

CHM 220 General Review for Covalent Bonding and Associated Topics

Electronegativity

1. Arrange the following elements in order of *increasing* electronegativity (least electronegative to most electronegative).

S Br F Na

- (A) Na<F<S<Br (B) Br<Na<S<F
 (C) Na<S<Br<F (D) Na<Br<F<S

2. Arrange the following elements in order of decreasing electronegativity.

O N C F S

- (A) F>O>N>C>S (B) F>N>O>S>C
 (C) O>S>F>N>C (D) F>O>N>S>C

3. Arrange the following elements in order of *increasing* electronegativity.

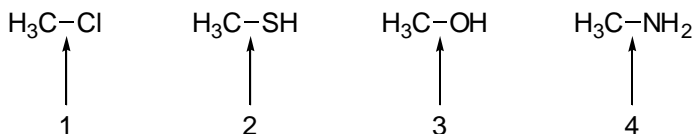
N S Li Si C

- (A) S<Si<Li<C<N (B) Li<Si<C<S<N
 (C) Si<C<Li<N<S (D) Li<C<N<S<Si

4. Which of the following molecules has the greatest difference in electronegativity between the two different elements?

(A) CO (B) CS₂ (C) H₂O (D) CN⁻

5. Arrange the following compounds in the order of *increasing* ionic character of the indicated bonds.



- (A) 1<2<4<3 (B) 2<4<1<3
 (C) 4<3<1<2 (D) 3<4<1<2

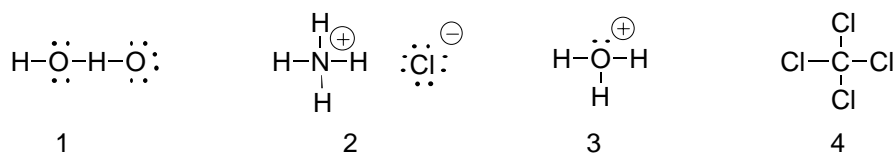
6. Which of the following compounds are nonpolar?

H₂O CO₂ NH₃ BF₃ CHCl₃
 1 2 3 4 5

- (A) 2&3 (B) 2&4
 (C) 1&3 (D) 3&4

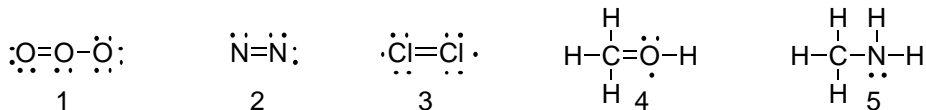
Lewis Structures

7. Which of the following Lewis structures are correct?



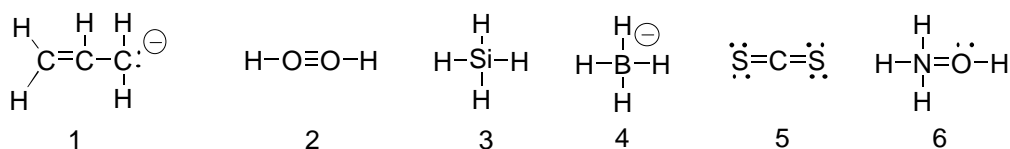
- | | |
|-------------|-------------|
| (A) 1, 2, 3 | (B) 1, 3, 4 |
| (C) 2, 3, 4 | (D) 1, 2, 4 |

8. Which of the following Lewis structures are incorrect?



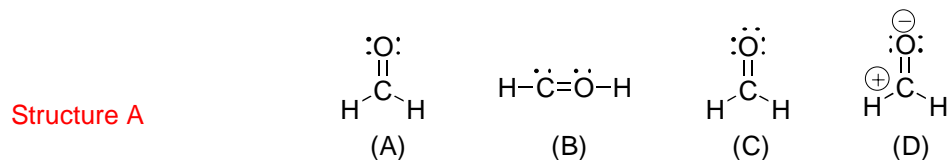
- | | |
|-------------|-------------|
| (A) 1, 2, 3 | (B) 1, 4, 5 |
| (C) 2, 3, 4 | (D) 3, 4, 5 |

9. Which of the following Lewis structures are correct?



- | | |
|-------------|----------------|
| (A) 2, 3, 4 | (B) 1, 3, 4, 5 |
| (C) 1, 2, 6 | (D) 3, 4, 5 |

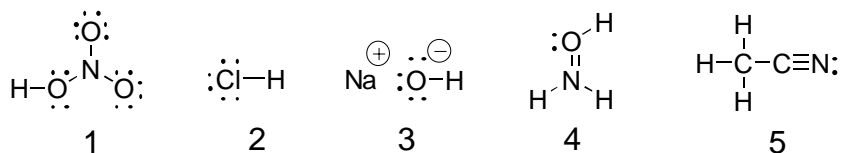
10. What is the correct Lewis structure for formaldehyde?



11. Which of the following are examples of electron configurations with completed outer shells?

- | | | | | | |
|-------------|-------------|-------------|---------------------|---------------------|---------------------|
| Sp
1 | $1s^2$
2 | $1s2s$
3 | $1s^22s^22p^2$
4 | $1s^22s^23s^2$
5 | $1s^22s^22p^6$
6 |
| (A) 1, 3, 4 | (B) 2, 4 | (C) 2, 6 | (D) 1, 4, 6 | | |

12. Which of the following Lewis structures are correct?



- | | |
|-------------|-------------|
| (A) 1, 2, 3 | (B) 1, 3, 4 |
| (C) 2, 4, 5 | (D) 2, 3, 5 |

Formal Charge

13. Carbon has a formal charge in which of the following compounds and ions?

- (A) CO_2 (B) CO_3^{-2}
(C) CS_2 (D) CF_3^+

14. Carbon has a formal charge in which of the following ions?

- (A) $[(\text{CH}_3)_4\text{N}]^+$ (B) $[\text{HCO}]^+$
(C) $[\text{CH}_3\text{CO}_2]^-$ (D) $[\text{CH}_3\text{OH}_2]^+$

15. Carbon has a formal charge in which of the following?

- (A) HCO_3^- (B) CH_3CO_2^-
(C) CH_3OH (D) LiCH_3

16. Nitrogen has a negative charge in which of the following compounds?

- (A) NaNH_2 (B) N_2
(C) NH_4Cl (D) HCN

Bond Angles and Geometry

17. Which of the following molecules have bond angles of about 109.5 degrees?

- | | | | | | |
|-----|---------------|----------------|-------------------|-----------------|-----------------|
| | CS_2 | BCl_3 | AlCl_4^- | NH_2^- | NH_4^+ |
| | 1 | 2 | 3 | 4 | 5 |
| (A) | 1, 2, 4 | | (B) 3, 4, 5 | | |
| (C) | 2, 3, 4 | | (D) 1, 3, 5 | | |

18. What is the bond angle for the indicated atom in the following molecules?

- | | | | | |
|-----|-----------------------|----------------------------------|--|--|
| | H_2CO | $\text{H}_2\text{C}=\text{CH}_2$ | $\text{H}_3\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$ | $\text{H}_3\text{C}-\text{C}=\text{NOH}$ |
| | ↑ | ↑ | ↑ | ↑ |
| | 1 | 2 | 3 | 4 |
| (A) | 109.5° | | (B) 180° | |
| (C) | 90° | | (D) 120° | |

19. Which of the following molecules have a tetrahedral shape?

- | | | | | | |
|-----|---------------|----------------------|------------------------|------------------------|----------------|
| | BH_3 | H_2O | H_3O^+ | NH_4Cl | CCl_4 |
| | 1 | 2 | 3 | 4 | 5 |
| (A) | 1, 3, 5 | | (B) 1, 2, 4, 5 | | |
| (C) | 3, 4, 5 | | (D) 2, 3, 5 | | |

20. What is the molecular geometry (shape) of NO_2^+ ?

- (A) tetrahedral (B) linear
(C) planar (D) trigonal

21 What is the geometry (shape) of CH_3^- ?

(A) tetrahedral

(B) linear

(C) planar

(D) trigonal

Functional Groups

22 Which of the following matches of names and molecules is correct?

A. ester

1. $\text{CH}_3\text{CO}_2\text{CH}_3$

B. alcohol

2. H_2CO

C. aldehyde

3. CH_3CHO

D. carboxylic acid

4. CH_3OH

(A) A&3, C&2

(B) B&2, D&1

(C) A&1, B&4

(D) C&3, D&4

23 Which of the following matches of names and molecules is correct?

A. alcohol

1. HCOOH

B. aldehyde

2. $(\text{CH}_3)_3\text{COH}$

C. ketone

3. CH_3OCH_3

D. carboxylic acid

4. CH_3COCH_3

(A) A&2, C&4

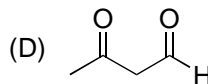
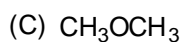
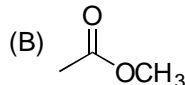
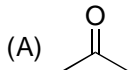
(B) B&2, D&1

(C) A&3, B&4

(D) C&3, D&4

24 Which of the following is an acid derivative?

(B) is an acid derivative



25 Which functional groups are in the following molecule?

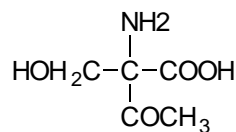
1. carboxylic acid

4. ester

2. alcohol

5. ketone

3. aldehyde



(A) 1, 2, 3

(B) 2, 3, 4

(C) 1, 3, 5

(D) 1, 2, 5

26 Which functional groups are in the following molecule (Penicillin G)?

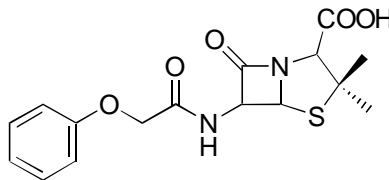
1. carboxylic acid

2. alcohol

3. aldehyde

4. ether

5. ketone



(A) 1, 4

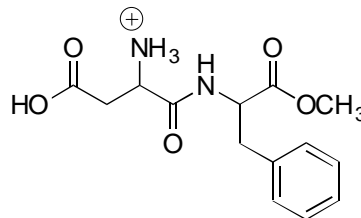
(B) 2, 3, 5

(C) 3, 4, 5

(D) 1, 4, 5

27. Which functional groups are in the following molecule (Nutrasweet™)?

1. carboxylic acid
2. alcohol
3. aldehyde
4. ether
5. ester
6. ketone



- (A) 1, 5
(C) 2, 4
- (B) 1, 4
(D) 3, 4

Constitutional Isomers

28. How many constitutional isomers are there for an alcohol having the molecular formula C_4H_9OH ?

- (A) 2
(C) 4
- (B) 3
(D) 5

29. How many different aldehydes or ketones can there be for compounds with the molecular formula C_3H_6O ?

- (A) 1
(C) 3
- (B) 2
(D) 4

30. How many constitutional isomers are possible for a compound having the molecular formula $C_4H_{10}O$?

- (A) 4
(C) 6
- (B) 5
(D) 7

31. Which of the following do not belong in the group of constitutional isomers?

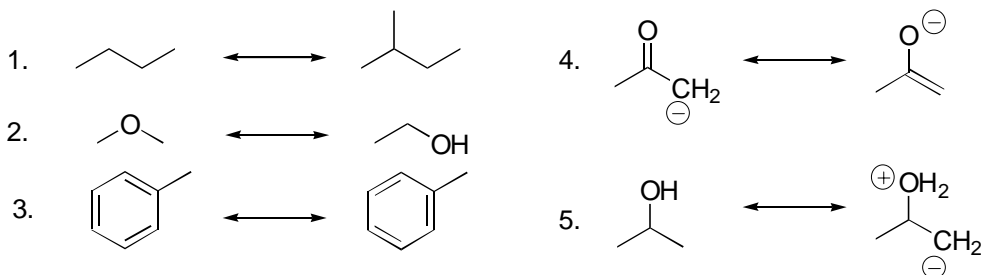
- (A)
- (B)
- (C)
- (D)

32. Which of the following do not belong in the group of constitutional isomers of C_5H_{10} ?

- 1
- 2
- 3
- 4
- 5
- (A) 1, 3, 4
(C) 1, 2, 4
- (B) 2, 4, 5
(D) 2, 3, 5

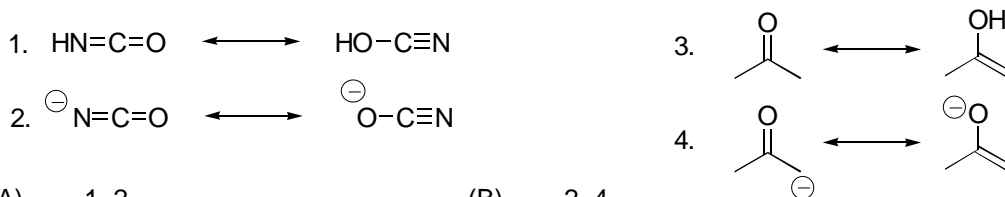
Resonance

33. Which of the following are contributing resonance structures?



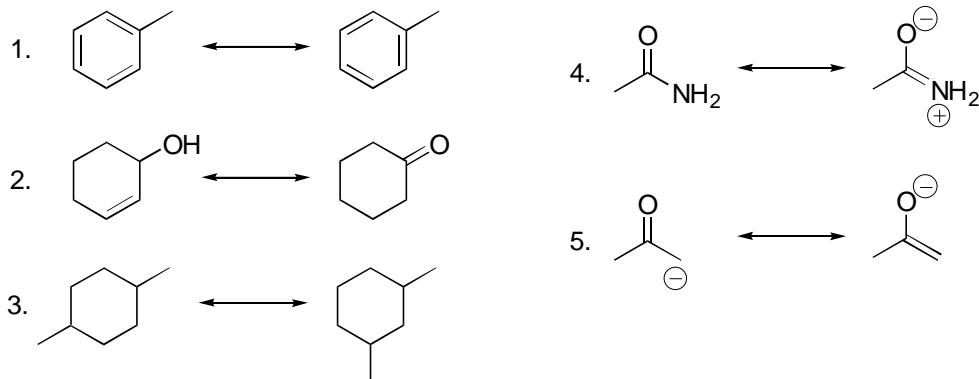
- | | |
|----------|----------|
| (A) 1, 2 | (B) 3, 4 |
| (C) 2, 5 | (D) 1, 3 |

34. Which of the following are not contributing resonance structures?



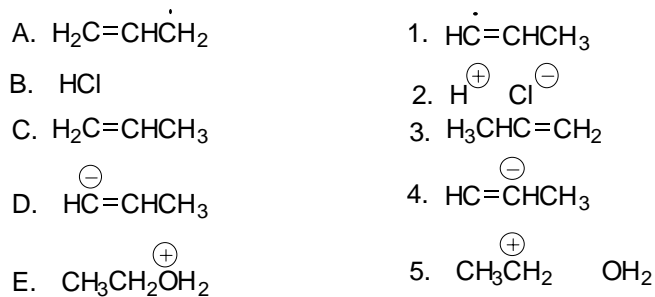
- | | |
|----------|----------|
| (A) 1, 2 | (B) 2, 4 |
| (C) 1, 3 | (D) 3, 4 |

35. Which of the following are contributing resonance structures?



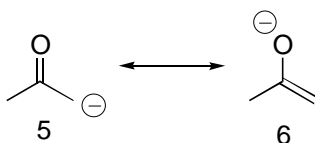
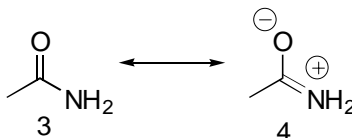
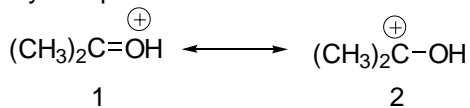
- | | |
|-------------|-------------|
| (A) 1, 4, 5 | (B) 2, 3, 5 |
| (C) 2, 3, 4 | (D) 1, 2, 3 |

36. Which of the following pairs are contributing resonance structures?



- | | |
|----------------------|----------------------|
| (A) A and 1, B and 2 | (B) C and 3, D and 4 |
| (C) A and 4, D and 1 | (D) B and 2, E and 5 |

37. Contributing resonance structures can have different energies, and the structure that has the lowest energy is the most important. In the following pairs of resonance structures, which structure makes the greater contribution? (Can you explain why and put in the arrows that show the electron movements?)



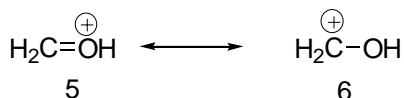
(A) 1, 3, 5

(B) 2, 4, 6

(C) 2, 3, 6

(D) 1, 3, 6

38. In each pair of contributing structures, which structure makes the greater contribution? (Can you explain why and put in the arrows that show the electron movements?)



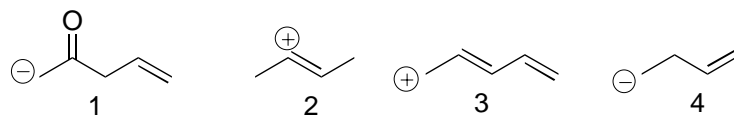
(A) 1, 3, 4

(B) 2, 4, 6

(C) 1, 4, 5

(D) 2, 3, 6

39. Which of the following ions are stabilized by resonance?



(A) 1, 2

(B) 1, 3

(C) 2, 4

(D) 3, 4

Orbitals and Hybridization

40. What is the order of increasing energy for the following orbitals?

1. sp^3 2. sp^2 3. sp 4. s 5. p

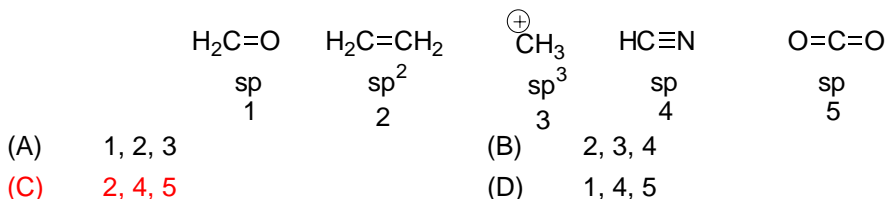
(A) 5, 3, 2, 1, 4

(B) 4, 5, 3, 2, 1

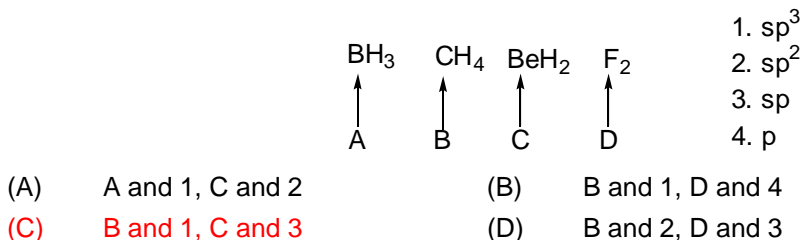
(C) 1, 2, 3, 4, 5

(D) 4, 3, 2, 1, 5

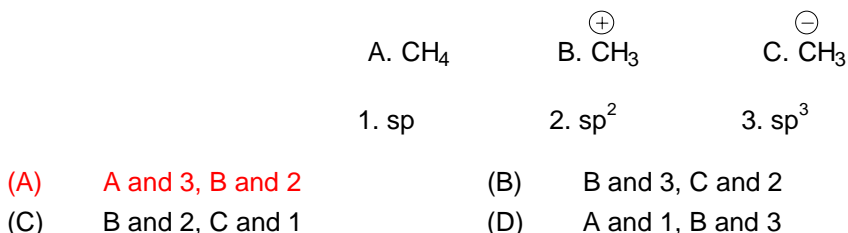
41. Which are the correct orbital hybridizations for the carbon atoms in the following structures?



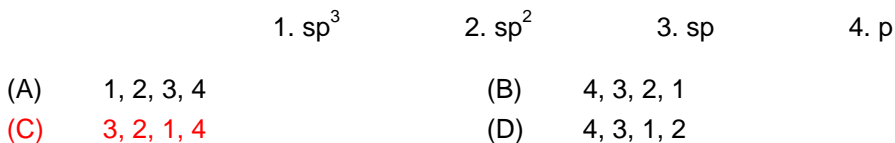
42. What are the correct orbital descriptions for the indicated atoms?



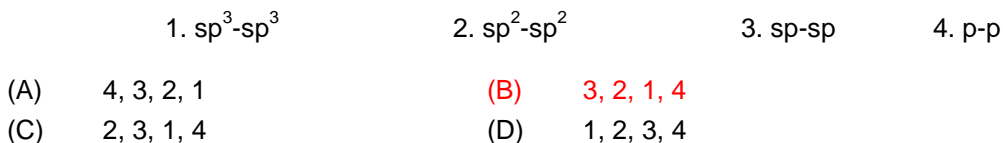
43. What are the correct orbital hybridizations for carbon in the following?



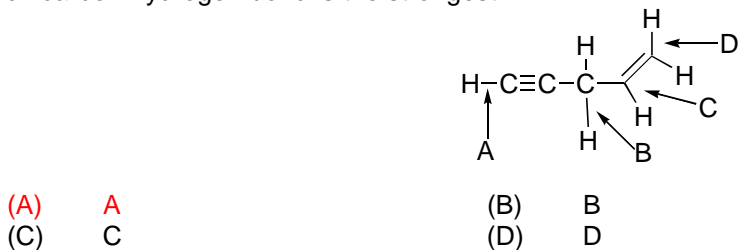
44. When forming molecular orbitals from the following atomic orbitals, what is the order of decreasing strength for the resulting bond (strongest first)?



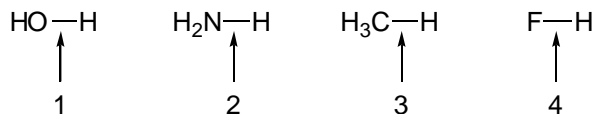
45. What is the order of increasing bond length (shortest and strongest first) derived from the following molecule orbitals?



46. Which carbon-hydrogen bond is the strongest?



47. Arrange the following in decreasing order of s character for the indicated bonds.



(A) 3, 2, 1, 4

(B) 4, 3, 2, 1

(C) 1, 2, 3, 4

(D) 4, 1, 2, 3

48. What is the hybridization of the carbon-hydrogen bond in the methyl cation (⁺CH₃)?

(A) sp³

(B) sp²

(C) sp

(D) p

49. What is the hybridization of the boron in BH₄⁻?

(A) sp³

(B) sp²

(C) sp

(D) p

50. What orbitals are overlapping to form the nitrogen-boron bond in H₃N-BF₃?

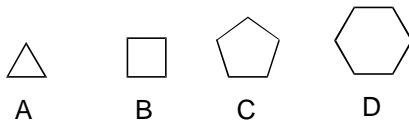
(A) p-sp³

(B) sp³-sp²

(C) sp³-sp³

(D) p-p

51. Which compound has the most s character in the carbon-hydrogen bond?



(A) A

(B) B

(C) C

(D) D