3. (a) H_2O, NH_3, CH_4
   (b) Water and ammonia are mutually soluble, methane is not soluble in the other two; electronegativity values of O, N, C, and H are 3.5, 3.0, 2.5, and 2.1, respectively. Thus, the O–H and N–H bonds in water and in ammonia are more polar than C–H bonds in methane. The polar bonds in water and ammonia allow them to form hydrogen bonds; thus, they are soluble in each other.
   (c) All three compounds are produced by living organisms (e.g., water by animals and plants, ammonia and methane by bacteria) and may be considered “organic” by the definition that a substance is organic if produced by a living organism. By the chemical definition of “organic” being compounds of carbon, only methane is organic.

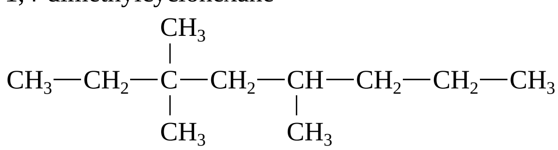
1.2 HYDROCARBONS

PRACTICE

(Page 15)

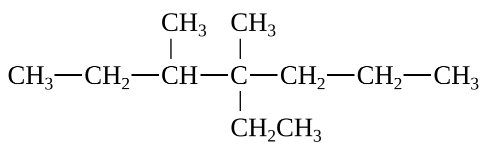
Understanding Concepts

1. (a) 4-ethyl-2,3,5-trimethylheptane
   (b) 3,7-dimethylnonane
   (c) 3,5,7-trimethyldecane
   (d) 1,4-dimethylcyclohexane
2. (a)



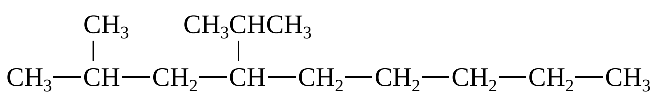
3,3,5-trimethyloctane

   (b)



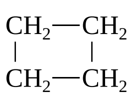
3,4-dimethyl-4-ethylheptane

   (c)



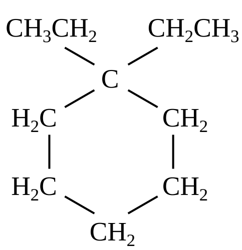
2-methyl-4-isopropylnonane

   (d)



cyclobutane

   (e)



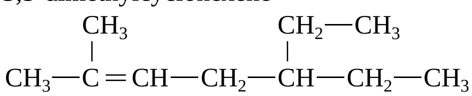
1,1-diethylcyclohexane

PRACTICE

(Page 18)

Understanding Concepts

3. There is only one possible molecular structure for ethene and propene; the double bond in ethene can only be between the 2 C atoms, and the double bond in propene may be between C-1 and C-2, or between C-2 and C-3, both resulting in the same molecule.
4. The IUPAC name is ethyne; the common name is acetylene.
5. (a) 5-ethyl-4-methyl-2-heptyne
   (b) 3-ethyl-2-hexene
   (c) 1,4,7-nonatriene
   (d) 5-methyl-1,3-octadiene
   (e) 3,5-dimethylcyclohexene
6. (a)

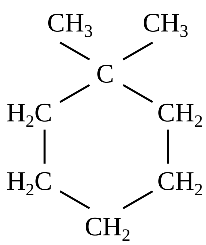


2-methyl-5-ethyl-2-heptene

(b) $CH_2{=}CH{-}CH{=}CH{-}CH{=}CH_2$

1,3,5-hexatriene

(c)

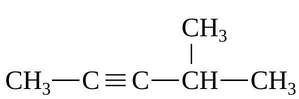


3,4-dimethylcyclohexene

(d) $CH{\equiv}C{-}CH_2{-}CH_3$

1-butyne

(e)



4-methyl-2-pentyne

Try This Activity: Building Hydrocarbons

(Page 20)

(a) (Answers should include straight and branched chain alkanes with 6 carbons, such as hexane, 2-methylpentane, 3-methylpentane, 2,3-dimethylbutane, 2,2-dimethylbutane.)
(b) (Answers should include straight and branched chain alkenes with 6 carbons and 1 double bond, and cycloalkanes with a total of 6 carbons, such as hexene; 2-methyl-1-pentene, 3-methyl-2-pentene; 2,4-dimethyl-2-butene; 2,3-dimethyl-1-butene; cyclohexane; methylpentane.)
(c) (Answers should show an increasing number of double bonds or triple bonds.)
(d) All the molecules in (a) are structural isomers, all in (b) are structural isomers, etc. Geometric isomers are also possible — *cis*- or *trans*- about a double bond.

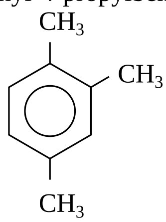
PRACTICE

(Page 21)

Understanding Concepts

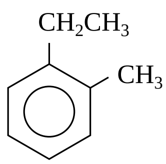
7. (a) 3-methyl-4-phenylhexane
   (b) 2-phenyl-3-heptene
   (c) 4-phenyl-1-pentyne
   (d) 1-methyl-4-propylbenzene

8. (a)



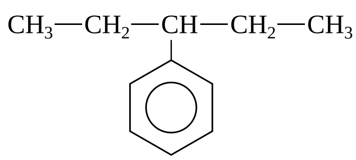
1,2,4-trimethylbenzene

(b)



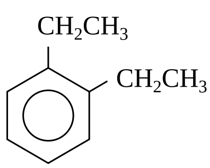
1-ethyl-2-methylbenzene

(c)



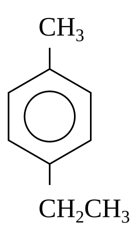
3-phenylpentane

(d)



o-diethylbenzene

(e)



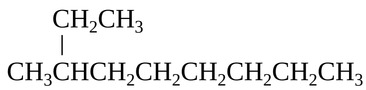
p-ethylmethylbenzene

SECTION 1.2 QUESTIONS

Understanding Concepts

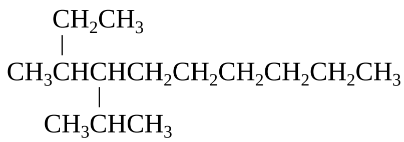
(Page 22)

1. (a)



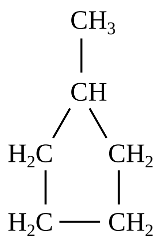
2-ethyloctane

(b)



2-ethyl-3-*i*-propylnonane

(c)

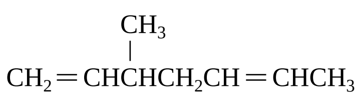


methylcyclopentane

(d) $CH_3CH_2C \equiv CCH_2CH_3$

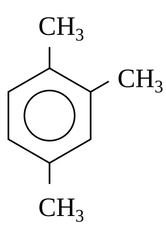
3-hexyne

(e)



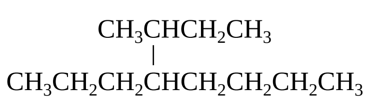
3-methyl-1,5-heptadiene

(f)



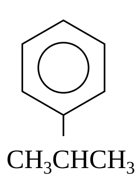
1,2,4-trimethylbenzene

(g)

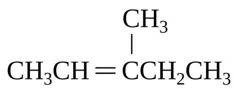


4-*s*-butyloctane

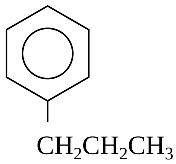
(h)



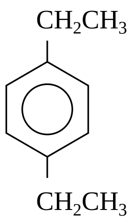
2-phenylpropane

(i) 

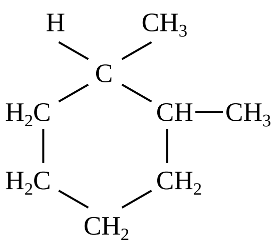
3-methyl-2-pentene

(j) 

n-propylbenzene

(k) 

p-diethylbenzene

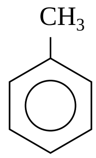
(l) 

o-dimethylcyclohexane

2. (a) 2-dimethylhexane: incorrect; does not indicate location of second methyl group. Possible correct name: 2,2-dimethylhexane
   (b) 3-methyl-1-pentyne: correct
   (c) 2,4-dimethylheptene: incorrect; does not indicate location of double bond. Possible correct name: 2,4-dimethyl-1-heptane
   (d) 3,3-ethylpentane: incorrect; should be diethyl. Possible correct name: 3,3-diethylpentane
   (e) 3,4-dimethylhexane: correct
   (f) 3,3-dimethylcyclohexene: correct (location of double bond in cyclohexene is understood to be position 1)
   (g) 2-ethyl-2-methylpropane: incorrect; the longest carbon chain is 4 carbons long. Possible correct name: 2,2-dimethylbutane
   (h) 2,2-dimethyl-1-butene: incorrect; compound does not exist because carbon-2 cannot form 5 bonds. Possible correct name: 3,3-dimethyl-1-butene
   (i) 1-methyl-2-ethylpentane: incorrect; the longest carbon chain is 6 carbons long. Correct name: 3-ethylhexane
   (j) 2-methylbenzene: incorrect; no numbering is needed for a single attached group. Correct name: methylbenzene
   (k) 1,5-dimethylbenzene: incorrect; use the lowest numbering system. Correct name: 1,3-dimethylbenzene
   (l) 3,3-dimethylbutane: incorrect; use the lowest numbering system. Correct name: 2,2-dimethylbutane
3. (a) 4-*i*-propyl-2,5-octadiene
   (b) 1-ethyl-3-methylbenzene
   (c) 3-methyl-2-phenylpentane
   (d) 1,2-diethylcyclopentane
   (e) 3,4-dimethyl-3-isopropyl-1-hexene
4. (a) ethylene
   $CH_2{=}CH_2$
   (b) propylene
   $CH_2{=}CHCH_3$

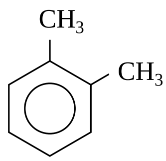
(c) acetylene
$CH{\equiv}CH$

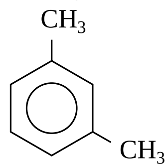
(d) toluene, the toxic solvent used in many glues

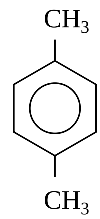


toluene

(e) the *o*-, *m*-, and *p*- isomers of xylene







i) *o*-xylene ii) *m*-xylene iii) *p*-xylene

Making Connections

5. The graph shows a direct relationship between the number of carbon atoms and the boiling points of alkanes. This relationship is explained by the increasing number of van der Waals attractions between molecules, as the length of the carbon chain increases. As the intermolecular attraction increases, the amount of energy required to separate the molecules increases, resulting in a higher boiling point.

1.3 REACTIONS OF HYDROCARBONS

PRACTICE

(Page 27)

Understanding Concepts

1. (a)
$$\begin{array}{lllll} & \mathrm{H} & \mathrm{H} & & \\ & | & | & & \\ \mathrm{CH_3} & \mathrm{CH_2} & \mathrm{C} & \mathrm{CH_2} & \mathrm{CH_3} \\ & & | & & \\ & & \mathrm{CH_2CH_3} & & \end{array}$$

(b)
$$\begin{array}{lllll} & \mathrm{H} & & \mathrm{Br} & \\ & | & & | & \\ \mathrm{CH_3} & \mathrm{CH} & — & \mathrm{C} & \mathrm{CH_2CH_3} \\ & & & | & \\ & & & \mathrm{CH_3} & \end{array}$$

(c)
$$\begin{array}{lllll} & & & \mathrm{OH} & \mathrm{H} \\ & & & | & | \\ \mathrm{CH_3} & \mathrm{CH_2} & \mathrm{CH} & \mathrm{CH_2} & \mathrm{CH_2} \\ & & | & & \\ & & \mathrm{CH_3} & & \end{array}$$

(d)