Chapter 13 – Answers to end of chapter questions

1  a  Alcohols  
   b  Ketones  
   c  Halogenoalkanes  
   d  Carboxylic acids  
   e  Alkenes  
   f  Amino acids  
   g  Ethers

(Answers continue on the next page)
C—F bond is difficult to break and forming the F—O bond does not release much energy. C—H bond is easier to break, and forming the H—O bond releases more energy than is required for this process.
4  a  C = (12/44 \times 1.37) \times 100 = 37.36%  
H = (2/18 \times 1.12) \times 100 = 12.44%  

b  Oxygen  
c  \% O = 50.2\% ; \text{ratio } C : H : O \text{ is } 1 : 4 : 1 \text{ so empirical formula is } CH_4O  
d  i  \text{ M}_r = 32, \text{ molecular formula is } CH_4O  
  ii  CH_3OH  
  iii  32 = CH_3O^-  
       31 = CH_2O^-  
       30 = CH_2O^-  
       29 = CHO^-  
       17 = OH^-  
       15 = CH_3^+  

5  a  

5  b  Structure 4, since this is the only one with four carbon atoms that are each in a different environment (i.e. with four different types of carbon atom).  

d  i  the carbon atom joined to the two oxygen atoms.  
  ii  The carbon atom joined to one oxygen atom with a single bond.  

6  a  i  Phenyl hydrogens  
  ii  

\[
\begin{align*} 
\text{Ph} & \quad \text{CH}_2 \quad \text{CH}_2 \quad \text{CH}_2 \quad \text{CH}_2 \\
\end{align*}
\]  
  iii  \text{--CH}_3  

b  

![Diagram of chemical structure]
c  The first peak, on the left, has a relative area of 5. This is for the 5 protons in the benzene ring.

The second and third peaks have relative areas of 2. These are for the two protons attached to each CH$_2$ carbon atom in the side chain. These two pairs of protons are in different environments – one is attached to a carbon joined to the C=O carbon and the benzene ring, and the other is joined to the C=O carbon and a CH$_3$ group.

The fourth peak, on the right, has a relative area of 3. This is for the 3 protons in the CH$_3$ group at the end of the side chain.

d  i  TMS stands for tetramethylsilane

   ii  TMS is the NMR reference. Its protons give a single peak that is well separated from the peaks found in the NMR spectra of most organic compounds.

7  a

i

b  i  11.0 is the OH hydrogen and 0.9 are the CH$_3$ hydrogen atoms.

   ii  The peaks at approximately 2.4 and 3.5 each have a relative height of 1, so were caused by the two H atoms circled. By elimination, the peak at 2.0 was caused by the two equivalent H atoms joined to the N atom.

   iii  The peaks at 2.0 and 11.0. These hydrogen atoms would be exchanged with D atoms from the solvent, and so would not form peaks on the spectrum.

8  a  A is butan-1-ol; B is ethoxyethane.

   b  1  :  O—H in butan-1-ol

   2  :  C—H in butan-1-ol

   3  :  C—O in butan-1-ol

   4  :  C—O in ethoxyethane