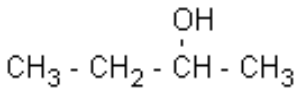
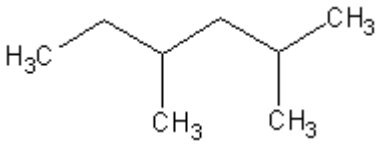
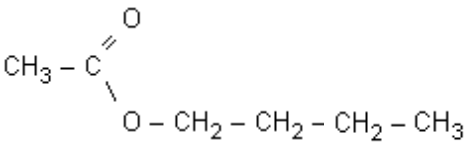
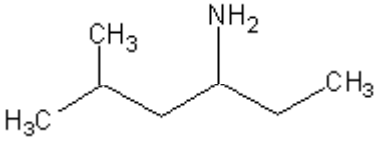
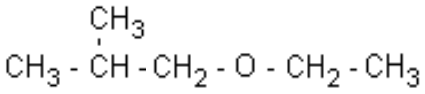
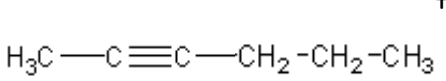
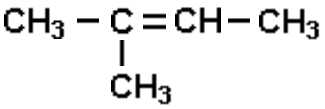
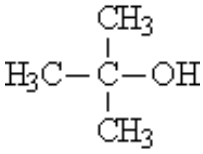
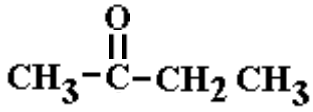
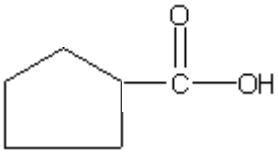
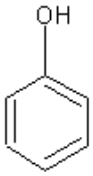
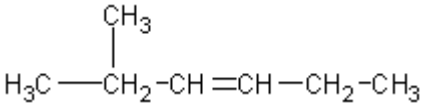
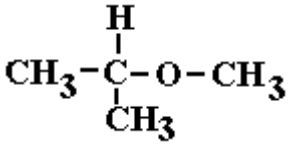
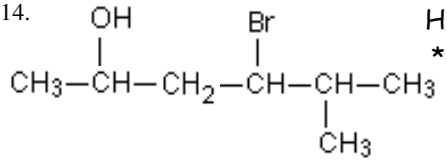
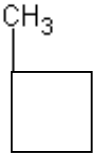
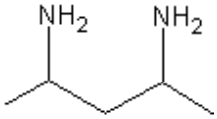
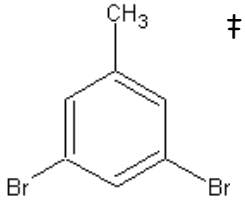
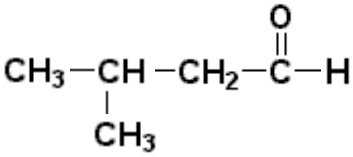
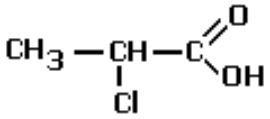
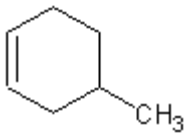
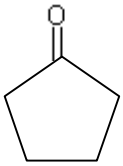
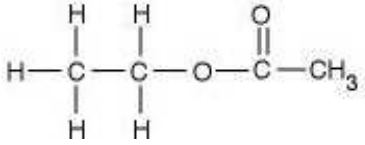
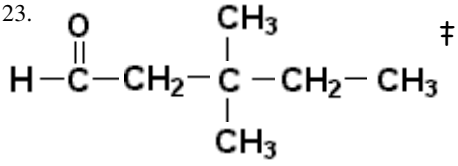
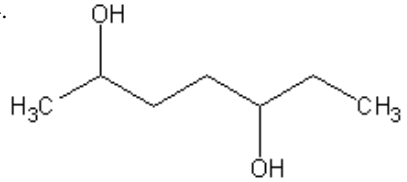
Answers to Review #3: Naming, Physical Properties and Reactions of Organic Compounds (Chap.1 & 2)

1. Name the following organic compounds using their IUPAC names. Identify the type (family) of each compound.

1.  H * 2-butanol (alcohol)	2.  ‡ 2,4-dimethylhexane (alkane)	3  butyl ethanoate (ester)
4.  H * 5-methyl-3-hexanamine (amine)	5.  1-ethoxy-2-methylpropane (ether)	6.  ‡ 2-hexyne (alkyne)
7.  ‡ 2-methyl-2-butene (alkene)	8.  H * 2-methyl-2-propanol (alcohol)	9.  butanone (ketone)
10.  H * cyclopentanoic acid (carboxylic acid)	11.  H phenol (hydroxybenzene, aromatic)	12.  ‡ 2-methyl-3-hexene (alkene)
13.  2-methoxy propane (ether)	14.  H * 4-bromo-5-methyl-2-hexanol (alcohol)	15.  ‡ methylcyclobutane (cycloalkane)
16.  H * 2,4-pentanediamine (amine)	17. 1,3-dibromo-5-methylbenzene (aromatic)  ‡	18.  3-methylbutanal (aldehyde)
19.  H * 2-chloropropanoic acid (carboxylic acid)	20.  ‡ 4-methylcyclohexene (cycloalkene)	21.  cyclopentanone (ketone)
22.  ethyl ethanoate (ester)	23.  ‡ 3,3-dimethylpentanal (aldehyde)	24.  H * 2,5-heptanediol (alcohol)

2. Referring to the "numbers" of each molecule (1, 2, 3 etc) on the first page, identify the following:

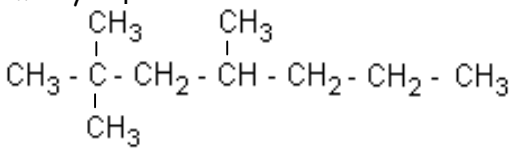
a) all secondary alcohols: 1, 11, 14, 24
b) all aromatic compounds: 11, 17
c) all unsaturated aliphatic hydrocarbons: 6, 7, 12, 20
d) all tertiary alcohol(s): 8
e) all saturated hydrocarbons: 2, 15
f) substances that turn Br_2 (l) colourless: 6,7,12,20

3. On the chart on the first page:

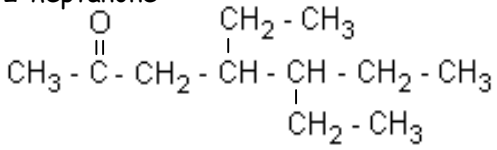
a) write the letter "H" in the top right-hand corner of all compounds that are capable of H-bonding
b) put a star (*) beside the compound in each **row** that will be the most soluble in water
c) put a "‡" sign beside the compound in each **row** with the **lowest** boiling point

4. Draw the structural formula for each of the following molecules. Identify the family of each.

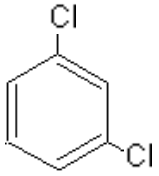
a) 2,2,4-trimethylheptane



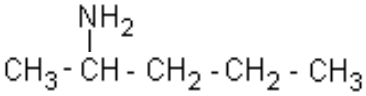
b) 4,5-diethyl-2-heptanone



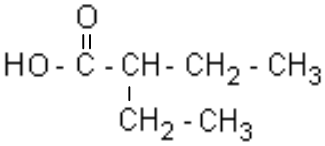
c) meta-dichlorobenzene



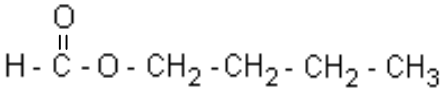
d) 2-pentanamine



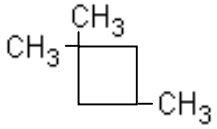
e) 2-ethylbutanoic acid



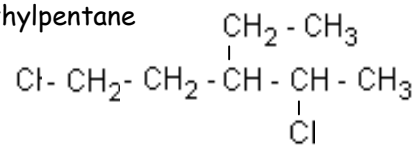
f) butyl methanoate



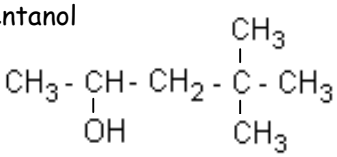
g) 1,1,3-trimethylcyclobutane



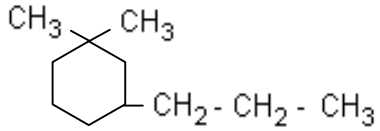
h) 1,4-dichloro-3-ethylpentane



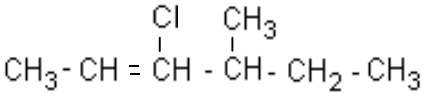
i) 4,4-dimethyl-2-pentanol



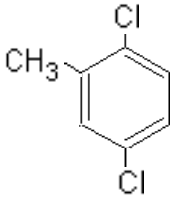
j) 1,1-dimethyl-3-propylcyclohexane



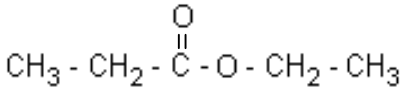
k) 3-chloro-4-methyl-2-hexene



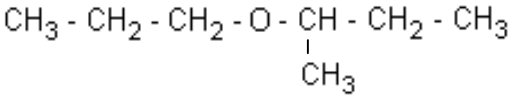
l) 1,4-dichloro-2-methylbenzene



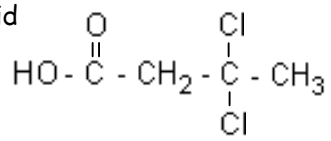
m) ethyl propanoate



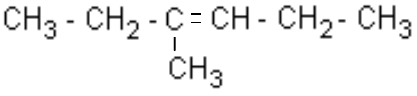
n) 2-propoxy butane



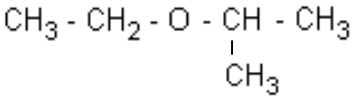
o) 3,3-dichlorobutanoic acid



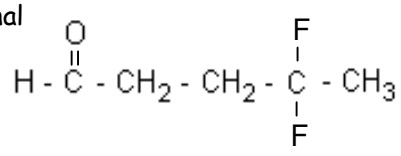
p) 3-methyl-3-hexene



q) 2-ethoxypropane



r) 4,4-difluoropentanal

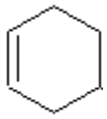
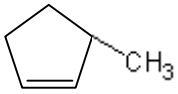
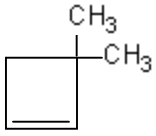


5. Draw three possible isomers with the chemical formula $C_4H_{10}O$. Name each compound.

- Compare the physical properties of each isomer in terms of melting point and solubility in water.

$CH_3 - CH_2 - O - CH_2 - CH_3$ **ethoxy ethane** • slightly polar and no H bonding • will be slightly soluble in water and have a relatively low melting point	$CH_3 - CH_2 - CH_2 - O - CH_3$ **1 – methoxy propane** • slightly polar and no H bonding • will be slightly soluble in water and have a relatively low melting point	$CH_3 - \underset{\displaystyle CH_3}{\underset{\vert}{CH}} - O - CH_3$ **2 – methoxy propane** • slightly polar and no H bonding • will be slightly soluble in water and have a melting point just a little lower than the first two ethers because of the branched chain
$CH_3 - CH_2 - CH_2 - CH_2 - OH$ **1-butanol (1° alcohol)** • polar and capable of H bonding • will be very soluble in water and have a medium melting point	$CH_3 - \underset{\displaystyle OH}{\underset{\vert}{CH}} - CH_2 - CH_3$ **2-butanol (2° alcohol)** • polar and capable of H bonding • will be very soluble in water and have a medium melting point	$CH_3 - \underset{\displaystyle OH}{\underset{\vert}{\overset{\displaystyle CH_3}{\overset{\vert}{C}}}} - CH_3$ **2-methyl-2-propanol (3° alcohol)** • polar and capable of H bonding • will be very soluble in water and have a melting point just a little lower than the first two alcohols because of the branched chain

6. Draw three possible isomers with the chemical formula C_6H_{10}. Name each compound.

 cyclohexene	 3-methylcyclopentene (any cyclopentene with a methyl group)	 3,3-dimethyl cyclobutene (any cyclobutene with two methyl groups)
$H_3C - C \equiv C - CH_2 - CH_2 - CH_3$ 2-hexyne (any six carbon alkyne)	$CH_2 = CH - CH = CH - CH_2 - CH_3$ 2,4-hexadiene (any six carbon diene)	$CH_3 - CH_2 - \underset{\displaystyle CH_3}{\underset{\vert}{C}} = C = CH_2$ 3-methyl-1,2-pentadiene

- Write the balanced chemical equation for the combustion reaction of any C_6H_{10} compound.

$$C_6H_{10}\,(l) + 17/2\ O_2\,(g) \xrightarrow{\lambda \text{ or } \Delta} 6\ CO_2\,(g) + 5\ H_2O\,(v)$$

7. Reactions of organic substances:

a) describe two tests for saturation (chemical tests that can be used to see if an organic compound contains any double [C = C] or triple [C ≡ C] bonds)

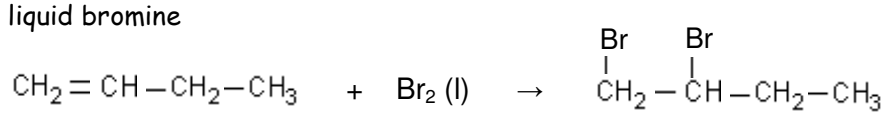
- if liquid bromine is added to an unsaturated organic compound, it will turn from orange to colourless
- if a solution of $KMnO_4$ is added to an unsaturated organic compound, it will turn from purple to brown or green
- if these compounds are added to saturated organic compounds, they will not react

b) describe a chemical test that can be used to distinguish a 3° alcohol from a 1° alcohol

- if an oxidizing agent such as $K_2Cr_2O_7$ or $KMnO_4$ is added to a primary alcohol, the alcohol is oxidized to an aldehyde, and then further oxidized to a carboxylic acid. The colour of the oxidizing agent will change
- if an oxidizing agent such as $K_2Cr_2O_7$ or $KMnO_4$ is added to a tertiary alcohol, there is no reaction (tertiary alcohols can not be oxidized with oxidizing agents) so the colour of the oxidizing agent will not change

c) draw and name the products that form (remember Markovnikov's rule) when 1-butene reacts with:

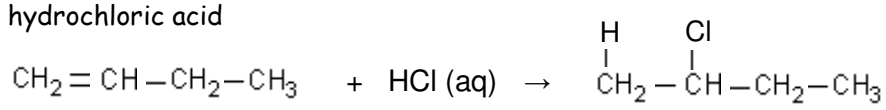
i) liquid bromine



1,2-dibromobutane (colourless)

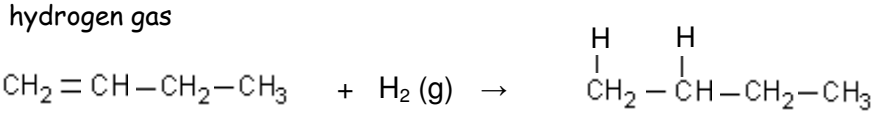
These are all **addition** reactions.
The reverse of these reactions are called **elimination** reactions.

ii) hydrochloric acid



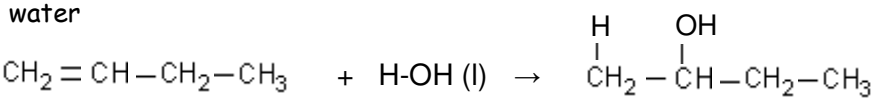
2-chlorobutane

iii) hydrogen gas



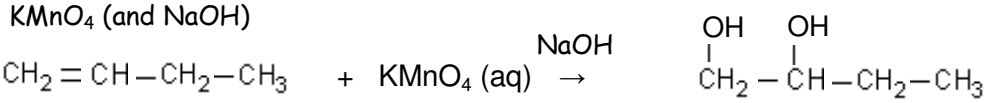
butane

iv) water



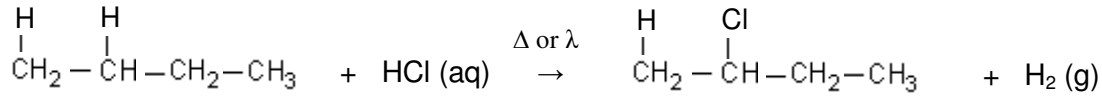
2-butanol

v) $KMnO_4$ (and NaOH)



d) draw and name one possible product that will form when butane reacts in a substitution reaction with:

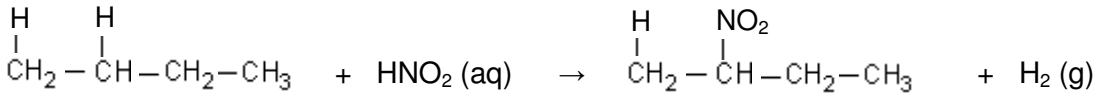
i) hydrochloric acid



2-chlorobutane

(the Cl can replace any H on the butane molecule)

ii) nitrous acid



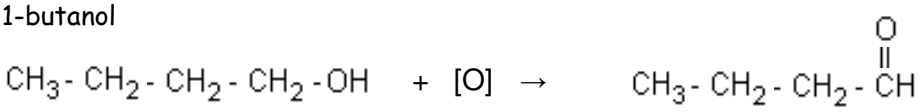
2-nitrobutane

(the NO_2 group can replace any H on the butane molecule)

e) draw and name the products that form (if any) when these substances are oxidized by an oxidizing agent [O]:

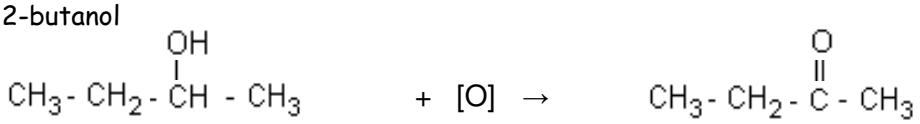
These reactions are considered to be oxidation reactions because the number of C – O bonds increases and/or the number of C – H bonds decreases.

i) 1-butanol



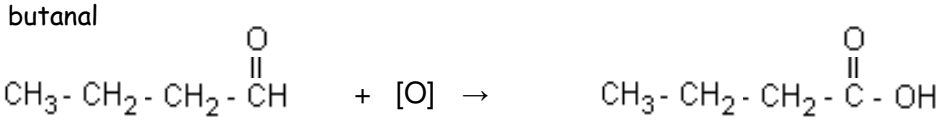
1-butanol (1° alcohol) butanal

ii) 2-butanol



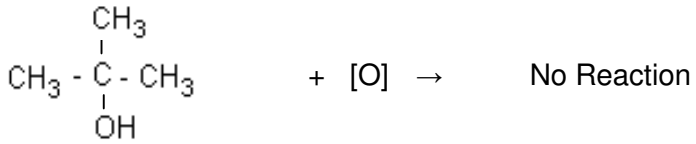
2-butanol (2° alcohol) butanone

iii) butanal



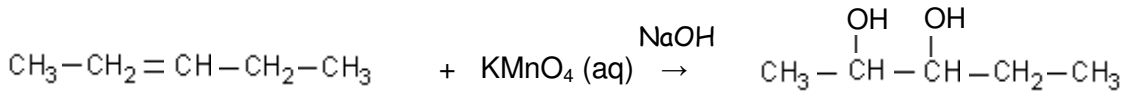
butanal (aldehyde) butanoic acid

iv) 2-methyl-2-propanol



2-methyl-2-propanol (3° alcohol)

v) 2-pentene with $KMnO_4$ (and NaOH)

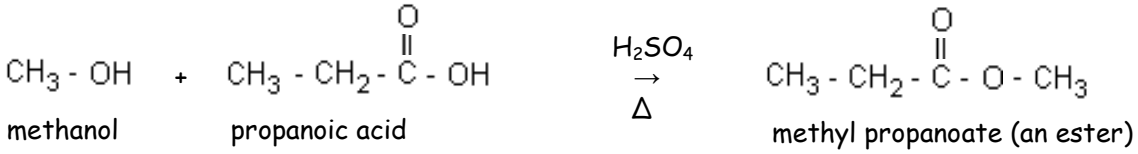


2-pentene 2,3-pentanediol

f) draw and name the products that form when these substances react in the presence of heat and H_2SO_4

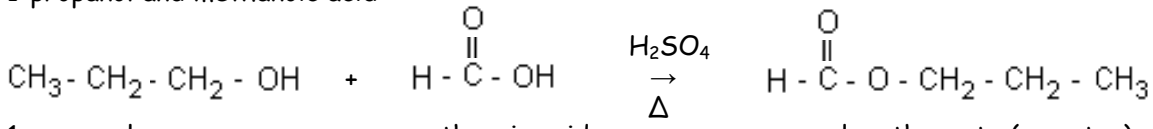
These reactions are all **dehydration** or **condensation** reactions.

i) methanol and propanoic acid



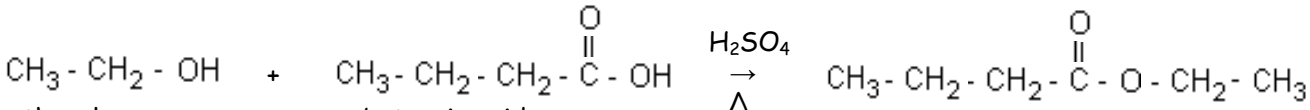
methanol propanoic acid methyl propanoate (an ester)

ii) 1-propanol and methanoic acid



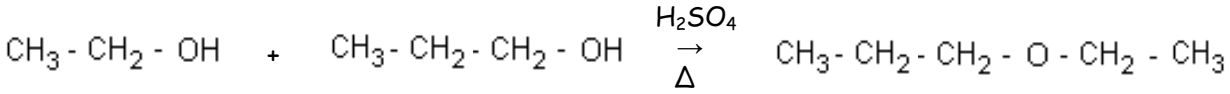
1-propanol methanoic acid propyl methanoate (an ester)

iii) ethanol and butanoic acid



ethanol butanoic acid ethyl butanoate (an ester)

iv) ethanol and 1-propanol



ethanol 1-propanol 1 - ethoxy propane (an ether)