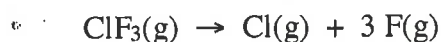


1. The enthalpy change for the following reaction is 759 kJ. Calculate the average Cl-F bond energy.



- A. 88.0
- B. 253
- C. 312
- D. 514
- E. 1540

2. The bond angles in XeF_4 are _____.

- A. exactly 90°
- B. slightly less than 90°
- C. exactly 109.5°
- D. slightly less than 109.5°
- E. exactly 120°

3. Write resonance structures for CO_3^{2-} . Based on these structures one can conclude that the bond order of the C - O bond is

- A. $\frac{1}{2}$
- B. $\frac{2}{3}$
- C. 1
- D. $1\frac{1}{3}$
- E. $1\frac{2}{3}$

4. In the following oxidation reaction the shape of the reactant is ___ and the shape of the product is ___.

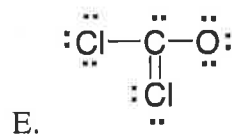
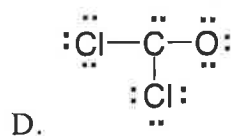
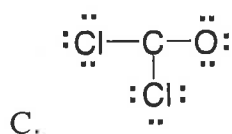
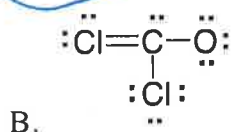
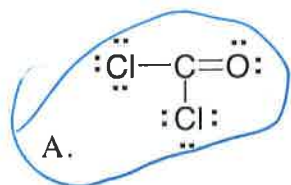


- A. see-saw, tetrahedral
- B. tetrahedral, see-saw
- C. T-shaped, tetrahedral
- D. T-shaped, square planar
- E. square planar, T-shaped

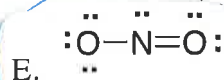
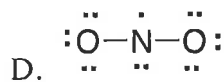
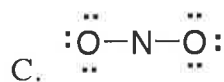
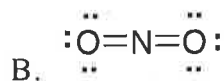
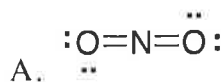
5. Draw the Lewis formula for BrF_3 . What term describes the shape of this species?

- A. planar trigonal
- B. trigonal pyramid
- C. T shaped
- D. square planar
- E. tetragonal pyramid

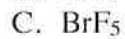
6. Which of the following is the correct Lewis structure for COCl_2 ?



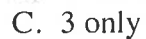
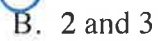
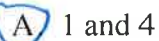
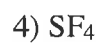
7. Which of the following is the correct Lewis structure for NO_2^- ?



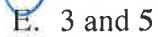
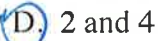
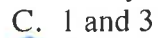
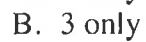
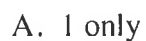
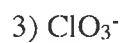
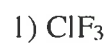
8. Which of the following is a nonpolar molecule?



9. Which of the following has bond angles of approximately 90° ?



10. Which of the species in the following list is trigonal planar?



11. A 352.2 mL sample of O_2 is collected at 738 mm Hg. What would be the volume (mL) at 1.00 atm assuming that the temperature remains constant?
- A. 331
 - B. 342
 - C. 350
 - D. 339
 - E. 328
12. Calculate the density, g/L, of Freon-12, CF_2Cl_2 at STP.
- A. 3.80
 - B. 5.40
 - C. 4.35
 - D. 6.14
 - E. 4.98
13. Four identical 1.0-L flasks contain the following gases each at $0^\circ C$ and 1 atm pressure. For which gas do the molecules have the smallest average kinetic energy?
- A. HCl
 - B. Cl_2
 - C. CH_4
 - D. NH_3
 - E. all are the same
14. A 2.00 L sample of air at $-50.0^\circ C$ has a pressure of 700. torr. What will be the new pressure (torr) if the temperature is raised to $50.0^\circ C$ and the volume is increased to 4.00 L?
- A. 411
 - B. 443
 - C. 485
 - D. 506
 - E. 552

15. The density of a hydrocarbon at STP is 1.97 g/L. What is the molecular weight of the gas?

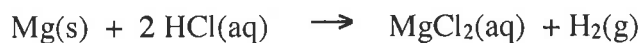
- A. 16.3
- B. 30.6
- C. 44.1
- D. 26.2
- E. 40.7

16. A 0.815 g sample of a mixture contains copper and aluminum. Aluminum reacts with HCl but copper does not. What is the % Al if 927 mL of hydrogen gas is collected by displacement of water at 740. mm Hg and 20.0°C. The vapor pressure of water is 17.5 mm Hg.



- A. 81.7
- B. 80.8
- C. 79.2
- D. 85.3
- E. 77.1

17. Calculate the mass (g) of magnesium required to produce 325 mL of hydrogen gas at 0.00°C and 1.00 atm.



- A. 0.353
- B. 0.391
- C. 0.323
- D. 0.421
- E. 0.290

18. A 0.995 g gaseous sample of $\text{C}_2\text{H}_3\text{X}_3$ has a volume of 355 mL at 769 mm Hg at 95°C. What is the atomic weight of X?

- A. 19.0
- B. 34.4
- C. 16.0
- D. 32.0
- E. 79.9

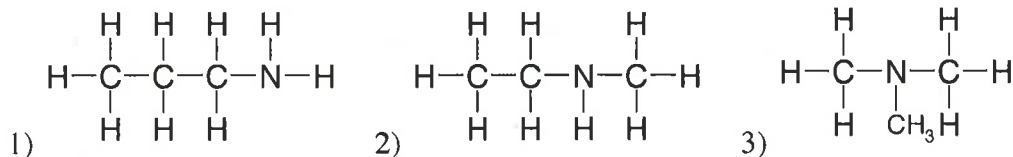
19. A mixture of 0.50 mole N_2 and 0.50 mole of CO_2 is introduced into a 10.0 L container at $25^\circ C$. The container has pinhole leak. After a period of time:

- A. the partial pressure of N_2 exceeds that of CO_2 in the remaining gas
- B. the partial pressure of CO_2 exceeds that of N_2 in the remaining gas
- C. the partial pressures of the two gases remain equal throughout this time

20. A mixture of hydrogen and helium is 25.0% hydrogen by mass. What is the partial pressure (mm Hg) of helium in the mixture at STP?

- A. 457
- B. 303
- C. 520
- D. 250
- E. 280

21. Which of the following can form intermolecular hydrogen bonds in the pure liquid?



- A. 1 only
- B. 2 only
- C. 3 only
- D. 1 and 2
- E. 2 and 3

22. Given the following boiling point data, which one of the liquids would you expect to have the highest vapor pressure at room temperature (normal boiling point is parenthesis)?

- A. Water, H_2O ($100^\circ C$)
- B. methanol, CH_3OH ($64.96^\circ C$)
- C. ethanol, CH_3CH_2OH ($78.5^\circ C$)
- D. diethyl ether, $CH_3CH_2-O-CH_2CH_3$ ($34.5^\circ C$)
- E. ethylene glycol, $HO-CH_2-CH_2-OH$ ($198^\circ C$)

23. Which molecule or ion below has the shortest oxygen-oxygen bond length?

- a. **O₂**
- b. O₂²⁻
- c. H₂O₂ (i.e HOOH)
- d. All of the above have equal oxygen-oxygen bond lengths

24. In which of the molecules below does oxygen have the greatest partial negative charge?

- a. CO₂
- b. O₂
- c. **H₂O**
- d. NO
- e. CO

25. Which molecule in each pair has the longest bond length?

- | | I. O₂ or F₂ | II. NH₃ or PH₃ | III. NO⁺ or NO⁻ |
|-----------|--|---|--|
| a. | I. O ₂ | II. NH ₃ | III. NO ⁺ |
| b. | I. O ₂ | II. PH ₃ | III. NO ⁻ |
| c. | I. F ₂ | II. NH ₃ | III. NO ⁺ |
| d. | I. F₂ | II. PH₃ | III. NO⁻ |
| e. | I. O ₂ | II. PH ₃ | III. NO ⁺ |

26. What is the bond order of He₂⁺? (Hint: Consider its molecular orbital diagram).

- a. -1
- b. -1/2
- c. 0
- d. **+1/2**
- e. +1

27. Which statement is true about sulfur dioxide?

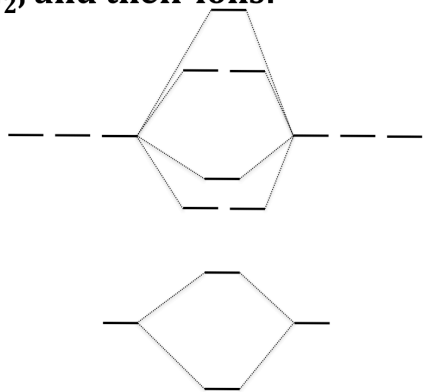
- a. SO₂ is a non-polar compound
- b. **Sulfur dioxide has two equivalent sulfur-oxygen bonds of 3/2 bond order**
- c. Experimentally, one oxygen atom bears a charge of -1 and the other of zero
- d. According to hybrid theory, the central sulfur atom is sp hybridized
- e. None of the above statements are true

28. Which molecule below contains the weakest carbon-oxygen bond?

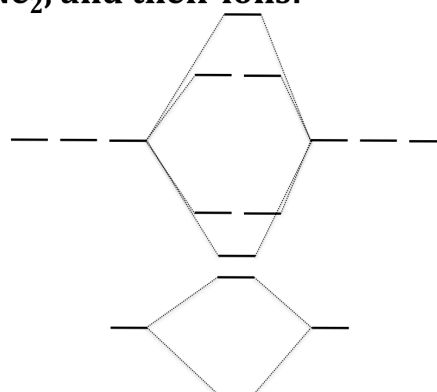
- a. CO
- b. CO₂
- c. **CH₃OH**
- d. CH₂O
- e. H₂CO₃

Use the diagram below for the next 4 questions:

B₂, C₂, N₂, and their ions:



O₂, F₂, Ne₂, and their ions:



29. Which molecule below has the lowest bond order?

- C₂²⁺
- C₂
- C₂²⁻
- O₂
- O₂⁻

30. Which statement is true for the molecules/ions in the answers to question #29?

- All the molecules/ions are paramagnetic
- All the molecules/ions are paramagnetic except one
- All the molecules/ions are paramagnetic except two**
- All the molecules/ions are diamagnetic except two
- All the molecules/ions are diamagnetic except one

31. An important property of molecules is the energy difference between the highest energy molecular orbital occupied with electrons (HOMO) and the lowest energy molecular orbital unoccupied with electrons (LUMO). Identify the HOMO of N₂.

- σ*_{2s}
- σ_{2p}**
- π_{2p}
- π*_{2p}
- σ*_{2p}

32. Which ranking of F₂, N₂, and B₂ by order of increasing bond length is correct?

- F₂ < N₂ < B₂
- B₂ < N₂ < F₂
- N₂ < F₂ < B₂**
- N₂ < B₂ < F₂
- B₂ < F₂ < N₂