < Mg
b) Rb < Br < Kr
c) Se < Br < Cl
d) Xe < I < Ba
e) K < P < F

5. Rank these elements by increasing IE_1.

a) Cs < Xe < I
b) Kr < Ar < He
c) Rb < Ca < K
d) Sn < Sb < I
e) A and C
f) B and D

6. Which of the following statements on successive IE is true?

a) Between Rb, Sr, and Y, Rb has the highest IE_2
b) Between Rb, Sr, and Y, Sr has the highest IE_2
c) Between Na, Mg, Al, and Si, Al has the highest IE_4
d) Between Na, Mg, Al, and Si, Si has the highest IE_4
e) A and C
f) B and D

7. Which of the following ions are paramagnetic?

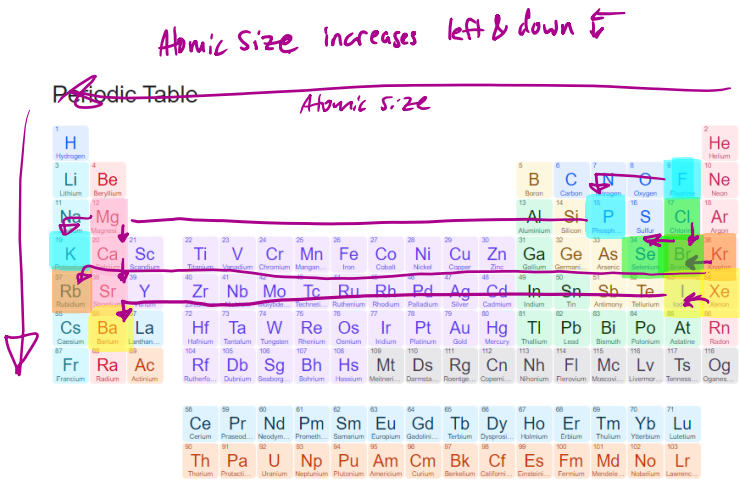
I. Co^{3+}
II. La^{3+}
III. Cr^{3+}
IV. V^{3+}
V. Zn^{2+}

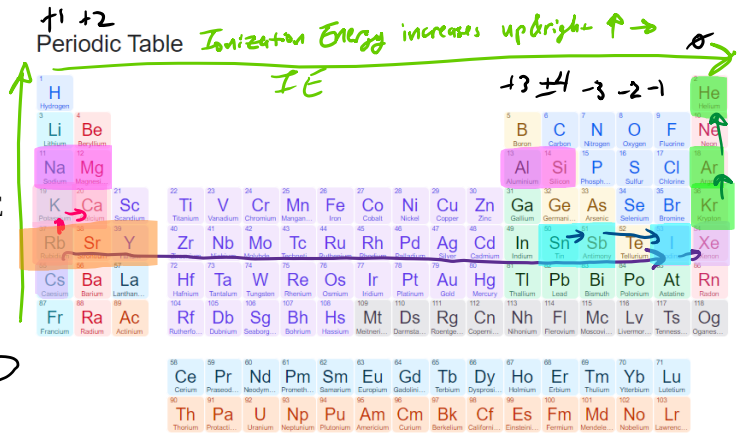
a) I, III, IV
b) I, III, V
c) II, V
d) All
e) None

8. Which of the following ions are diamagnetic?

I. Os^{3+}
II. Hg^{2+}
III. Ni^{2+}
IV. Zr^{2+}
V. Zn^{2+}

a) II, III, IV
b) II, V
c) I, V
d) All
e) None





Notes on Ionic Size: 1) Down a group, ionic size ↑ as n↑
2) For cations, ↑ charge, ↓ size ($Na^+ > Mg^{2+} > Al^{3+}$)
3) Cation size ↓ with ↑ charge ($Fe^{2+} > Fe^{3+}$; Fe^{2+} bigger, smaller)
From last cation to first anion, a big jump in size
$P^{3-} > Al^{3+}$
For anions, ↑ charge ↓ size ($P^{3-} > S^{2-} > Cl^-$)
Isoelectronic anions > cations

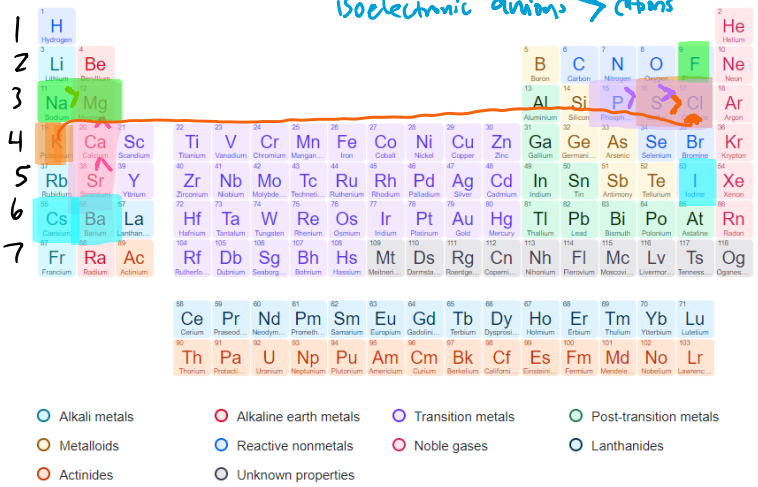
Cations get smaller
Anions get bigger

9. Which ions are ranked correctly by decreasing size?

✓ I. $Sr^{2+} > Ca^{2+} > Mg^{2+}$ down a group, ion size ↑
✓ II. $S^{2-} > Cl^- > K^+$ isoelectronic anions > cations; for anions ↑ charge ↓ size
✗ III. $Mg^{2+} > Na^+ > F^-$ $F^- > Na^+ > Mg^{2+}$
✗ IV. $Ba^{2+} > Cs^+ > I^-$ $I^- > Cs^+ > Ba^{2+}$
✓ V. $P^{3-} > S^{2-} > Cl^-$ anion size ↓ with ↑ charge

a) I, III, V
b) II, IV
c) I, II, V
d) I, IV, V
e) II, III, IV, V

Periodic Table



Alkali metals · Alkaline earth metals · Transition metals · Post-transition metals
Metalloids · Reactive nonmetals · Noble gases · Lanthanides
Actinides · Unknown properties

Chapter 9: Chemical Bonding Models

10. Which of the following is the correct order for increasing bond length?

C-C, C=C, C≡C

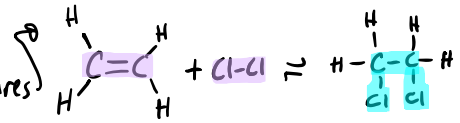
Single bonds are longest & weakest
Triple bonds are shortest & strongest
Double bonds are in the middle; shorter than single bond, longer than triple bond; stronger than single bond, weaker than triple bond

a) C≡C < C=C < C-C
b) C=C < C≡C < C-C
c) C-C < C=C < C≡C
d) C≡C < C-C < C=C

11. How are bond length and bond strength related?

a) Inversely related → The longer the bond, the weaker it is. The shorter the bond, the stronger it is.
b) Directly related
c) Length = ½ Strength
d) Strength = ½ Length

12. Calculate the enthalpy of the reaction. Draw Lewis structures



$$C_2H_{4(g)} + Cl_{2(g)} \rightleftharpoons C_2H_4Cl_{2(g)}$$

Bonds broken: C=C ×1, Cl-Cl ×1
Bonds formed: C-C ×1, C-Cl ×2

Given the following bond energies:

C-C 347 kJ/mol	~~C-H 413 kJ/mol~~	~~H-H 432 kJ/mol~~
C=C 614 kJ/mol	C-Cl 339 kJ/mol	~~H-Cl 427 kJ/mol~~
~~C≡C 839 kJ/mol~~	Cl-Cl 243 kJ/mol	

a) -1078 kJ
b) +168 kJ
c) -168 kJ
d) +563 kJ
e) -563 kJ

$$\Delta H^\circ_{rxn} = \sum \Delta H^\circ_{bonds\ broken} - \sum \Delta H^\circ_{bonds\ formed}$$

$$\Delta H^\circ_{rxn} = [(C{=}C)(1) + (Cl{-}Cl)(1)] - [(C{-}C)(1) + (C{-}Cl)(2)]$$

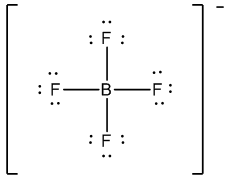
$$\Delta H^\circ_{rxn} = [(614\ kJ/mol)(1\ mol) + (243\ kJ/mol)(1\ mol)] - [(347\ kJ/mol)(1\ mol) + (339\ kJ/mol)(2\ mol)]$$

$$\Delta H^\circ_{rxn} = -168\ kJ$$

Chapter 10: Molecular Geometry

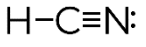
13. Which of the following Lewis structures is incorrect?

a)



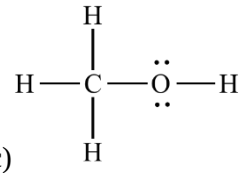
BF_4^-

b)



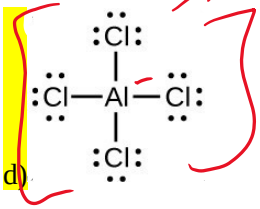
HCN

c)



CH_3OH

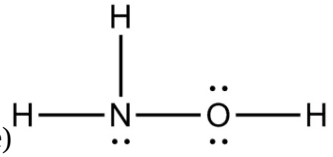
d)



It is missing the bracket & negative charge

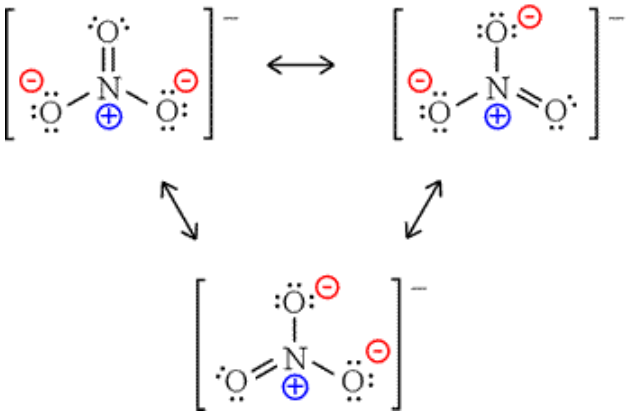
$AlCl_4^-$

e)



NH_2OH

14. Draw NO3- and its resonance structures. Calculate its formal charges.



FC = Valence e^- − (# bonds + # ℓpe^-)

N →

5 − (4 + 0) = +1

Oxygen

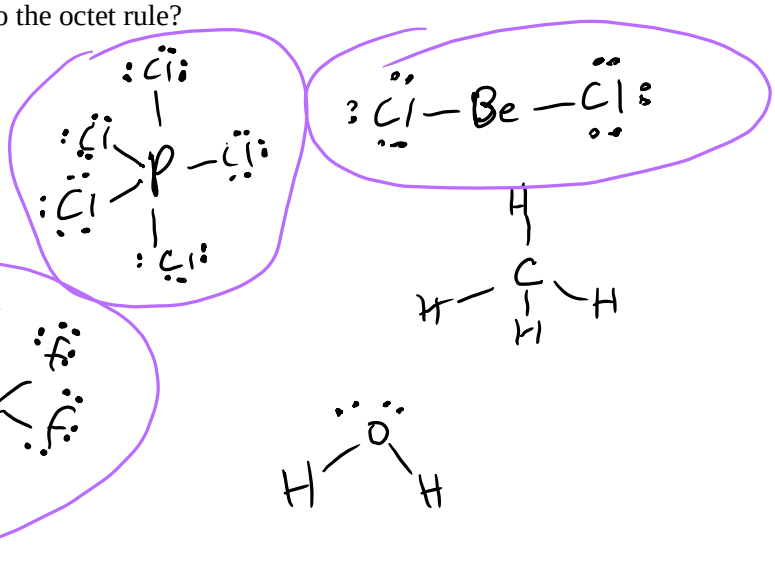
6 − (1 + 6) = −1

6 − (2 + 4) = 0

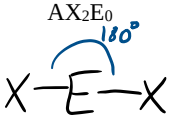
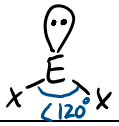
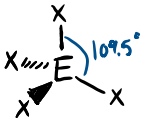
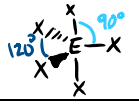
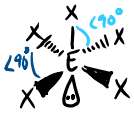
15. Which of the following are exceptions to the octet rule?

I. PCl_5 II. $BeCl_2$ III. CH_4 IV. SF_6 V. H_2O

a) I, III, V
b) I, II, IV
c) II, IV
d) I, II, V
e) II, III, IV

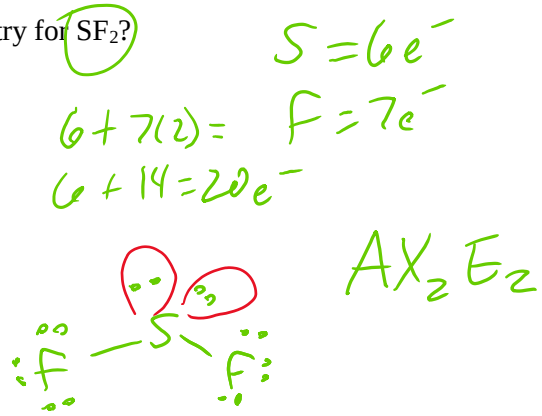


16.VSEPR Theory. Fill in the following chart including the structure, bond angles, shape name, and AX_yE_z format.

VSEPR Geometries					
Electron Pairs ↓	0 Lone Pair	1 Lone Pair	2 Lone Pairs	3 Lone Pairs	4 Lone Pairs
2	Linear 180° AX_2E_0 				
3	Trigonal Planar 120° AX_3E_0 	Bent <120° AX_2E_1 			
4	Tetrahedral 109.5° AX_4E_0 	Trigonal Pyramidal <109.5° AX_3E_1 	Bent <<109.5° AX_2E_2 		
5	Trigonal Bipyramidal 90° & 120° AX_5E_0 	Seesaw <90° & <120° AX_4E_1 	T-Shaped <90° AX_3E_2 	Linear 180° AX_2E_3 	
6	Octahedral 90° AX_6E_0 	Square Pyramidal <90° AX_5E_1 	Square Planar 90° AX_4E_2 	T-Shaped <90° AX_3E_3 	Linear 180° AX_2E_4 

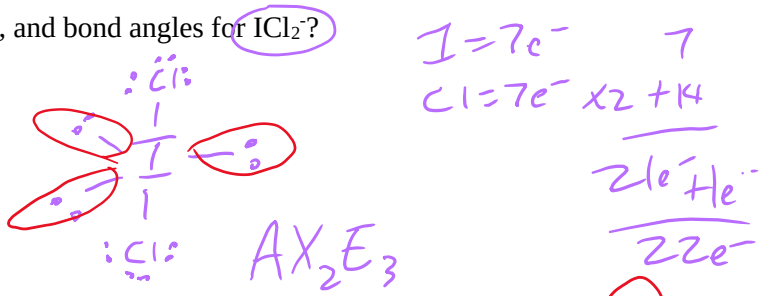
17. What is the electron geometry and molecular geometry for SF_2?

a) Tetrahedral, tetrahedral
b) Linear, linear
c) Tetrahedral, bent
d) Trigonal bipyramidal, T-shaped
e) Trigonal bipyramidal, Linear



18. What are the electron geometry, molecular geometry, and bond angles for ICl_2^-?

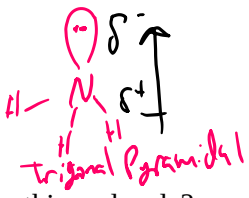
a) Trigonal bipyramidal, T-shaped, <90º
b) Tetrahedral, Trigonal pyramidal, <109.5º
c) Tetrahedral, Bent, <<109.5º
d) Linear, Linear, 180º
e)Trigonal bipyramidal, Linear, 180º

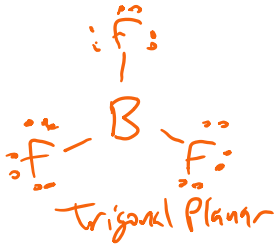


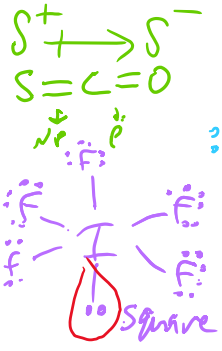
19. Which of the following molecules are polar?

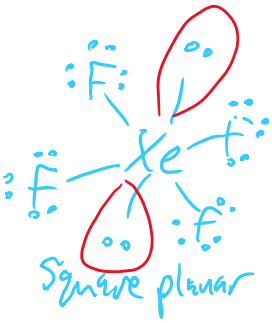
I. NH_3 II. BF_3 III. COS IV. XeF_4 V. IF_5

a) I, III, V
b) I, II, III
c) II, III, V
d) All
e) None



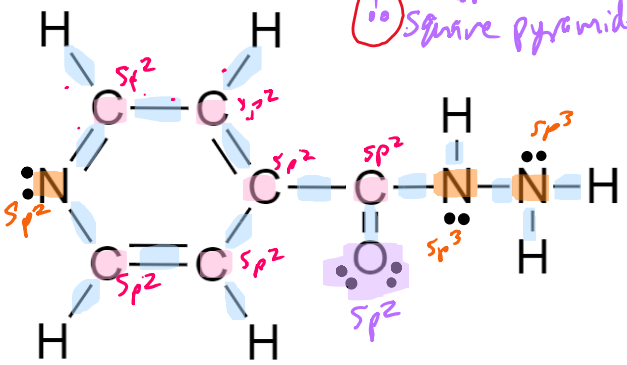






20. How many σ bonds are in this molecule?

a) 20
b) 36
c) 17
d) 19
e) 16



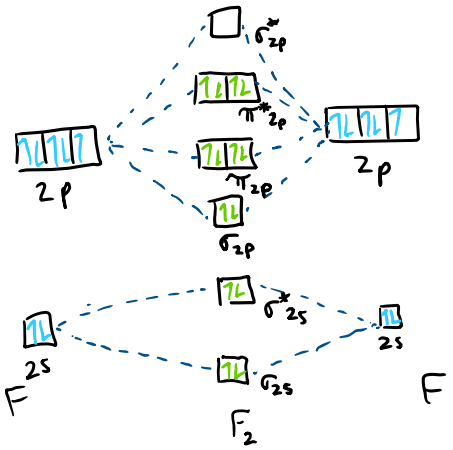
21. For the previous structure, what are the hybridizations of the C, N, and O atoms?

a) C: sp^2; N (ring): sp^2; N: sp^3; O: sp^2
b) C (ring): sp^3; C (other): sp^2; N (all): sp^2; O: sp^2
c) C: sp^2; N: sp^2; O: sp^2
d) C: sp^3; N (ring): sp^2; N: sp^3; O: sp^2

22. Which of the following statements is/are likely true:

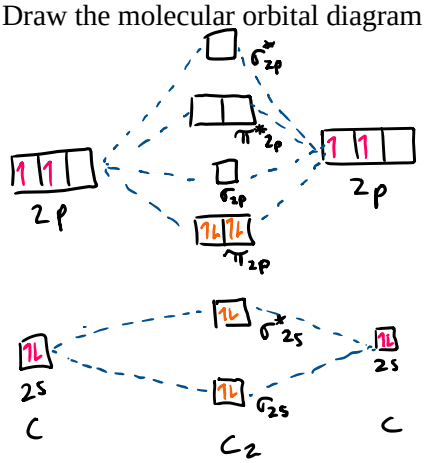
a) NH_3 should have a higher boiling point than CH_4 → NH_3 has stronger bonding; H-bonding
b) PH_3 should have a higher boiling point than NH_3 → NH_3 has stronger bonding; H-bonding
c) SO_2 should have a higher boiling point than CO_2 → SO_2 is larger than CO_2 (weighs more)
d) A and C
e) All of the above

23. Draw the molecular orbital diagram for F2.



F = 7e⁻
×2
14e⁻

24. Draw the molecular orbital diagram for C2.



C = 4e⁻
×2
8e⁻

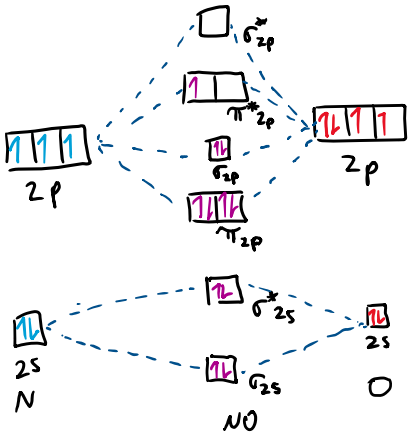
25. Which MO are affected by the mixing of s and p orbitals?

I. N_2 II. C_2 III. O_2 IV. F_2 V. B_2 VI. Ne_2

By definition, in textbook

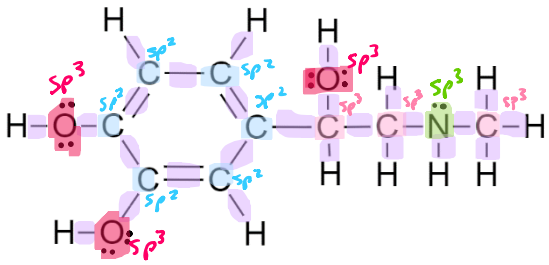
a) I, II, III, V
b) I, II, V
c) I, III, IV VI
d) II, III, IV
e) III, IV, VI

26. Draw the MO for NO.



N = 5e⁻
+O = 6e⁻
11e⁻ total

27. How many σ bonds are in this structure?



a) 25
b) 26
c) 19
d) 18
e) 29

28. What are the hybridizations of each C, N, and O atom?

a) C (all): sp^2; O: sp^3; N: sp^2
b) C (ring): sp^3; C (other): sp^2; O: sp^2; N: sp^3
c) C (all): sp^3; O: sp^2; N: sp^2
d) C (ring): sp^2; C (other): sp^3; O: sp^3; N: sp^3

29. Which of the following is true about σ bonding and π bonding.

I. A single bond has 1 σ bond.

II. A single bond has 1 π bond.

III. A double bond has 1 σ bond and 1 π bond.

IV. A double bond has 2 π bonds.

V. A double bond has 2 σ bonds.

VI. A triple bond has 3 π bonds.

VII. A triple bond has 1 σ and 2 π bonds.

VIII. A triple bond has 3 σ bonds.

a) II, III, V, VIII
b) I, III, VII
c) I, V, VI
d) II, IV, VIII
e) I, IV, VI

30. Which hybridization will a molecule with a trigonal bipyramidal electron-group arrangement have?

a) sp
b) sp^2
c) sp^3
d) sp^3d
e) sp^3d^2