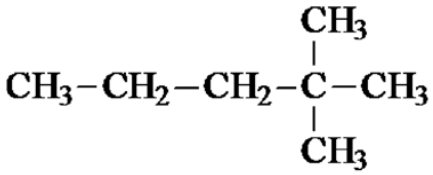
Chapter 2: Hydrocarbon Frameworks – Alkanes

1. 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

2. 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

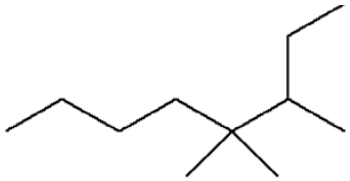
3. The carbon-carbon sigma bond in ethane is formed by overlap of which two orbitals?
   A) 2p-2p B) sp-sp C) sp^2-sp^2 D) sp^3-sp^3
   Ans: D

4. What is the IUPAC name of the following compound?



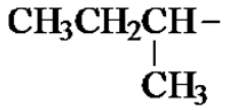
   A) 4,4-dimethylpentane
   B) 1-tert-butylpropane
   C) 2,2-dimethylpentane
   D) 1,1,1-trimethylbutane
   Ans: C

5. The correct IUPAC name of the following compound is



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

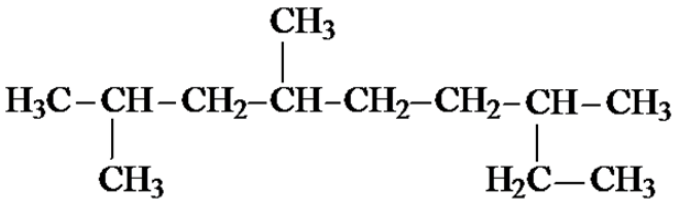
6. The common name of the following group is



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

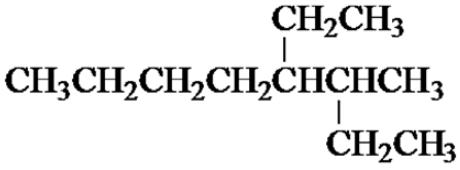
7. Which one of the following is 2,2,5-trimethylhexane?
A) $(CH_3)_2CHCH_2C(CH_3)_3$ C) $CH_3CH_2CH(CH_3)C(CH_3)_3$
B) $(CH_3)_2CHCH_2CH_2C(CH_3)_3$ D) $(CH_3)_2CHCH_2\ CH_2CH_2C(CH_3)_3$
Ans: B

8. The correct IUPAC name of the following is



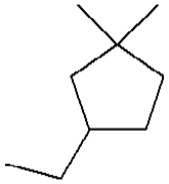
A) 2,4,7-trimethylnonane. C) 7-ethyl-2,4-dimethyloctane.
B) 3,6,8-trimethylnonane. D) 2-ethyl-5,7-dimethyloctane.
Ans: A

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?

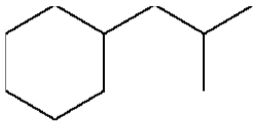


A) 1-ethyl-4.4-dimethylcyclopentane
B) 1-ethyl-3,3-dimethylcyclopentane
C) 3-ethyl-1,1-dimethylcyclopentane
D) 4-ethyl-1,1-dimethylcyclopentane
Ans: C

11. Cyclohexane is composed of
A) methine groups.
B) methylene groups.
C) methyl groups.
D) both methine and methylene groups.
Ans: B

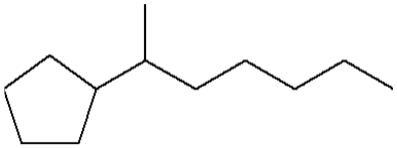
12. All the carbons in cyclopentane are
A) primary carbons.
B) secondary carbons.
C) tertiary carbons.
D) quaternary carbons.
Ans: B

13. The correct name of the following compound is



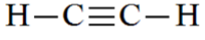
A) (1-methylpropyl)cyclohexane.
B) (2-methylpropyl)cyclohexane.
C) (2,2-dimethylethyl)cyclohexane.
D) (2,2-dimethylpropyl)cyclohexane.
Ans: B

14. The correct IUPAC name of the following compound is



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

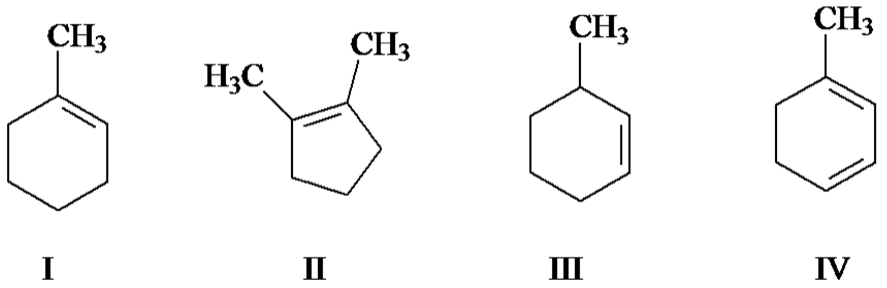
15. The C—C sigma bond in acetylene is formed by the overlap of which two orbitals?



A) 2p-2p B) sp-sp C) sp^2-sp^2 D) sp^3-sp^3
Ans: B

16. The boiling point of isobutane (-10.2°C) is lower than *n*-butane (-0.4°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?



I **II** **III** **IV**

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

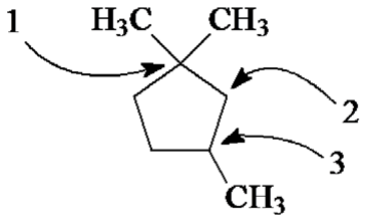
18. Arrange the following isomeric alkanes in order of increasing boiling point.
    I. *n*-heptane
    II. 2,3-dimethylpentane
    III. 2,2,3-trimethylbutane
    A) I < II < III B) II < III < I C) III < I < II D) III < II < I
    Ans: D

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, $H_2C{=}O$?
    I. CH_3OH
    II. HCO_2H
    III. H_2CO_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.
    B) 1,1-dimethylethyl.
    C) 2,2-dimethylpropyl.
    D) 2,2-dimethylethyl.
    Ans: B

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



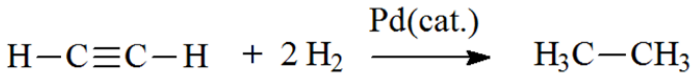
A) tertiary, primary, secondary.
B) quaternary, primary, tertiary.
C) quaternary, secondary, secondary.
D) quaternary, secondary, tertiary.
Ans: D

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-dimethypentane are 4,817 and 4,809 kJ/mol, respectively. Which statement is true?
A) Heptane is 8 kJ/mol more stable then 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?

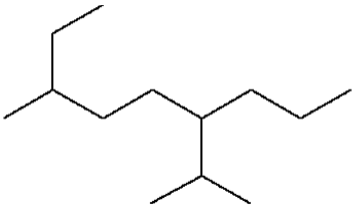


I. Acetylene is oxidized to ethane.
II. Acetylene is reduced to ethane.
III. Carbon changes oxidation state from -1 to -3.
IV. Hydrogen (from H_2) changes oxidation state from 0 to +1.
A) I and III B) II and IV C) I, III, and IV D) II, III, and IV
Ans: D

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 C_5H_{12}?
A) two B) three C) four D) five
Ans: B

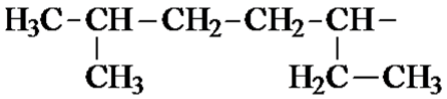
29. What is the IUPAC name of the following?



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

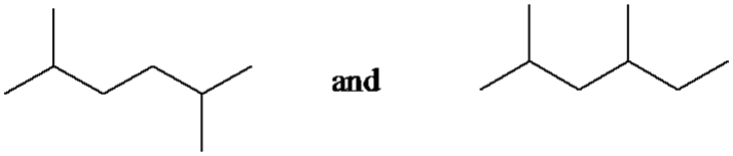
30. How many moles of O_2 gas would be consumed in the complete combustion of 0.100 mole of C_5H_{12}?
A) 0.100 mole O_2 B) 0.400 mole O_2 C) 0.800 mole O_2 D) 1.60 mole O_2
Ans: C

31. The systematic name of the following group is



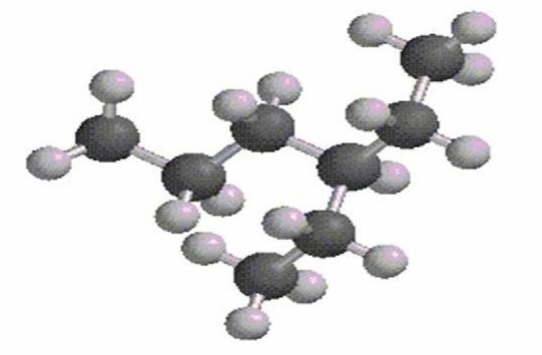
A) 5-ethyl-2-methylpentyl.
B) 1-ethyl-4-methylpentyl.
C) 6-methyl-3-heptyl.
D) 2-methyl-5-heptyl.
Ans: B

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

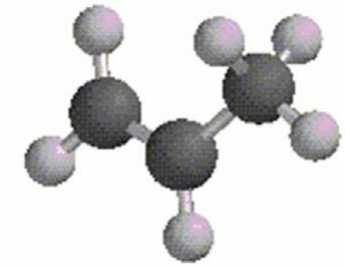
33. What is the IUPAC name of the following structure?



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

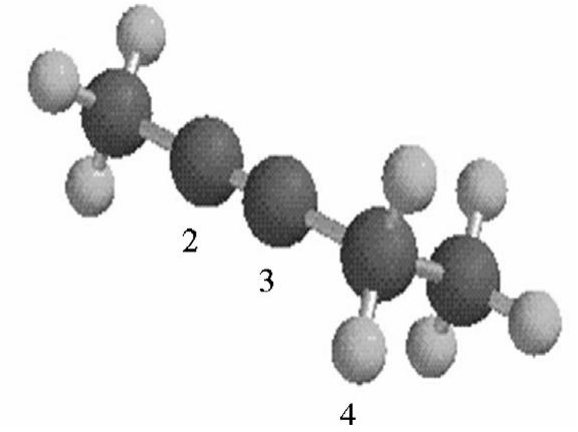
34. Which of the following are constitutional isomers?
I. 2,3,3-dimethylhexane
II. 2,2-diethylpentane
III. 3-ethyl-2-methylheptane
A) I and II B) I and III C) II and III D) they are all constitutional isomers
Ans: A

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



A) 90° B) 109.5° C) 120° D) 180°
Ans: C

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

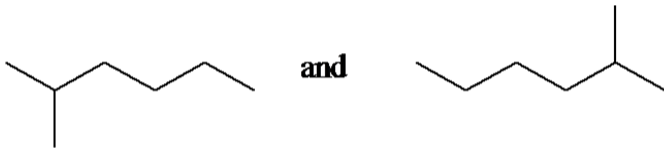


A) sp, sp^2, sp^2 B) sp, sp^2, sp^3 C) sp, sp, sp^2 D) sp, sp, sp^3
Ans: D

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

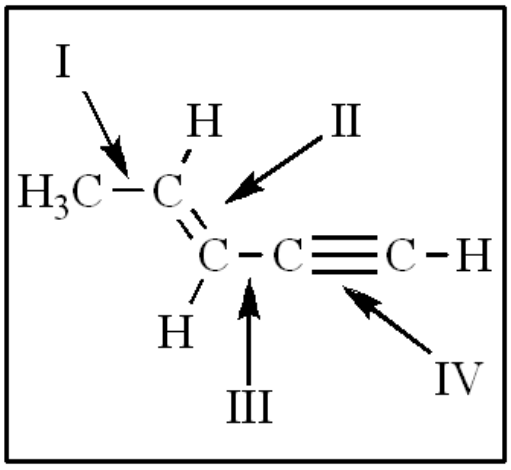
40. The sp^3 orbitals of carbon in CH_4 are formed from the
A) three 2p orbitals.
B) 2s and one of the 2p orbitals.
C) 2s and two of the 2p orbitals.
D) 2s and the three 2p orbitals.
Ans: D

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^o B) 90^o C) 109.5^o D) 120^o
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

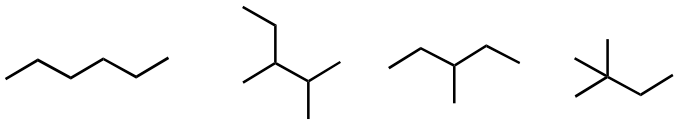
44. The shortest and longest carbon-carbon bonds, respectively, in this molecule are:



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

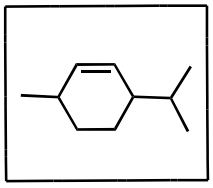
45. How many isomers of C_6H_{14} are possible?
A) four B) five C) six D) seven
Ans: B

46. Which of the molecules below is NOT an isomer of formula C_6H_{14}?



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

47. What is the molecular formula of methane?

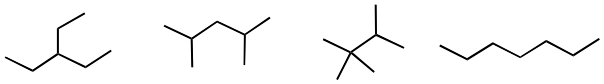


A) $C_{10}H_{16}$ B) $C_{10}H_{18}$ C) $C_{10}H_{19}$ D) $C_{10}H_{20}$
Ans: B

48. How many isomers of C_4H_9Cl are possible?
A) two B) three C) four D) five
Ans: C

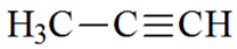
49. The smallest straight-chain alkane that is liquid at room temperature and atmospheric pressure is
A) propane. B) butane. C) pentane. D) hexane.
Ans: C

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



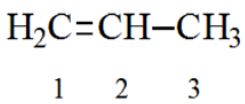
A B C D
A) A. B) B. C) C. D) D.
Ans: C

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



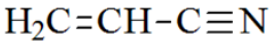
A) 90°. B) 109.5°. C) 120°. D) 180°.
Ans: D

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



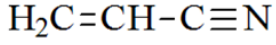
A) sp, sp, and sp^2.
B) sp, sp, and sp^3.
C) sp^2, sp^2, and sp^3.
D) sp^2, sp^3, and sp^3.
Ans: C

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