Practice MT3 – 2: Take exam like at the real exam!

1. Which statement is true about the polarity of HCN, which has a structure of H–C≡N: ? (Hint: The electronegativities of H, C, and N are 2.1, 2.5, and 3.0, respectively.)

a. The carbon-nitrogen bond in HCN is a polar-covalent bond
b. Both bonds in HCN are nonpolar covalent bonds
c. The total molecular dipole moment in HCN points towards the H atom.
d. Statements a and c are correct
e. Statements b and c are correct

2. Why does the most proper Lewis structure of $BeCl_2$ contain two single Be-Cl bonds instead of two double Be=Cl bonds?

a. The formal charges of the atoms would be maximized, rather than minimized as required by the formal charge rule, if $BeCl_2$ contained two double bonds
b. Neither Be nor Cl could satisfy the octet rule if $BeCl_2$ contained two double bonds
c. Be would be surrounded by more than eight electrons if $BeCl_2$ had two double bonds
d. The Cl atoms would be surrounded by more than eight electrons each if $BeCl_2$ contained two double bonds
e. The formal charges could not sum to zero if $BeCl_2$ contained two double bonds

3. Which molecule in each pair has the shortest bond length?

I. O_2 vs. N_2 II. H_2O or H_2S III. NO^+ or NO^-

a. I. N_2 II. H_2O III. NO^+
b. I. N_2 II. H_2O III. NO^-
c. I. O_2 II. H_2O III. NO^+
d. I. O_2 II. H_2S III. NO^-
e. I. N_2 II. H_2S III. NO^-

4. Which statement(s) about the effect of resonance and the nitrate ion is/are true?

a. Nitrate has three different, yet equivalent resonance structures
b. All bonds in NO_3^- are equal in length
c. Only two of the bonds in NO_3^- are equal in bond length
d. Both statements a and b are true
e. Both statements a and c are true

5. Which Lewis structure below best represents N_2O.

a. N=O=N
b. N=N=O
c. N≡N-O
d. N≡O-N
e. N-N≡O

6. How many total σ and π bonds are there in N_2O?

a. 1 σ and 1 π bond
b. 2 σ and 1 π bond
c. 1 σ and 2 π bond
d. 2 σ and 2 π bonds
e. 2 σ and 3 π bonds

7. Choose the member in each pair with the shortest bond length. Explain your choice.

a. The carbon-oxygen bond in CO or the carbon-oxygen bond in CH_2O

C=O Shorter than H-C(H)=O double

b. The carbon-hydrogen bond in CH_4 or the boron-hydrogen bond in BH_3

H-C(H)(H)-H vs H-B(H)-H

C is smaller than B so CH < BH

c. The oxygen-oxygen bond in O_2 or the oxygen-oxygen bond in O_2^{2-} (Hint: you can consider either their Lewis structures or molecular orbital diagrams to answer this question)

O=O double shorter than O-O single

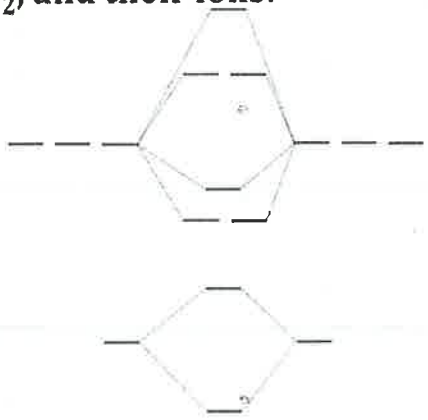
8. Consider sulfur dioxide.
   a. Draw all of its possible Lewis structure(s).

   b. Select and explain the most proper statement about the bonds in nitrite: (Circle one)
      i. The bonds in the molecule are equal in bond length
      ii. The bonds in the molecule differ in bond length

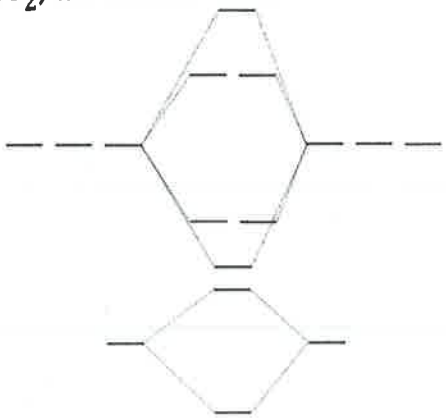
Explanation:

↳ Bonds exist at all times as the average of its 2 possible Lewis structures.

B_2, C_2, N_2, and their ions:



O_2, F_2, Ne_2, and their ions:



9. Which molecule has the greatest bond order?

   a. C_2^{2+}
   b. C_2^{2-}
   c. O_2
   d. O_2^{2-}
   e. F_2

10. Which ranking of by order of increasing bond length is correct for O_2, C_2, and N_2?

   a. $O_2 < N_2 < C_2$
   b. $C_2 < N_2 < O_2$
   c. $N_2 < O_2 < C_2$
   d. $N_2 < C_2 < O_2$
   e. $C_2 < O_2 < N_2$

11. Which molecule/ion would has the shortest oxygen-oxygen bond length?

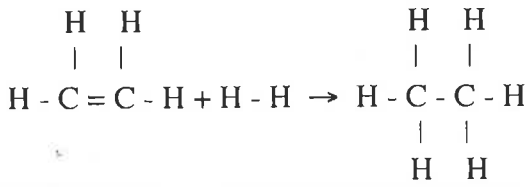
   a. O_2^-
   b. O_2
   c. O_2^+
   d. O_2^{2-}
   e. More information is needed

12. The valence orbitals in bromine interact with the same pattern as fluorine. What is the proper valence MO configuration of bromine?

   a. $\sigma_{2s}^2\,\sigma^*_{2s}{}^2\,\sigma_{2p}^2\,\pi_{2p}^4\,\pi^*_{2p}{}^4$
   b. $\sigma_{4s}^2\,\sigma^*_{4s}{}^2\,\sigma_{4p}^2\,\pi_{4p}^4\,\pi^*_{4p}{}^4$
   c. $\sigma_{4s}^2\,\sigma^*_{4s}{}^2\,\pi_{4p}^4\,\sigma_{4p}^2\,\pi^*_{4p}{}^4$
   d. $\sigma_{4s}^2\,\sigma^*_{4s}{}^2\,\sigma_{4p}^2\,\sigma^*_{4p}{}^2\,\pi_{4p}^4\,\pi^*_{4p}{}^2$
   e. None of the above

(Exam continues with #23).

23. Use the following bond energies to calculate ÄH° for the given reaction.
(H - C = 414; C - C = 347; C = C = 619; H - H = 435)



A. -55
B. -102
C. -72
D. -121
E. -92

24. The bond angles in IF_2^+ are _____.

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

25. Write resonance structures for NO_2^-. Based on these structures one can conclude that the bond order of the N - O bond is

A. ½
B. 1
C. 1 ⅓
D. 1 ½
E. 1 ⅔

26. In the following oxidation reaction the shape of the reactant is __ and the shape of the product is __.

$$SF_4 \text{ -----} \rightarrow SF_4^{2+} + 2\ e^-$$

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

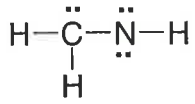
27. What types of hybrid orbitals are involved in bonding of SO_4^{2-}?

A. sp^3
B. sp^2
C. sp
D. dsp^3
E. d^2sp^3

28. Draw the Lewis formula for NH_2^-. What term describes the shape of this species?

A. linear
B. bent
C. tetrahedral
D. square planar
E. see-saw

29. Which of the following is an acceptable Lewis structure for H_2CNH?

A.


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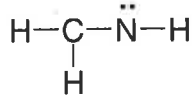

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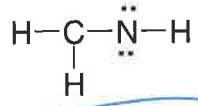

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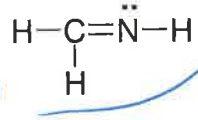

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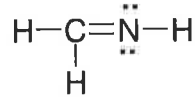


30. Consider the following molecules and select those that are polar.

1) ClF 2) ClF_3 3) ClF_5

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

31. The oxalate ion, $C_2O_4^{2-}$ has a single bond between the carbon atoms and each carbon atom is bonded to two oxygen atoms. Write a resonance form conforming to the Lewis octet rule and determine the number of double bonds in this species.

A. one
B. two
C. three
D. zero

32. Which of the following has bond angles of approximately 120°?

1) ClF_3 2) BF_3 3) ClO_3^- 4) SF_4 5) $GeCl_4$

A. 1 and 4
B. 2 and 3
C. 2 only
D. 4 only
E. 5 only

33. Which of the following molecules is nonlinear?

A. SO_2
B. CO_2
C. HCN
D. C_2H_2
E. HCl

34. What is the density (g/L) of carbon dioxide at 30.3°C and 744 mm Hg?

A. 1.85
B. 1.73
C. 1.61
D. 1.42
E. 1.28

35. A gas occupies 250. mL at 700. torr and 300. K. What volume (mL) will the gas occupy at 350. torr and 450 K?

A. 750.
B. 83.3
C. 375
D. 500.
E. 950.

36. Imagine two flasks of identical volume. One contains 2 grams of H_2 at 200 K and the other contains 2 grams of He at 800 K. Which of the following properties are the same for the two flasks?

I pressure
II average KE
III density
IV number of molecules
V average velocity — Consider rms velocity

A. I
B. III & IV
C. III
D. IV
E. III & V

37. Consider three one-liter flasks labeled A, B, and C filled with the gases NO, NO_2, and N_2O, respectively, each at STP. Which flask contains 1.0 mole of gas?

A. flask A
B. flask B
C. flask C
D. none
E. all are the same

38. What volume (L) of O_2 at STP is required to burn 1.3 g of acetylene at STP?

$$2\ C_2H_2(g) + 5\ O_2(g) \rightarrow 4\ CO_2(g) + 2\ H_2O(g)$$

A. 2.1
B. 2.8
C. 1.8
D. 3.2
E. 2.5

39. A 1.14 g sample of impure aluminum carbide reacts with water to give 452 mL of CH_4 at 20.0°C and 745 mm Hg. What is the % Al_4C_3?

$$Al_4C_3(s) + H_2O(l) \rightarrow 3\ CH_4(g) + 4\ Al(OH)_3(s)$$

A. 74.2
B. 80.2
C. 77.6
D. 82.4
E. 72.1

40. Which of the following statements about kinetic energy (K.E.) is true?

A. All objects moving with the same velocity have the same K.E.
B. As the velocity of a body increases, its K.E. decreases.
C. The K.E. of a body will quadruple if its velocity doubles.
D. The K.E. of a body is independent of its mass.
E. None of the these are true.

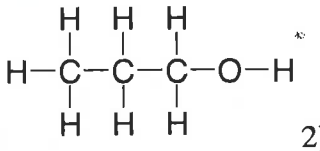
41. A mixture contains 1.20 g helium, 4.00 g neon and 6.50 g argon. What is the partial pressure (mm Hg) of argon in the mixture at STP?

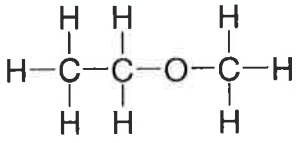
A. 242
B. 345
C. 187
D. 425
E. 122

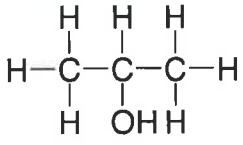
42. The rms speed of an O_2 molecule is 425 m/s at 0.00°C. What is the rms speed at 100.0°C?

A. 425
B. 497
C. 515
D. 535
E. 581

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

1) 

2) 

3) 

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

44. Which one of the following **DECREASES** as the strength of the attractive intermolecular forces **INCREASES**?

A. The heat of vaporization.
B. The normal boiling temperature.
C. The extent of deviations from the ideal gas law.
D. The sublimation temperature of a solid.
E. The vapor pressure of a liquid.