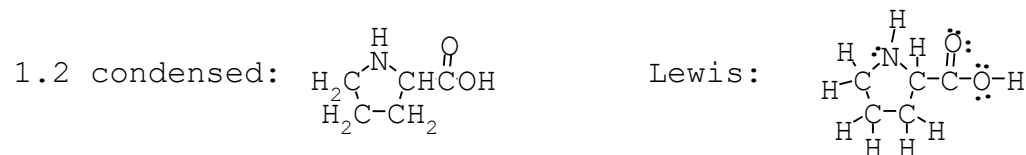
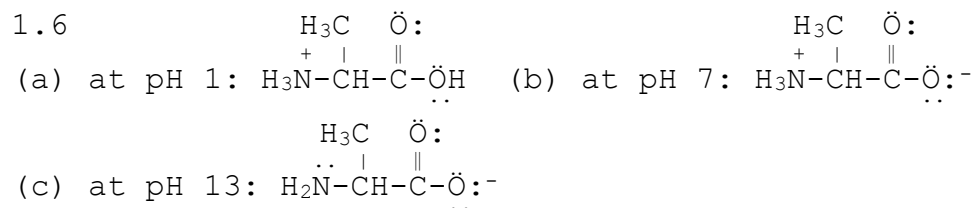
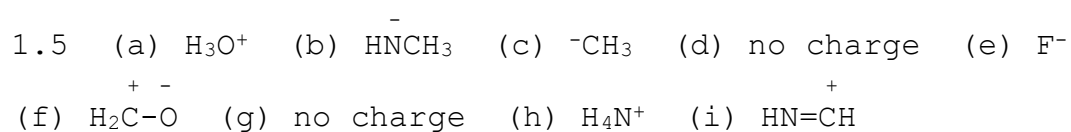


Answers to Puzzles of Chapter 1
Bonding, Structure, and Physical Properties

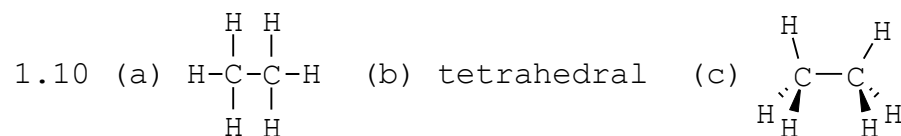
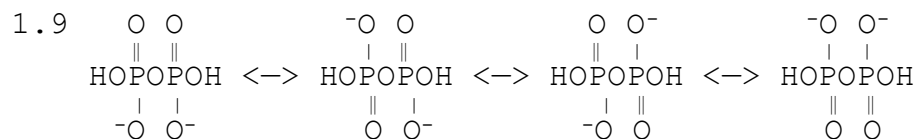
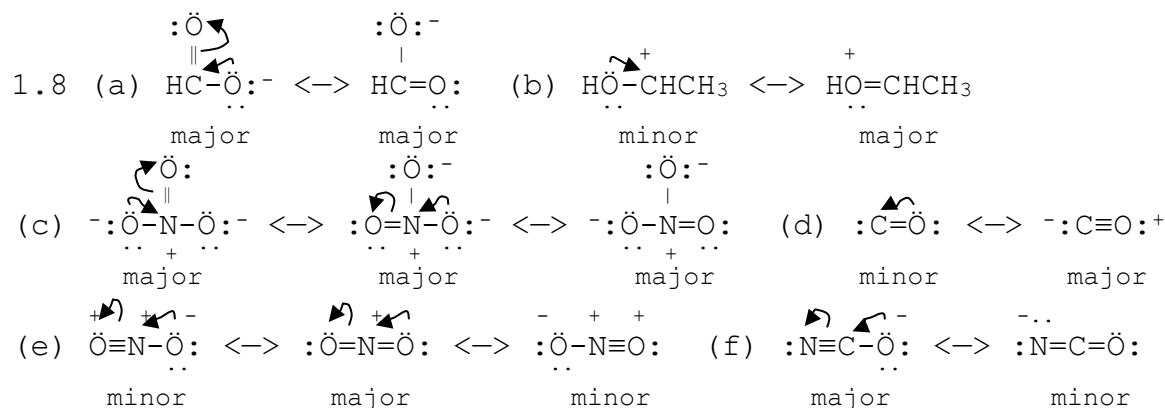


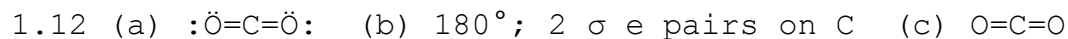
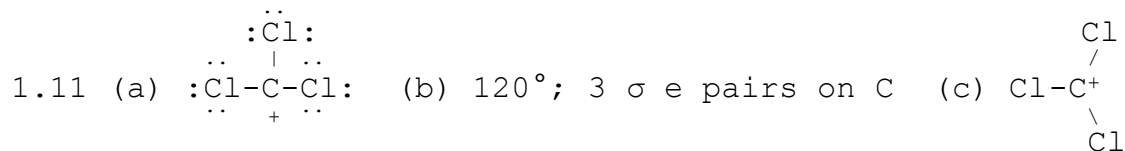
1.3 (a) aldehyde (b) ketone (c) alkyl halide (d) alkyne (e) amine (f) alkene
(g) carboxylic acid (h) phenyl ring (i) alcohol (j) amide (k) ether (l) ester

1.4 benzene ring, amide, ether, alkene, amine



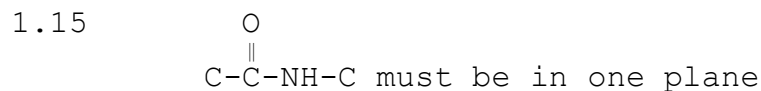
1.7 (d) C in CF_2 (f) C in H_2CO (g) C in CH_3 (i) C in $\text{HN}=\text{CH}$



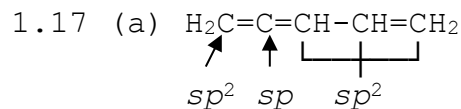


- 1.13 (a) O is sp^3 , tetrahedral (b) O is sp^3 , tetrahedral (c) C is sp^3 , tetrahedral
 (d) C is sp^2 , trigonal planar (e) each N is sp , linear (f) O is sp^3 , tetrahedral
 (g) 1st C & N are sp^2 , trigonal planar; 2nd C is sp^3 , tetrahedral
 (h) S & each singly bonded O are sp^3 , tetrahedral; each doubly bonded O is sp^2 , trigonal planar
 (i) P & Cl's are sp^3 ; tetrahedral

- 1.14 (a) C & O's are sp^2 , trigonal planar
 (b) O & 1st C are sp^2 , trigonal planar; 2nd C is sp^3 , tetrahedral (c) all are sp^2 , trigonal planar
 (d) both are sp , linear (e) O's are sp^2 , trigonal planar; N is sp , linear
 (f) N & C are sp , linear; O is sp^2 , trigonal planar



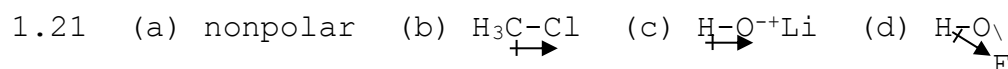
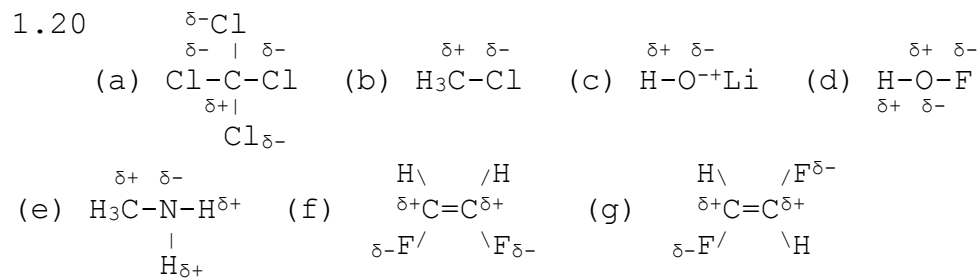
1.16 The sp^2 C-H bond length is shorter because the sp^2 orbital has more s character and is shorter than the sp^3 orbital.

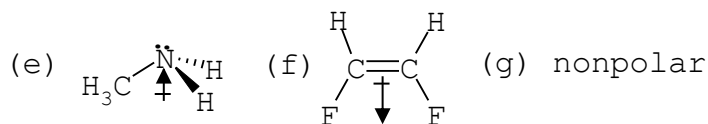


- (b) shortest C-C bond: the 2 sp^2 C - sp C double bonds
 next shortest C-C bond: the sp^2 C - sp^2 C double bond
 longest C-C bond: the C-C single bond

1.18 All 12 atoms are in one plane. All carbons are sp^2 hybridized and trigonal planar.

- 1.19 (a) H-H and Cl-Cl bonds broken; 2 H-Cl bonds made
 (b) $\Delta H = (436 + 243) - 2(432) = -185$ kJ/mol (c) ΔH is negative, exothermic, and favorable.





1.22 O

(a) are all polar bonds

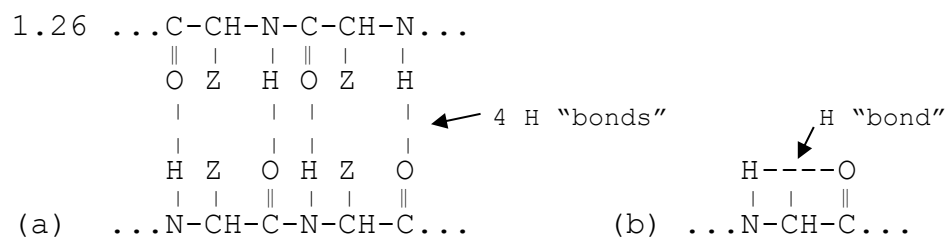
(b) It is not a very polar molecule because it has so many nonpolar bonds.

1.23 (a) $F^- Be^{2+} F$ (b) covalent bonds only (c) $K^+ Br$ (d) $H_2N^+ Li$

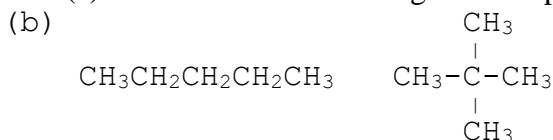
1.24 (a) nonpolar (b) (c) (d) nonpolar

(e) Only (b), (c) & (e) are polar with dipole-dipole forces

1.25 Only (a), (b), (c), and (g) have H "bonds".



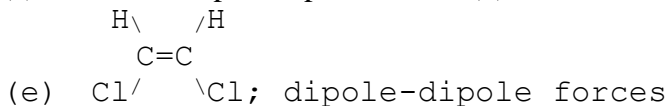
1.27 (a) Octadecanoic acid has greater dispersion forces because it has more surface area.



The unbranched compound has greater dispersion forces because it has more surface area.

1.28 (a) $Li^+ Cl$; ionic bonds (b) $NH_2CH_2CH_2CH_3$; H "bonds"

(c) CH_3CH_2F ; dipole-dipole forces (d) CH_3CH_2OH ; more dispersion forces



1.29 (a) more time in boiling water (b) oil (it cooks faster without boiling)

(c) without H "bonds", oil still has much larger dispersion forces among its huge molecules

(d) water (from dehydration)

1.30 The same rankings & explanations as in Puzzle 1.28

1.31 Octadecanoic acid because it has larger dispersion forces.

1.32 (a) $Na^+ Br$; ionic & very polar (b) CH_3F ; more polar (c) CH_3OH ; more polar

(d) $H_2NCH_2CH_2CH_2NH_2$; 2 polar groups (e) CH_3Cl ; more polar


1.33 No, because its bonds are almost all nonpolar, so its molecules are practically nonpolar.

1.34 (a) $S=C=S$, covalent (b) K^+Cl , ionic (c) Li^+O-H , both (d) CF_4 , covalent
(e) $Na^+C\equiv N$, both

1.35 (a) condensed: CH_3CH_2OH ; line: 

(b) condensed: $CH_3NHCH_2CH_3$; line: 

(c) condensed: $O=CHCH_2Br$; line: 

(d) condensed: $\begin{array}{c} \text{---CH---CH}_2\text{---} \\ | \quad | \\ \text{H}_2\text{C---O} \end{array}$; line: 

1.36 (a) condensed: $CH_3CH_2CH_2CH_2CH_2CH_2CH_2^+$

Lewis: $\begin{array}{cccccccc} & H & H & H & H & H & H & H \\ & | & | & | & | & | & | & | \\ H & -C & -C & -C & -C & -C & -C & -C^+ \\ & | & | & | & | & | & | & | \\ & H & H & H & H & H & H & H \end{array}$

(b) condensed: $CH_3CH_2NCH_3^-$ Lewis: $\begin{array}{ccccccc} & H & H & & H & & \\ & | & | & & | & & \\ H & -C & -C & -N & -C & -H \\ & | & | & & | & & \\ & H & H & & H & & \end{array}$



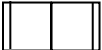
(c) condensed: $\begin{array}{c} \text{---}^+O\text{H} \\ | \quad | \\ \text{H}_2\text{C---CH}_2 \end{array}$ Lewis: $\begin{array}{c} \text{---}^+O\text{H} \\ | \quad | \\ \text{H---C---C---H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$

(d) condensed: $\begin{array}{c} \text{---}Cl^+ \\ | \quad | \\ \text{H}_2\text{C---CH}_2 \end{array}$ Lewis: $\begin{array}{c} \text{---}:Cl:^+ \\ | \quad | \\ \text{H---C---C---H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$

(e) condensed: $\begin{array}{c} HC-CH \\ // \quad \backslash \\ HC \quad C-Cl \\ \backslash \quad // \\ \quad \quad \quad \end{array}$ Lewis: $\begin{array}{c} H \quad \quad H \\ \backslash \quad / \\ C=C \\ / \quad \backslash \\ H-C \quad C-Cl \\ \backslash \quad / \\ H \quad \quad H \end{array}$

1.37 (a) e.g. $CH_3CH_2OCH_2CH_3$ (b) e.g. $CH_3CH_2CH_2CH_2OH$ (c) $CH_3CH_2CH=O$
(d) $(CH_3)_2C=O$ (e) e.g. CH_3NHCH_3

(f) $CH_3CH_2\overset{O}{\parallel}COH$ (g) e.g. $CH_3\overset{O}{\parallel}COCH_3$ (h) e.g. $CH_3CH_2C\equiv CH$

(i) e.g.  (j)  (k) 

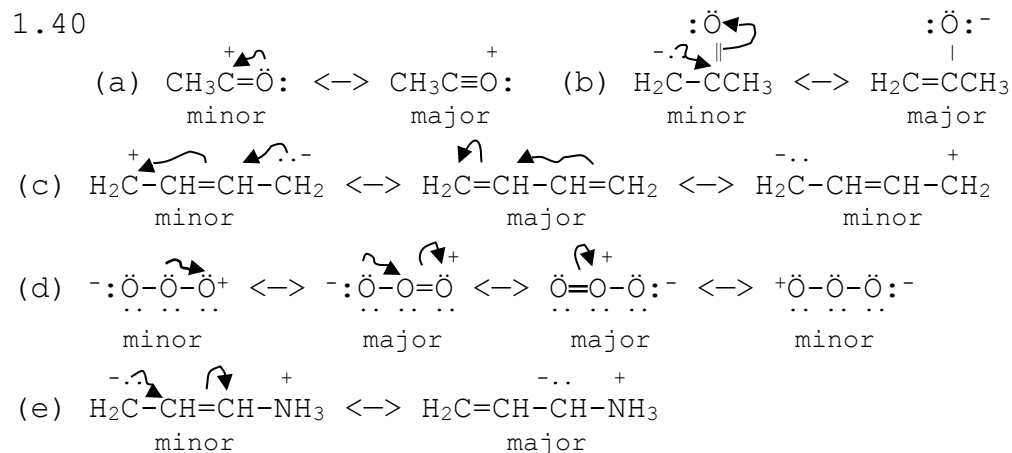
1.38 (a) $^+CH_3$ (b) $^+NH_4$ (c) $^+OH_3$ (d) $\cdot CH_3$ (e) $\overset{\cdot\cdot}{N}H_3$ (f) $:\overset{\cdot\cdot}{O}H_2$

(g) $H\overset{\cdot\cdot}{F}:$ (h) $^-:\overset{\cdot\cdot}{C}H_3$ (i) $^-:\overset{\cdot\cdot}{N}H_2$ (j) $H\overset{\cdot\cdot}{O}:-$ (k) $:\overset{\cdot\cdot}{Cl}:-$ (l) $:\overset{\cdot\cdot}{C}H_2$

(m) $\cdot\overset{\cdot\cdot}{N}H_2$ (n) $H\overset{\cdot\cdot}{O}\cdot$ (o) $:\overset{\cdot\cdot}{Br}\cdot$

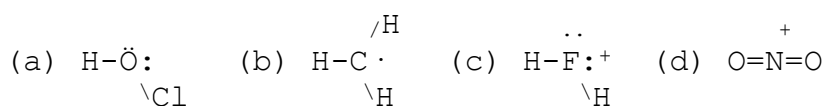
1.39 (a) C (b) C (c) none (d) C (e) C (f) none (g) N (h)-(l) none

1.40

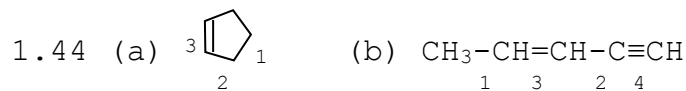


1.41 (a) C: sp^3 , 109° ; F: sp^3 (b) N: sp^3 , 109° (c) B: sp^2 , 120° ; Cl: sp^3 (d) C: sp^2 , 120°
 (e) Be: sp , 180° (f) C: sp , 180° ; S: sp^2 (g) N: sp^3 , 109°
 (h) S: sp^3 , 109° ; 2 singly bonded O's: sp^3 , 109° ; doubly bonded O: sp^2

1.42

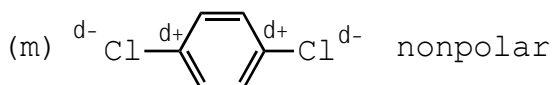
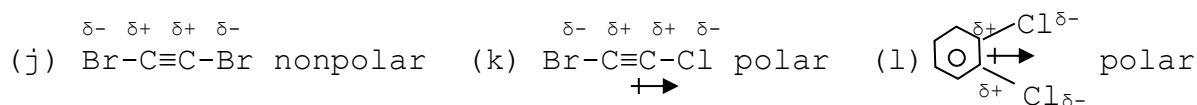
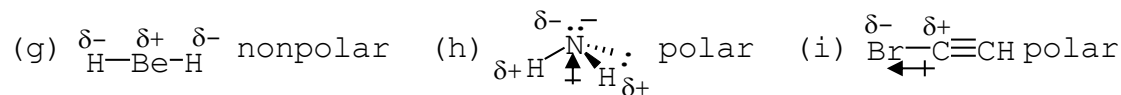
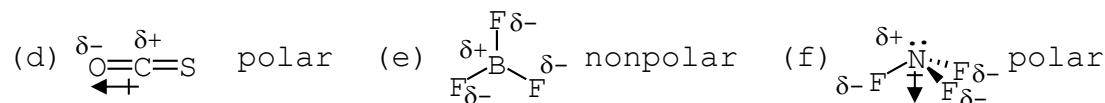
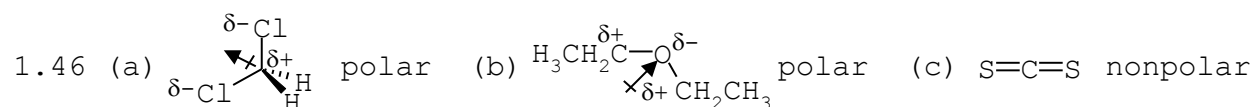


1.43 (a) 1st C: sp^3 , 109° ; 2nd C & O: sp , 180° (b) 1st 2 C's & O: sp^2 , 120° ; 3rd C: sp^3 , 109°
 (c) each C: sp^2 , 120° (d) each O: sp^2 , 120° (e) each C: sp^2 , 120°
 (f) each C: sp^2 , 120° ; N: sp^3 , 109°



(c) $\text{C}_6\text{H}_5-\text{CH}_2-\text{CH}=\text{CH}_2$; all benzene C-C bonds 2nd longest

1.45 (a) C-H (431 kJ/mol) (b) H-Cl (432 kJ/mol)
 (c) $\Delta H = (431 + 243) - (339 + 432) = -97$ kJ/mol
 ΔH is negative, exothermic, and favors the forward reaction.



1.47 (a) none (b) HF--HF (c) none (d) CH₃OH--OHCH₃ (e) none (f) CH₃NH₂--NH₂CH₃
(g) none

1.48 (a) CH₃F--HOH (b) e.g. HF--HOH (c) e.g. CH₃OH--OH₂
(d) e.g. CH₃NH₂--OH₂ (e) (CH₃)₂C=O--HOH (f) e.g. HOH--C≡N (g) ⁺NH₄--OH₂

1.49 (a) dipole-dipole, dispersion (b) dispersion (c) dipole-dipole, dispersion
(d) ionic, H “bonds”, dipole-dipole, dispersion (e) H “bonds”, dipole-dipole, dispersion
(f) dispersion (g) dispersion (h) dipole-dipole, dispersion (i) dispersion
(j) dipole-dipole, dispersion

1.50 (a) CH₃CH₂NH₂; more dispersion forces (b) CH₃CH₂CH₂OH; H “bonds”
(c) CH₃Cl; dipole-dipole force (d) NaNH₂; ionic bonds
(e) CH₃(CH₂)₃CH₃; more dispersion forces

1.51 as in Puzzle 1.50, except (e): (CH₃)₄C; very symmetric with stabler lattice

1.52 (a) With many more nonpolar bonds (CH₃CH₂)₄N⁺Cl is less polar than H₄N⁺Cl and therefore more soluble in slightly polar chloroform.
(b) An ammonium salt with longer hydrocarbon chains should be less polar and more soluble.

1.53 The oxygen-hydrogen hydrogen “bond” between water molecules because it is much weaker than a covalent bond.

1.54 (a) The double bond is less than twice as strong.
(b) The σ bond is stronger because its energy is 369 kJ/mol, whereas the π bond is only about 682 – 369 = 313 kJ/mol.

1.55 Resonance puts partial charges in one direction: $\begin{array}{c} \curvearrowright \\ \text{:C=}\ddot{\text{O}}\text{:} \end{array} \longleftrightarrow \begin{array}{c} - \quad + \\ \text{:C}\equiv\text{O:} \end{array} \equiv \begin{array}{c} \delta- \quad \delta+ \\ \text{C}\equiv\text{O} \end{array}$
But electronegativities assign opposite partial charges: $\begin{array}{c} \delta+ \quad \delta- \\ \text{C}\equiv\text{O} \end{array}$

So CO is almost nonpolar. The nearly identical sizes of CO and N₂ give them about equal dispersion forces, their only intermolecular forces.

1.56 Propanone would make the anion more reactive because it cannot hydrogen bond with the anion. Ethanol can hydrogen bond with the anion and thereby stabilize it.

1.58 (a) first, ester; second, carboxylic acid
(b) first, dispersion, dipole-dipole; second, dispersion, dipole-dipole, H “bonds”
(c) despite their H “bonds”, the carboxylic acids are much smaller with much smaller dispersion forces.

1.59 The N has 3 δ- charges from its 3 polar bonds, whereas the Cl has only 1 δ- charge to attract the H.

1.60 (a) Yes, the O’s sp² hybridization and 120° orbital angle ensure that the H is about linear with the lone pair and the N.
(b) Yes, the N’s sp² hybridization and 120° orbital angle ensure that the H is about linear with the lone pair and the other N.

1.61 Dispersion forces, because they work equally well with polar and nonpolar surfaces, unlike dipole-dipole forces and H “bonds”.

7/09