

**Chapters 9 – 12: This review goes over important concepts needed for your exam but is not exhaustive of everything you need to know and should be used as a supplement (not the sole resource) to your own studying.**

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

C-C, C=C, C≡C

- 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

2. 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

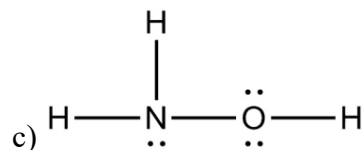
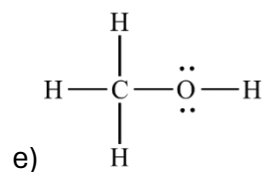
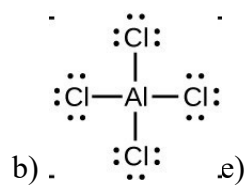
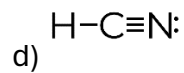
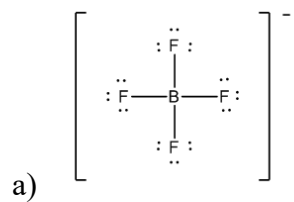
3. Calculate the enthalpy of the reaction:

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≡C 839 kJ/mol Cl-Cl 243 kJ/mol

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

4. Which of the following Lewis structures is incorrect?



5. Draw  $\text{NO}_3^-$  and its resonance structures. Calculate its formal charges.

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

I.  $\text{PCl}_5$  II.  $\text{BeCl}_2$  III.  $\text{CH}_4$  IV.  $\text{SF}_6$  V.  $\text{H}_2\text{O}$

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

7. VSEPR Theory. Fill in the following chart including the structure, bond angles, shape name, and AX<sub>y</sub>E<sub>z</sub> format.

VSEPR Geometries

Electron Pairs ↓	0 Lone Pair	1 Lone Pair	2 Lone Pair	3 Lone Pair	4 Lone Pair
1					
2					
3					
4					
5					
6					

8. Name to electron geometry, molecular geometry, and bond angles for the following compounds:

a)  $\text{H}_2\text{O}$

b)  $\text{ICl}_2$

c)  $\text{SF}_4$

d)  $\text{BeCl}_2$

e)  $\text{CO}_3^{2-}$

9. Which of the following molecules are polar?

I.  $\text{NH}_3$  II.  $\text{BF}_3$  III.  $\text{COS}$  IV.  $\text{XeF}_4$  V.  $\text{IF}_5$

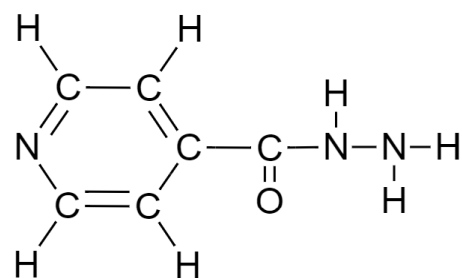
- a) I, III, V
- b) I, II, III
- c) II, III, V
- d) All
- e) None

10. Which of the following is a nonpolar molecule with polar covalent bonds?

- a)  $\text{Cl}_2$
- b)  $\text{SOCl}_2$
- c)  $\text{BeBr}_2$
- d)  $\text{NH}_3$
- e)  $\text{H}_2\text{O}$

11. How many  $\sigma$  bonds are in this molecule?

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



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

- a) C:  $\text{sp}^2$ ; N (ring):  $\text{sp}^2$ ; N:  $\text{sp}^3$ ; O:  $\text{sp}^2$
- b) C (ring):  $\text{sp}^3$ ; C (other):  $\text{sp}^2$ ; N (all):  $\text{sp}^2$ ; O:  $\text{sp}^2$
- c) C:  $\text{sp}^2$ ; N:  $\text{sp}^2$ ; O:  $\text{sp}^2$
- d) C:  $\text{sp}^3$ ; N (ring):  $\text{sp}^2$ ; N:  $\text{sp}^3$ ; O:  $\text{sp}^2$

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

- a)  $\text{NH}_3$  should have a higher boiling point than  $\text{CH}_4$
- b)  $\text{PH}_3$  should have a higher boiling point than  $\text{NH}_3$
- c)  $\text{SO}_2$  should have a higher boiling point than  $\text{CO}_2$
- d) A and C
- e) All of the above

14. Draw the molecular orbital diagram for  $F_2$ .

15. Draw the molecular orbital diagram for  $C_2$ .

16. Draw the MO for NO.

17. Which of the following is true about  $\sigma$  bonding and  $\pi$  bonding.

- I. A single bond has 1  $\sigma$  bond.
- II. A single bond has 1  $\pi$  bond.
- III. A double bond has 1  $\sigma$  bond and 1  $\pi$  bond.
- IV. A double bond has 2  $\pi$  bonds.
- V. A double bond has 2  $\sigma$  bonds.
- VI. A triple bond has 3  $\pi$  bonds.
- VII. A triple bond has 1  $\sigma$  and 2  $\pi$  bonds.
- VIII. A triple bond has 3  $\sigma$  bonds.

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

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

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

19. According to MO theory, which of the following dicarbon species is expected to have the shortest bond length.

Use the following valence MO order:  $\sigma 2s < \sigma^* 2s < \pi 2py = \pi 2pz < \sigma 2px < \pi^* 2py = \pi^* 2pz < \sigma^* 2px$

- a)  $C_2^+$
- b)  $C_2^{2-}$
- c)  $C_2$
- d)  $C_2^-$
- e) They all have the same length

20. Calculate the heat needed to convert 10.0 g of solid bromine from  $-7.2^{\circ}\text{C}$  to  $70.0^{\circ}\text{C}$ . Which of the following steps requires the most heat energy: melting the solid bromine, heating the liquid bromine from its melting point to its boiling point, boiling the bromine, or heating the gaseous bromine from its boiling point to  $110.0^{\circ}\text{C}$ ?

Melting point for bromine  $-7.2^{\circ}\text{C}$ , heat of fusion for bromine =  $66.15\text{ J/g}$ ; specific heat of liquid bromine =  $0.474\text{ J/g}^{\circ}\text{C}$ ; boiling point for bromine =  $58.7^{\circ}\text{C}$ , heat of vaporization for bromine =  $193.21\text{ J/g}$ , specific heat of gaseous bromine =  $0.225\text{ J/g}^{\circ}\text{C}$ .

21. Which response correctly identifies all the interactions that might affect the properties of  $\text{BF}_3$ ?

- a) dispersion force, ion-ion interaction
- b) hydrogen bonding force, dispersion force
- c) permanent dipole force
- d) permanent dipole force, dispersion force
- e) dispersion force



22. Which response has the following substances arranged in order of **increasing** boiling point?

Ar, NaClO<sub>3</sub>, H<sub>2</sub>O, H<sub>2</sub>Se

- A) NaClO<sub>3</sub> < H<sub>2</sub>O < H<sub>2</sub>Se < Ar
- B) NaClO<sub>3</sub> < H<sub>2</sub>Se < H<sub>2</sub>O < Ar
- C) Ar < NaClO<sub>3</sub> < H<sub>2</sub>Se < H<sub>2</sub>O
- D) Ar < H<sub>2</sub>O < H<sub>2</sub>Se < NaClO<sub>3</sub>
- E) Ar < H<sub>2</sub>Se < H<sub>2</sub>O < NaClO<sub>3</sub>

23. Which of the following solutions is matched with its correct intermolecular force between solute and solvent?

- A) NH<sub>3</sub> and F<sub>2</sub>: hydrogen bonding
- B) CH<sub>2</sub>F<sub>2</sub> and CH<sub>2</sub>O: dispersion
- C) Cl<sub>2</sub> and PH<sub>3</sub>: dipole-induced dipole
- D) HF and NH<sub>3</sub>: dipole-dipole
- E) PH<sub>3</sub> and H<sub>2</sub>O: dispersion

24. A certain metal has a specific gravity of 10.200 at 25°C. It crystallizes in a body-centered cubic arrangement with a unit cell edge length of 3.147 Å. Determine the atomic weight, the identity of the metal, and the radius of the atom in Å.