

Chapter 8: Electron Configuration and Periodic Trends

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

- ~~a)~~ The e^- gained from $\text{Br} \rightarrow \text{Br}^-$; $n=4, l=1, m_l=+1, m_s=-1/2$ $4p^6 \ n=4 \ l=1$
- ~~b)~~ The outermost e^- in Rb; $n=5, l=0, m_l=0, m_s=+1/2$ $5s^1$
- c) The 6th e^- in O; $n=2, l=0, m_l=0, m_s=+1/2$ $2p^2 \ n=2 \ l=1$
- ~~d)~~ The 3rd e^- in F; $n=2, l=0, m_l=0, m_s=+1/2$ $2s^1 \ n=2 \ l=0$
- ~~e)~~ The 8th e^- in O; $n=2, l=1, m_l=-1, m_s=-1/2$ $2p^4 \ n=2 \ l=1$

2. Which of the following electron configurations are correct?

- I. Hg: $[\text{Xe}] 6s^2 4f^{14} 5d^{10}$
 - II. Mo: $[\text{Kr}] 5s^1 4d^5$
 - ~~III.~~ Cr: $[\text{Ar}] 4s^2 3d^4$ $4s^1 3d^5$
 - ~~IV.~~ Au: $[\text{Xe}] 6s^2 4f^{14} 5d^9$ $6s^1 4f^{14} 5d^{10}$
 - V. Cu: $[\text{Ar}] 4s^1 3d^{10}$
- a) I, III, V
 - b) II, IV
 - c) I, II, V
 - d) None
 - e) All

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

- ~~I.~~ Ca^{2+} : $[\text{Ar}] 4s^2$
 - II. V^{3+} : $[\text{Ar}] 3d^2$ $\text{V}: [\text{Ar}] 4s^2 3d^3$
 - ~~III.~~ S^{2-} : $[\text{Ne}] 3s^2 3p^6$
 - IV. Cr^{3+} : $[\text{Ar}] 3d^3$ $\text{Cr}: [\text{Ar}] 4s^1 3d^5$
 - ~~V.~~ Br: $[\text{Ar}] 5s^2 4d^{10} 5p^6$ $\text{Br}: [\text{Ar}] 4s^2 3d^{10} 4p^5$
- a) All
 - b) I, V
 - c) II, IV, V
 - d) III, V
 - e) II, III, IV

4. Rank these elements by their increasing atomic size. Which one is correct?

- ~~a)~~ $\text{Sr} < \text{Ca} < \text{Mg}$ $\text{Mg} < \text{Ca} < \text{Sr}$
- ~~b)~~ $\text{Rb} < \text{Br} < \text{Kr}$ $\text{Kr} < \text{Br} < \text{Rb}$
- ~~c)~~ $\text{Se} < \text{Br} < \text{Cl}$ $\text{Cl} < \text{Se} < \text{Br}$
- d) $\text{Xe} < \text{I} < \text{Ba}$ $\text{Xe} < \text{I} < \text{Ba}$
- ~~e)~~ $\text{K} < \text{P} < \text{F}$ $\text{F} < \text{P} < \text{K}$

5. Rank these elements by increasing IE_1 .

- ~~a)~~ $\text{Cs} < \text{Xe} < \text{I}$ $\text{Cs} < \text{I} < \text{Xe}$
- b) $\text{Kr} < \text{Ar} < \text{He}$ $\text{Kr} < \text{Ar} < \text{He}$
- ~~c)~~ $\text{Rb} < \text{Ca} < \text{K}$ $\text{Ca} < \text{K} < \text{Rb}$
- d) $\text{Sn} < \text{Sb} < \text{I}$ $\text{Sn} < \text{Sb} < \text{I}$
- 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 IE₂ *core e⁻*
 b) Between Rb, Sr, and Y, Sr has the highest IE₂
 c) Between Na, Mg, Al, and Si, Al has the highest IE₄ *core e⁻, Al has the most protons out of Na, Mg, and Al*
 d) Between Na, Mg, Al, and Si, Si has the highest IE₄
 e) A and C
 f) B and D

7. Which of the following ions are paramagnetic?

- I. Co³⁺ II. La³⁺ III. Cr³⁺ IV. V³⁺ V. Zn²⁺
P: paramagnetic
D: diamagnetic
- a) I, III, IV *Co³⁺: [Ar]3d⁶ → P* *V³⁺: [Ar]3d² → P*
 b) I, III, V *La³⁺: [Xe] → D* *Zn²⁺: [Ar]3d¹⁰ → D*
 c) II, V *Cr³⁺: [Ar]3d³ → P*
 d) All
 e) None

8. Which of the following ions are diamagnetic?

- I. Os³⁺ II. Hg²⁺ III. Ni²⁺ IV. Zr²⁺ V. Zn²⁺
- a) II, III, IV *Os³⁺: [Xe]4f¹⁴5d⁵ → P* *Zr²⁺: [Kr]4d² → P*
 b) II, V *Hg²⁺: [Xe]4f¹⁴5d¹⁰ → D* *Zn²⁺: [Ar]3d¹⁰ → D*
 c) I, V
 d) All
 e) None *Ni²⁺: [Ar]3d⁸ → P*

9. Which ions are ranked correctly by decreasing size?

- I. Sr²⁺ > Ca²⁺ > Mg²⁺ II. S²⁻ > Cl⁻ > K⁺ III. Mg²⁺ > Na⁺ > F⁻ IV. Ba²⁺ > Cs⁺ > I⁻ V. P³⁻ > S²⁻ > Cl⁻
- a) I, III, V *I) Sr²⁺ > Ca²⁺ > Mg²⁺* *II) P³⁻ > S²⁻ > Cl⁻*
 b) II, IV *III) S²⁻ > Cl⁻ > K⁺*
 c) I, II, V *IV) F⁻ > Na⁺ > Mg²⁺*
 d) I, IV, V *V) I⁻ > Cs⁺ > Ba²⁺*
 e) II, III, IV, V

Chapter 9: Chemical Bonding Models

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

C-C, C=C, C≡C

↑ bond order = ↓ bond length

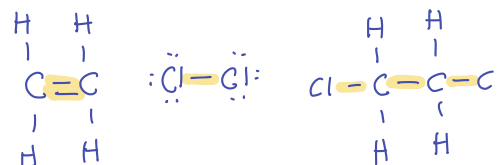
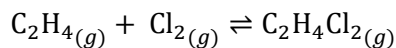
- a) C≡C < C=C < C-C
 b) C=C < C≡C < C-C
 c) C-C < C=C < C≡C
 d) C≡C < C-C < C=C

11. How are bond length and bond strength related?

- a) Inversely related
- b) Directly related
- c) Length = $\frac{1}{2}$ Strength
- d) Strength = $\frac{1}{2}$ Length

\uparrow bond length = \downarrow bond strength
inverse

12. Calculate the enthalpy of the reaction.



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 \equiv C 839 kJ/mol

Cl-Cl 243 kJ/mol

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

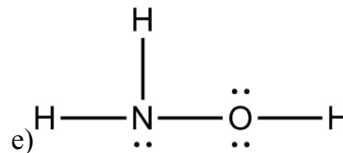
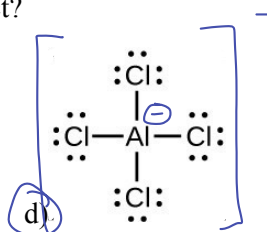
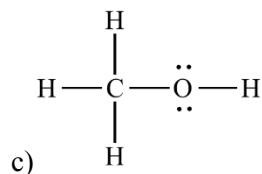
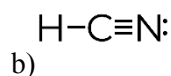
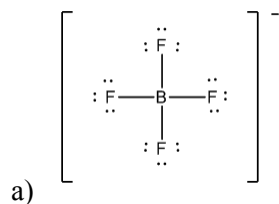
$$\Delta H_{\text{rxn}} = \Delta H_{\text{bonds broken}} - \Delta H_{\text{bonds formed}}$$

$$\Delta H = [614 + 243] - [347 + (2)(339)]$$

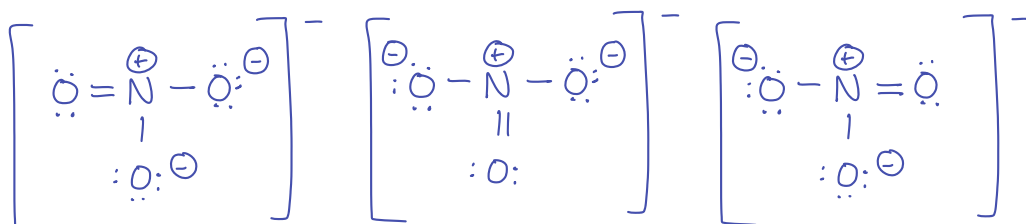
$$\Delta H = -168 \text{ kJ}$$

Chapter 10: Molecular Geometry

13. Which of the following Lewis structures is incorrect?



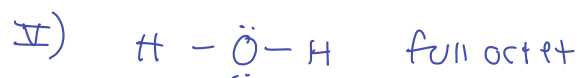
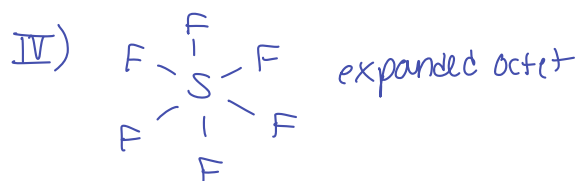
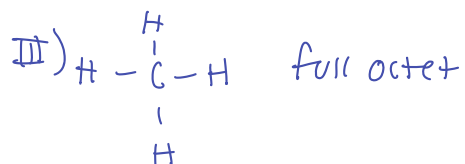
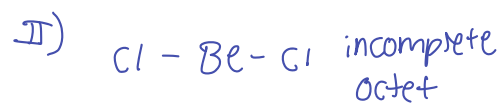
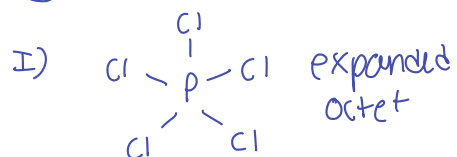
14. Draw NO_3^- and its resonance structures. Calculate its formal charges.



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

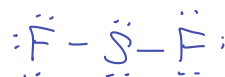


16. VSEPR Theory. Fill in the following chart including the structure, bond angles, shape name, and AX_yE_z format.

VSEPR Geometries					
Electron Pairs ↓	0 Lone Pair	1 Lone Pair	2 Lone Pairs	3 Lone Pairs	4 Lone Pairs
sp	<p>2</p> <p>AX₂</p> <p>X - A - X</p> <p>Linear 180°</p>				
sp ²	<p>3</p> <p>AX₃</p> <p>trigonal planar 120°</p>	<p>AX₂E, bent</p> <p><120°</p>			
sp ³	<p>4</p> <p>AX₄</p> <p>tetrahedron 109.5°</p>	<p>AX₃E</p> <p>trigonal pyramidal <109.5°</p>	<p>AX₂E₂</p> <p>bent, <109.5°</p>		
sp ³ d	<p>5</p> <p>AX₅</p> <p>trigonal bipyramidal 120°, 90°</p>	<p>AX₄E</p> <p>Seesaw 120°, 90°</p>	<p>AX₃E₂</p> <p>T-shape 90°</p>	<p>AX₂E₃</p> <p>Linear, 180°</p>	
sp ³ d ²	<p>6</p> <p>AX₆</p> <p>Octahedral 90°</p>	<p>AX₅E</p> <p>Square Pyramidal <90°</p>	<p>AX₄E₂</p> <p>Square Planar 90°</p>	<p>AX₃E₃</p> <p>T-shape <90°</p>	<p>AX₂E₄</p> <p>Linear 180°</p>

17. What is the electron geometry and molecular geometry for SF₂?

- Tetrahedral, tetrahedral
- Linear, linear
- Tetrahedral, bent
- Trigonal bipyramidal, T-shaped
- Trigonal bipyramidal, Linear

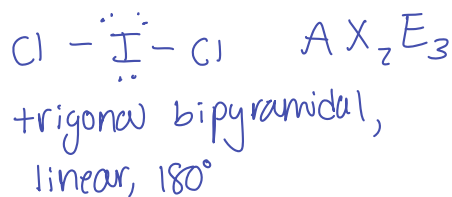


4 e⁻ groups → AX₂E₂

tetrahedral electronic geometry
bent molecular geometry

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

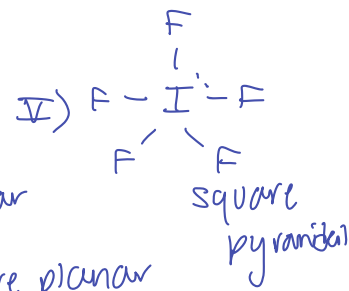
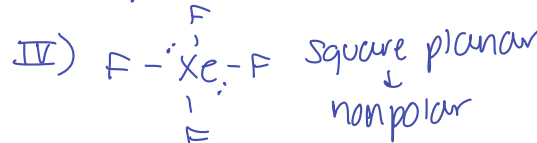
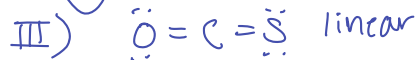
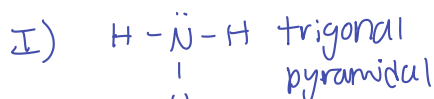
- a) Trigonal bipyramidal, T-shaped, $<90^\circ$
- b) Tetrahedral, Trigonal pyramidal, $<109.5^\circ$
- c) Tetrahedral, Bent, $<<109.5^\circ$
- d) Linear, Linear, 180°
- e) Trigonal bipyramidal, Linear, 180°



19. Which of the following molecules are polar?

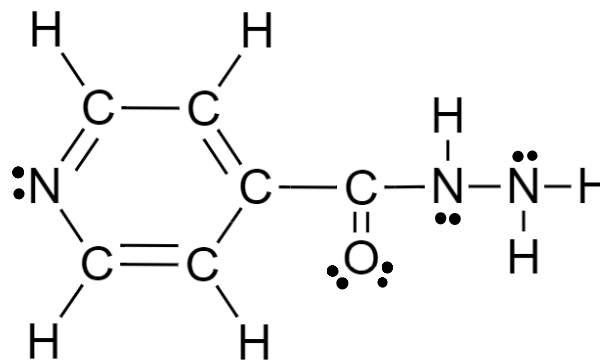
- I. NH_3
- II. BF_3
- III. COS
- IV. XeF_4
- V. IF_5

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



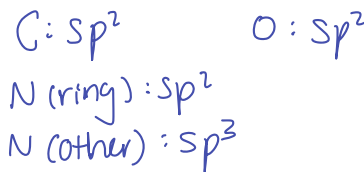
20. How many σ bonds are in this molecule?

- 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



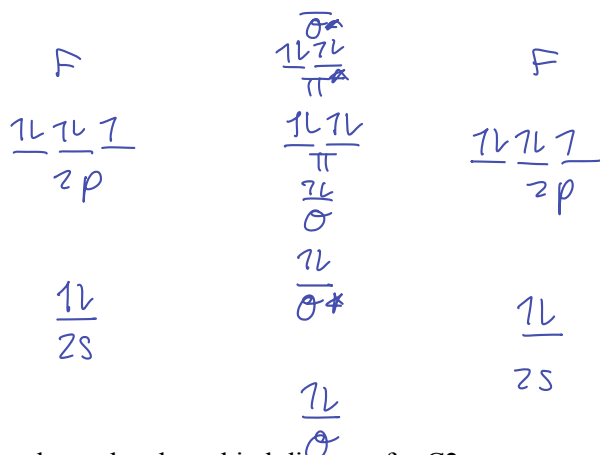
22. Which of the following statements is/are likely true:

- a) NH_3 should have a higher boiling point than CH_4
- b) PH_3 should have a higher boiling point than NH_3
- c) SO_2 should have a higher boiling point than CO_2
- d) A and C
- e) All of the above

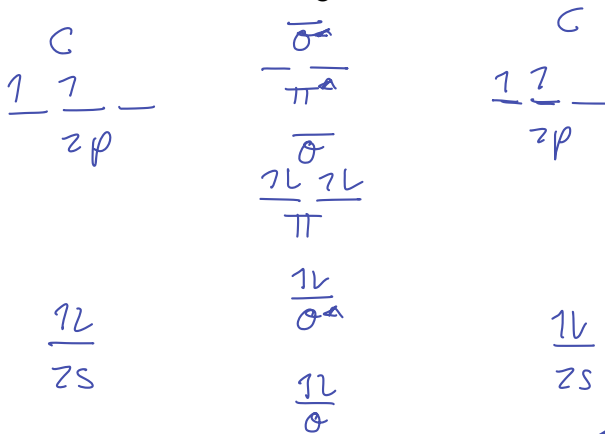
H-bonds



23. Draw the molecular orbital diagram for F₂.



24. Draw the molecular orbital diagram for C₂.

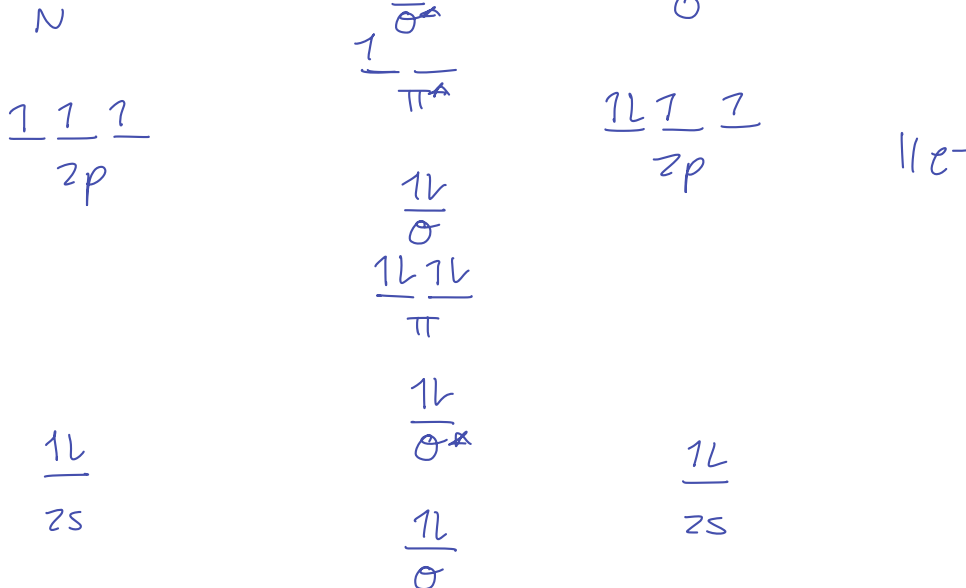


25. Which MO are affected by the mixing of s and p orbitals?

I. N₂ II. C₂ III. O₂ IV. F₂ V. B₂ VI. Ne₂

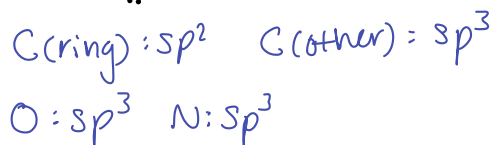
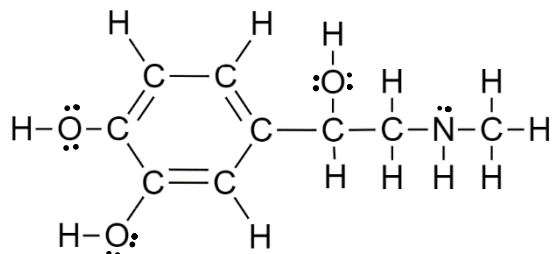
- a) I, II, III, V
- b) I, II, V
- c) I, III, IV, VI
- d) II, III, IV
- e) III, IV, VI

26. Draw the MO for NO.



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**