ACS Review – Structure and Properties

1. What is the ground state electron configuration of carbon?

   A. $1s^2 2s^2 2p_x^{\ 1}$
   B. $1s^2 2s^2 2p_x^{\ 2}$
   C. $1s^2 2s^2 2p_x^{\ 1} 2p_y^{\ 1}$
   D. $1s^2 2s^2 2p_x^{\ 2} 2p_y^{\ 1}$

2. Which of the following has(have) the same electron configuration as Ne?

   Na^- Mg^{2+} O^{2-} Mg^+

   A. Na^- and O^{2-}
   B. Mg^{2+} and O^{2-}
   C. Mg^+ and O^{2-}
   D. only Mg^{2+}

3. What is the letter designation given to dumbbell shaped orbitals like the one depicted below?

   A. s
   B. p
   C. d
   D. f

4. Which one of the following does not have an octet of electrons surrounding the central atom?

   A. BH_3
   B. CH_4
   C. NH_3
   D. H_2O

5. Predict which bond is the most polar in ethanol, CH_3CH_2OH?

   A. C-C
   B. C-H
   C. C-O
   D. O-H

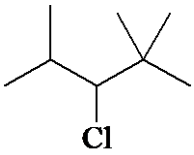
6. Which one of the following has a triple bond?

   A. O_2
   B. Cl_2
   C. CN^-
   D. OH^-

7. Which one of the following is the ionic compound formed between magnesium and chlorine?

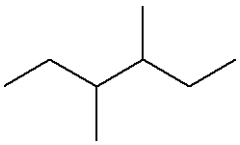
   A. MgCl
   B. $MgCl_2$
   C. Mg_2Cl_3
   D. $MgCl_3$

8. Identify the condensed formula of the following structure:



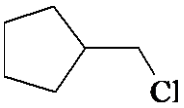
A. $(CH_3)_2CHCHClCH(CH_3)_2$
B. $CH_3CH(CH_3)CHClCH(CH_3)_2$
C. $(CH_3)_2CHCHClC(CH_3)_3$
D. $(CH_3)_3CCHClCH(CH_3)_2$

9. What is the chemical formula of the following carbon skeleton diagram?



A. C_8H_{14}
B. C_8H_{16}
C. C_8H_{18}
D. C_8H_{20}

10. What is the chemical formula of the following carbon skeleton diagram?

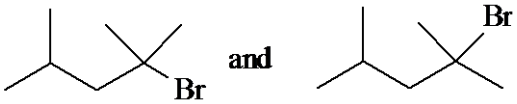


A. C_5H_9Cl
B. $C_5H_{11}Cl$
C. C_6H_9Cl
D. $C_6H_{11}Cl$

11. How many C_3H_8O constitutional isomers are possible?

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

12. Which of the following best describes the relationship between the following two structures?



A. identical compounds
B. resonance structures
C. constitutional isomers

D. different compounds with different constitutions

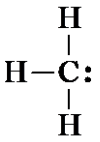
13. How many constitutional isomers of C_4H_9Br are possible?

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

14. How many constitutional isomers of $C_3H_6Cl_2$ are possible?

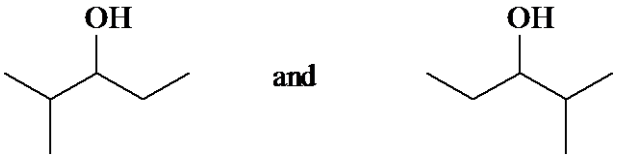
A. three
B. four
C. five
D. six

15. What is the formal charge on the carbon atom?



A. +1
B. 0
C. -1
D. -2

16. Which of the following describes the relationship between the following two structures?

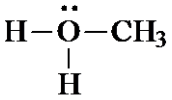


A. identical structures
B. resonance forms
C. constitutional isomers
D. different compounds with different compositions

17. Which of the following describes the relationship between the following two structures?

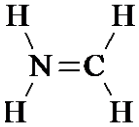
A. identical structures
B. resonance forms
C. constitutional isomers
D. different compounds with different compositions

18. What is the formal charge on the oxygen atom in the structure below?



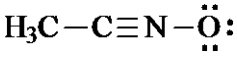
A. -1
B. 0
C. +1
D. +2

19. What is the formal charge on the nitrogen atom in the structure below?



A. -1
B. 0
C. +1
D. +2

20. The formal charges on the nitrogen and oxygen in the following structures are, respectively:



A. +1, -1
B. 0, -1
C. +1, 0
D. 0, 0

21. Identify the compound below which has a partial positive charge on the chlorine atom.

A. Cl-F
B. Cl_2
C. Cl-Br
D. Cl-I

22. Based on the VSEPR model, which of the following species has (have) a trigonal planar geometry?

I. BCl_3 II. NH_3 III. NO_3^-

A. only I
B. I and II
C. I and III
D. I, II, and III

23. Based on VSEPR theory, which of the following species has (have) a trigonal pyramidal geometry?

I. CO_3^{2-} II. NH_3 III. CH_3^+

A. only I
B. only II

C. I and II
D. II and III

24. Which of the following species has(have) a linear geometry?

I. CO_2 II. NO_2^+ III. NO_2^-

A. only I
B. only II
C. I and II
D. I, II, and III

25. Which of the following molecules would you expect to have a dipole moment?

I. CO_2 II. HCN III. $CHCl_3$

A. II and III
B. only II
C. only III
D. I, II, and III

26. Which of the following molecules would you expect to have a dipole moment?

I. CH_2Cl_2 II. CH_3Cl III. CCl_4

A. only I
B. only II
C. I and II
D. I, II, and III

27. The H-C-H bond angles in ethylene, C_2H_4, are closest to:

A. 90^o
B. 109.5^o
C. 120^o
D. 180^o

28. The C-C-C bond angle in propane, C_3H_8, is closest to:

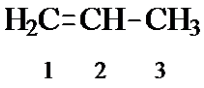
A. 90^o
B. 109.5^o
C. 120^o
D. 180^o

29. The C-C-C bond angle in propyne, shown below, is:

$H_3C-C\equiv CH$

A. 90^o
B. 109.5^o
C. 120^o
D. 180^o

30. The hybridization of carbon atoms 1, 2, and 3 in the following are, respectively:



A. sp, sp, and sp^2
B. sp, sp, and sp^3
C. sp^2, sp^2, and sp^3
D. sp^2, sp^3, and sp^3

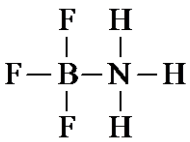
31. How many *pi* bonds are present in the following structure?

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

32. The carbon-carbon single bond in the following is formed by the overlap of which two orbitals?

A. sp-sp
B. sp^2-sp
C. sp^2-sp^2
D. sp^2-sp^3

33. What are the formal charges of boron and nitrogen, respectively, in the following structure?



A. -1 and +1
B. -1 and 0
C. 0 and +1
D. 0 and 0

34. Which one of the following is isoelectronic with CO_2?

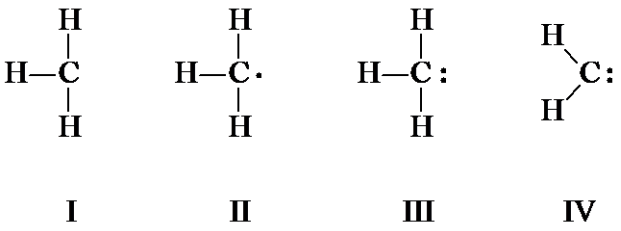
A. NO_2^-
B. NO_2^+
C. NO_2
D. O_3

35. In which of the following does hydrogen have a partial negative charge based on electronegativity?

A. BH_3
B. CH_4
C. NH_3

D. H_2O

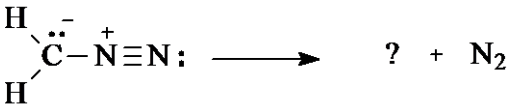
36. Which of the following species have a zero formal charge on its carbon atom?



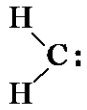
I II III IV

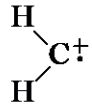
A. I and II
B. II and IV
C. III and IV
D. I, II, and III

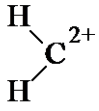
37. Which one of the following species is formed when diazomethane loses a nitrogen molecule?

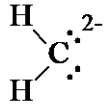


diazomethane

A) 

B) 

C) 

D) 

A. A

B. B
C. C
D. D

38. Which species is formed when the $CH_3N_2^+$ cation loses a nitrogen molecule?

A) $H_3C^{\oplus}$

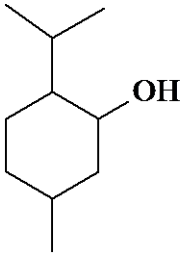
B) $H_2C:$

C) $H_3C^{\cdot}$

D) $H_3C:^{\ominus}$

A. A
B. B
C. C
D. D

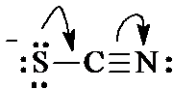
39. Give the molecular formula of the compound shown below:



menthol (found in mint oils)

A. $C_8H_{16}O$
B. $C_9H_{18}O$
C. $C_{10}H_{18}O$
D. $C_{10}H_{20}O$

40. The electron pair movement depicted below produces a second resonance form for the species. What is the formal charge on the nitrogen atom for this second resonance form?



A. -2
B. -1
C. 0
D. +1

41. Which statement correctly describes the structures of BH_3 and NH_3?

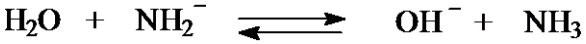
A. Both are trigonal and planar.
B. Both are pyramidal.
C. BH_3 is trigonal planar and NH_3 is trigonal pyramidal.

D. BH_3 is trigonal pyramidal and NH_3 is trigonal planar.

42. Which one of the following is the conjugate acid of ethanol?

A. $CH_3CH_2O^-$
B. $CH_3CH_2O^+$
C. $CH_3CH_2OH_2^+$
D. $CH_3CH_2OH_3^+$

43. In the equilibrium below, the strongest base is: (pK_a H_2O = 15.7, pK_a NH_3 = 36)



A) H_2O

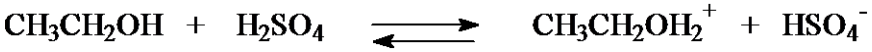
B) $NH_2^{\ominus}$

C) $OH^{\ominus}$

D) NH_3

A. A
B. B
C. C
D. D

44. In the equilibrium below, the strongest acid is:



A) H_2SO_4

B) CH_3CH_2OH

C) $HSO_4^{\ominus}$

D) $CH_3CH_2\overset{\oplus}{O}H_2$

A. A
B. B
C. C
D. D

45. Which one of the following is the strongest base?

A) 

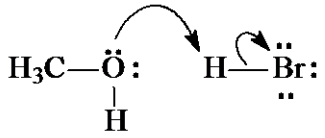
B) 

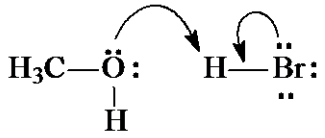
C) 

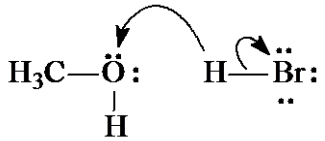
D) 

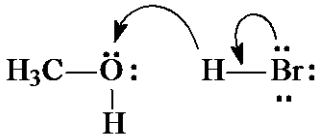
A. A
B. B
C. C
D. D

46. Which one of the following mechanistically depicts the protonation of methanol by hydrogen bromide?

A) 

B) 

C) 

D) 

A. A
B. B
C. C
D. D

47. Which one of the following is the strongest acid?

A. FCH_2CO_2H
B. $ClCH_2CO_2H$
C. $BrCH_2CO_2H$
D. ICH_2CO_2H

48. Which one of the following has the largest acid equilibrium constant, K_a?

A. CH_3CO_2H
B. CH_2ClCO_2H
C. $CHCl_2CO_2H$

D. CCl_3CO_2H

49. For which of the following does the equilibrium favor reactants.

A) $CH_3CH_2OH + NaNH_2 \rightleftharpoons CH_3CH_2ONa + NH_3$

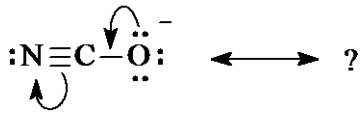
B) $CH_3CO_2H + NaOH \rightleftharpoons CH_3CO_2Na + H_2O$

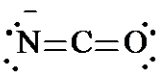
C) $HC{\equiv}CH + NaOH \rightleftharpoons HC{\equiv}CNa + H_2O$

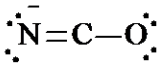
D) $HC{\equiv}CH + NaNH_2 \rightleftharpoons HC{\equiv}CNa + NH_3$

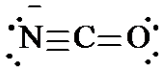
A. A
B. B
C. C
D. D

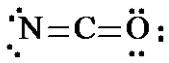
50. Identify the resonance structure which results from the following "electron pair movements".



A) 

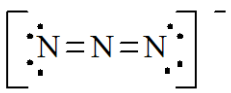
B) 

C) 

D) 

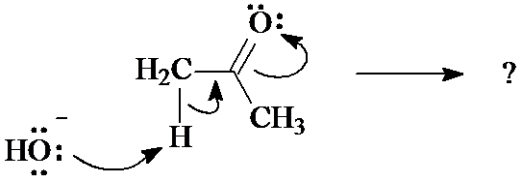
A. A
B. B
C. C
D. D

51. A Lewis structure of the azide ion, N_3^-, is shown below. The formal charge on the middle nitrogen atom is:



A. +2
B. +1
C. 0
D. -1

52. Identify the species which results from the following movement of electron pairs.



A) $H_2O + H_2C{=}C(:O:^-)-CH_3$

B) $H_2O + H_2C{=}C(=O)-CH_3$

C) $H_2C{=}C(:O:^-)(HO)-CH_3$

D) $H_2C(HO)-C(=O)-CH_3$

A. A
B. B
C. C
D. D

Structure and Properties KEY

1. C
2. B
3. B
4. A
5. D
6. C
7. B
8. C
9. C
10. D
11. C
12. A
13. D
14. B
15. C
16. A
17. B
18. C
19. C
20. A
21. A
22. C
23. B
24. C
25. A
26. C
27. C
28. B
29. D
30. C
31. C
32. B
33. A
34. B
35. A
36. B
37. A
38. A
39. D
40. B
41. C
42. C
43. B
44. A
45. A
46. A
47. A
48. D
49. C

50. A
51. B
52. A