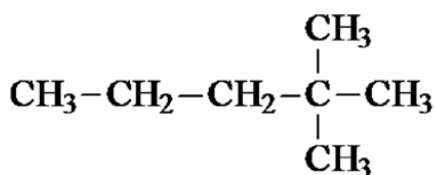


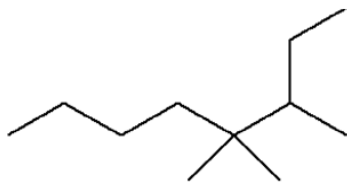
## Chapter 2: Hydrocarbon Frameworks – Alkanes

- Alkanes are characterized by the general molecular formula:  
A)  $C_nH_{2n-2}$  B)  $C_nH_{2n}$  C)  $C_nH_{2n+2}$  D)  $C_nH_{2n+4}$   
Ans: C
- Cycloalkanes are characterized by the general molecular formula:  
A)  $C_nH_{2n-2}$  B)  $C_nH_{2n}$  C)  $C_nH_{2n+2}$  D)  $C_nH_{2n+4}$   
Ans: B
- The carbon-carbon sigma bond in ethane is formed by overlap of which two orbitals?  
A) 2p-2p B) sp-sp C)  $sp^2-sp^2$  D)  $sp^3-sp^3$   
Ans: D
- What is the IUPAC name of the following compound?



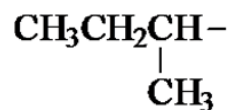
- |                        |                          |
|------------------------|--------------------------|
| A) 4,4-dimethylpentane | C) 2,2-dimethylpentane   |
| B) 1-tert-butylpropane | D) 1,1,1-trimethylbutane |
- Ans: C

- The correct IUPAC name of the following compound is



- |                                 |                           |
|---------------------------------|---------------------------|
| A) 2-ethyl-3,5-dimethylheptane. | C) 3,4,4-trimethyloctane. |
| B) 6-ethyl-5,5-dimethylheptane. | D) 5,5,6-trimethyloctane. |
- Ans: C

6. The common name of the following group is



A) *n*-butyl. B) *sec*-butyl. C) isobutyl. D) *tert*-butyl.

Ans: B

7. Which one of the following is 2,2,5-trimethylhexane?

A)  $(\text{CH}_3)_2\text{CHCH}_2\text{C}(\text{CH}_3)_3$

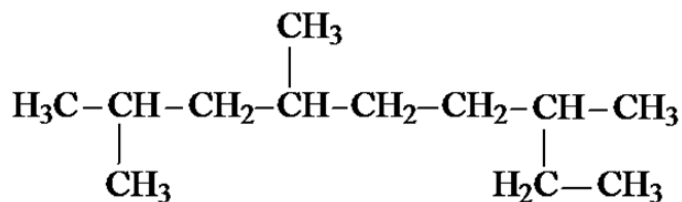
C)  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{C}(\text{CH}_3)_3$

B)  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{C}(\text{CH}_3)_3$

D)  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{CH}_2\text{C}(\text{CH}_3)_3$

Ans: B

8. The correct IUPAC name of the following is



A) 2,4,7-trimethylnonane.

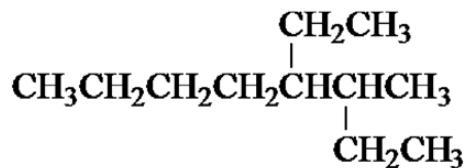
C) 7-ethyl-2,4-dimethyloctane.

B) 3,6,8-trimethylnonane.

D) 2-ethyl-5,7-dimethyloctane.

Ans: A

9. What is the IUPAC name of the following?



A) 5,6-diethylhexane

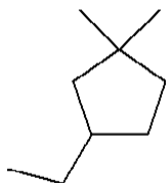
C) 5-ethyl-6-methylheptane

B) 2,3-diethylhexane

D) 4-ethyl-3-methylheptane

Ans: D

10. What is the IUPAC name of the following?



- A) 1-ethyl-4,4-dimethylcyclopentane      C) 3-ethyl-1,1-dimethylcyclopentane  
 B) 1-ethyl-3,3-dimethylcyclopentane      D) 4-ethyl-1,1-dimethylcyclopentane

Ans: C

11. Cyclohexane is composed of

- A) methine groups.      C) methyl groups.  
 B) methylene groups.      D) both methine and methylene groups.

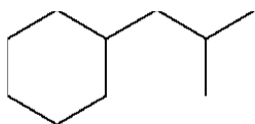
Ans: B

12. All the carbons in cyclopentane are

- A) primary carbons.      C) tertiary carbons.  
 B) secondary carbons.      D) quaternary carbons.

Ans: B

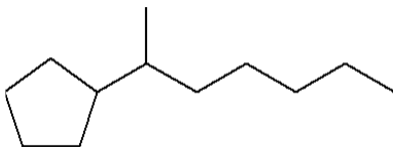
13. The correct name of the following compound is



- A) (1-methylpropyl)cyclohexane.      C) (2,2-dimethylethyl)cyclohexane.  
 B) (2-methylpropyl)cyclohexane.      D) (2,2-dimethylpropyl)cyclohexane.

Ans: B

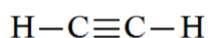
14. The correct IUPAC name of the following compound is



- A) (1-methylhexyl)cyclopentane.      C) 2-cyclopentylheptane.  
 B) (1-pentylethyl)cyclopentane.      D) 1-cyclopentyl-2-heptane.

Ans: C

15. The C—C sigma bond in acetylene is formed by the overlap of which two orbitals?



- A) 2p-2p    B) sp-sp    C) sp<sup>2</sup>-sp<sup>2</sup>    D) sp<sup>3</sup>-sp<sup>3</sup>

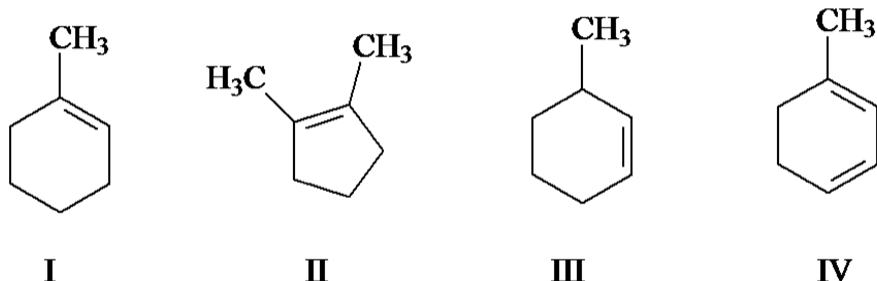
Ans: B

16. The boiling point of isobutane ( $-10.2^{\circ}\text{C}$ ) is lower than *n*-butane ( $-0.4^{\circ}\text{C}$ ) because isobutane has

- A) weaker intermolecular van der Waals forces.  
 B) stronger intermolecular van der Waals forces.  
 C) weaker dipole-dipole attractive forces.  
 D) stronger dipole-dipole attractive forces.

Ans: A

17. Which of the following are constitutional isomers?



- A) I, II, and III  
 B) I, III, and IV  
 C) only I and III  
 D) all are constitutional isomers

Ans: A

18. Arrange the following isomeric alkanes in order of increasing boiling point.

- I. *n*-heptane  
 II. 2,3-dimethylpentane  
 III. 2,2,3-trimethylbutane

- A) I < II < III    B) II < III < I    C) III < I < II    D) III < II < I

Ans: D

19. The oxidation states of carbon range from

- A) 0 to +2.    B) 0 to +4.    C) -4 to 0.    D) -4 to +4.

Ans: D

20. Which of the following has(have) a higher oxidation state of carbon than the carbon in formaldehyde,  $\text{H}_2\text{C}=\text{O}$ ?

- I.  $\text{CH}_3\text{OH}$   
 II.  $\text{HCO}_2\text{H}$   
 III.  $\text{H}_2\text{CO}_3$

- A) I    B) III    C) II and III    D) I, II, and III

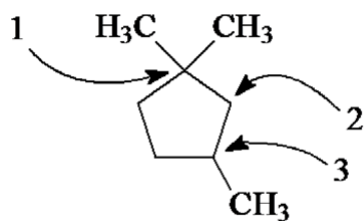
Ans: C

21. The *tert*-butyl group can also be called

- A) 1,1-dimethylpropyl.    C) 2,2-dimethylpropyl.  
 B) 1,1-dimethylethyl.    D) 2,2-dimethylethyl.

Ans: B

22. Carbon atoms 1, 2, and 3 in the following structure are classified, respectively, as



- A) tertiary, primary, secondary.      C) quaternary, secondary, secondary.  
 B) quaternary, primary, tertiary.      D) quaternary, secondary, tertiary.

Ans: D

23. Identify the isomer of  $C_6H_{14}$  that only has primary and tertiary carbons.

- A) hexane  
 B) 2,2-dimethylbutane  
 C) 3-methylpentane  
 D) 2,3-dimethylbutane

Ans: D

24. Why can heats of combustion of constitutional isomers of hydrocarbons be used to measure their stabilities?

- I. Combustion of constitutional isomers gives different final states.  
 II. Combustion of constitutional isomers gives the same final states.  
 III. Constitutional isomers of hydrocarbons have the same potential energies.  
 IV. Constitutional isomers of hydrocarbons have different potential energies.

- A) only I    B) only II    C) I and III    D) II and IV

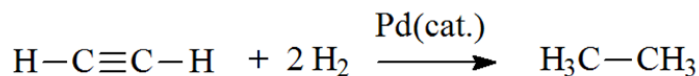
Ans: D

25. The heats of combustion ( $-\Delta H^\circ$ ) of heptane and 3,3-dimethylpentane are 4,817 and 4,809 kJ/mol, respectively. Which statement is true?

- A) Heptane is 8 kJ/mol more stable than 3,3-dimethylpentane.  
 B) 3,3-Dimethylpentane is 8 kJ/mol more stable than heptane.  
 C) Stabilities cannot be compared since they are not isomers.  
 D) Stabilities cannot be compared since they give different combustion products.

Ans: B

26. The reaction of acetylene with hydrogen gas is shown below. Which statements are true concerning the reaction?



- I. Acetylene is oxidized to ethane.  
 II. Acetylene is reduced to ethane.  
 III. Carbon changes oxidation state from -1 to -3.  
 IV. Hydrogen (from  $\text{H}_2$ ) changes oxidation state from 0 to +1.  
 A) I and III   B) II and IV   C) I, III, and IV   D) II, III, and IV  
 Ans: D

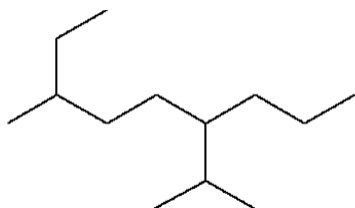
27. How many methine groups are there in isopropylcyclopentane?

- A) one   B) two   C) three   D) four  
 Ans: B

28. What is the total number of constitutional isomers with the formula  $\text{C}_5\text{H}_{12}$ ?

- A) two   B) three   C) four   D) five  
 Ans: B

29. What is the IUPAC name of the following?

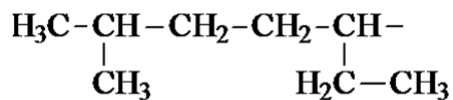


- A) 6-isopropyl-3-methylnonane                      C) 2-ethyl-5-isopropyloctane  
 B) 6-propyl-3-methylnonane                      D) 2-ethyl-5-propyloctane  
 Ans: A

30. How many moles of  $\text{O}_2$  gas would be consumed in the complete combustion of 0.100 mole of  $\text{C}_5\text{H}_{12}$ ?

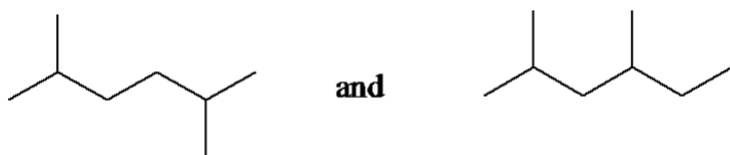
- A) 0.100 mole  $\text{O}_2$    B) 0.400 mole  $\text{O}_2$    C) 0.800 mole  $\text{O}_2$    D) 1.60 mole  $\text{O}_2$   
 Ans: C

31. The systematic name of the following group is



- A) 5-ethyl-2-methylpentyl.                      C) 6-methyl-3-heptyl.  
 B) 1-ethyl-4-methylpentyl.                      D) 2-methyl-5-heptyl.  
 Ans: B

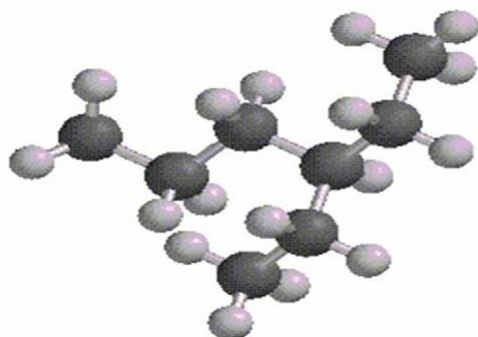
32. What is the relationship between the two structures below?



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

Ans: C

33. What is the IUPAC name of the following structure?



- A) 3-propylpentane
- B) 3-ethylhexane
- C) 2-ethylheptane
- D) 4-ethylpentane

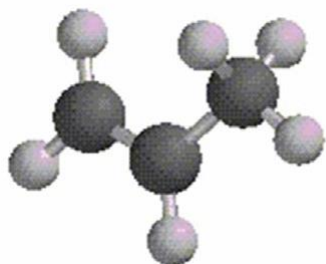
Ans: B

34. Which of the following are constitutional isomers?

- I. 2,3,3-dimethylhexane
  - II. 2,2-diethylpentane
  - III. 3-ethyl-2-methylheptane
- A) I and II   B) I and III   C) II and III   D) they are all constitutional isomers

Ans: A

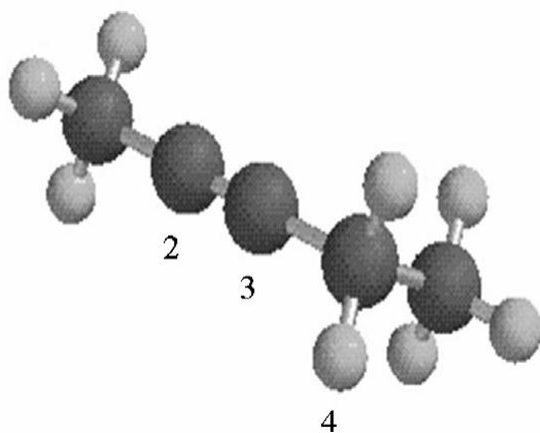
35. What is the estimated C—C—C bond angle in the following model?



A)  $90^\circ$  B)  $109.5^\circ$  C)  $120^\circ$  D)  $180^\circ$

Ans: C

36. What are the hybridizations of carbon atoms 2, 3, and 4 shown in the model below?



A)  $sp, sp^2, sp^2$  B)  $sp, sp^2, sp^3$  C)  $sp, sp, sp^2$  D)  $sp, sp, sp^3$

Ans: D

37. Arrange the following hydrocarbons in order of increasing boiling point.

I. pentane

II. 2,2-dimethylpropane

III. 2-methylbutane

A)  $I < II < III$  B)  $I < III < II$  C)  $II < I < III$  D)  $II < III < I$

Ans: D

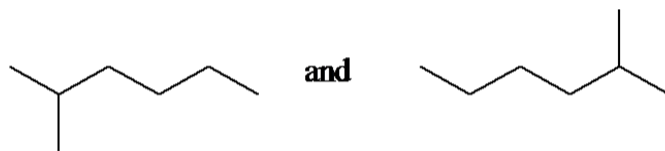
38. The 1,1-dimethylethyl group,  $-C(CH_3)_3$ , can also be called

A) butyl. B) isobutyl. C) *sec*-butyl. D) *tert*-butyl.

Ans: D



39. What is the relationship between the following two structures?



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

Ans: A

40. The  $sp^3$  orbitals of carbon in  $CH_4$  are formed from the

- A) three 2p orbitals.
- B) 2s and one of the 2p orbitals.
- C) 2s and two of the 2p orbitals.
- D) 2s and the three 2p orbitals.

Ans: D

41. The geometry of  $sp^3$  hybrid orbitals can be described as pointing towards the corners of a

- A) triangle.
- B) square.
- C) tetrahedron.
- D) square pyramid.

Ans: C

42. What is the Cl—C—Cl bond angle in  $CCl_4$ ?

- A)  $60^\circ$
- B)  $90^\circ$
- C)  $109.5^\circ$
- D)  $120^\circ$

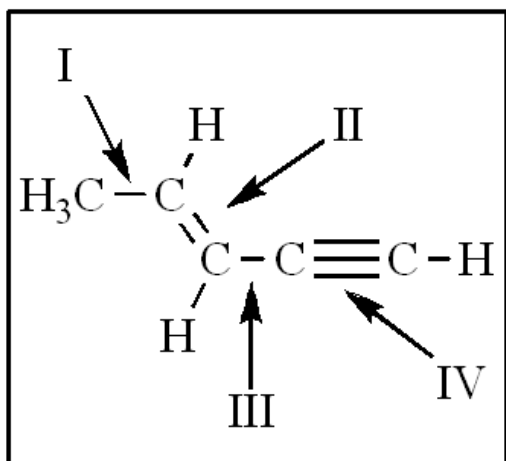
Ans: C

43. Which of the following has the lowest boiling point?

- A) pentane
- B) 2,2-dimethylpropane
- C) 2-methylbutane
- D) hexane

Ans: B

44. The shortest and longest carbon-carbon bonds, respectively, in this molecule are:

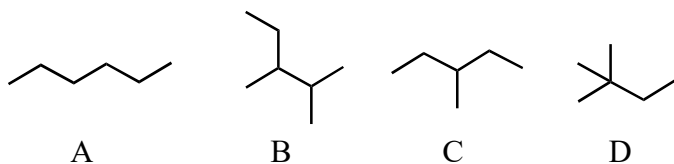


- A) II and III    B) IV and III    C) I and IV    D) IV and I  
 Ans: D

45. How many isomers of C<sub>6</sub>H<sub>14</sub> are possible?

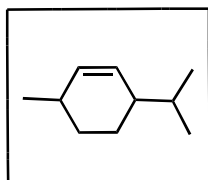
- A) four    B) five    C) six    D) seven  
 Ans: B

46. Which of the molecules below is NOT an isomer of formula C<sub>6</sub>H<sub>14</sub>?



- A) A    B) B    C) C    D) D  
 Ans: B

47. What is the molecular formula of methane?



- A) C<sub>10</sub>H<sub>16</sub>    B) C<sub>10</sub>H<sub>18</sub>    C) C<sub>10</sub>H<sub>19</sub>    D) C<sub>10</sub>H<sub>20</sub>  
 Ans: B

48. How many isomers of C<sub>4</sub>H<sub>9</sub>Cl are possible?

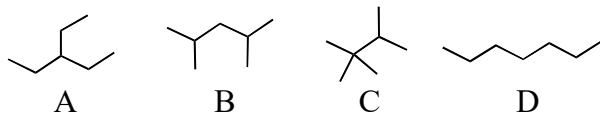
- A) two    B) three    C) four    D) five  
 Ans: C

49. The smallest straight-chain alkane that is liquid at room temperature and atmospheric pressure is

- A) propane. B) butane. C) pentane. D) hexane.

Ans: C

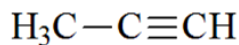
50. The lowest-boiling isomer of  $C_7H_{16}$  would be



- A) A. B) B. C) C. D) D.

Ans: C

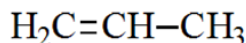
51. The C—C—C bond angle in propyne, shown below, is



- A)  $90^\circ$ . B)  $109.5^\circ$ . C)  $120^\circ$ . D)  $180^\circ$ .

Ans: D

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

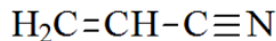


1    2    3

- A)  $sp$ ,  $sp$ , and  $sp^2$ .                      C)  $sp^2$ ,  $sp^2$ , and  $sp^3$ .  
 B)  $sp$ ,  $sp$ , and  $sp^3$ .                        D)  $sp^2$ ,  $sp^3$ , and  $sp^3$ .

Ans: C

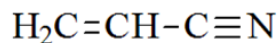
53. How many  $\pi$  bonds are present in the following structure?



- A) one B) two C) three D) four

Ans: C

54. 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)  $sp^2-sp^3$

Ans: B