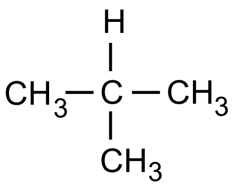
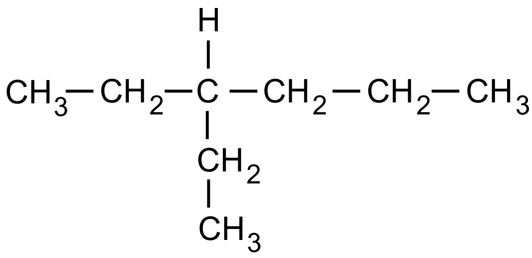
Hydrocarbons (revision)

1. (a) 2-methylpentane
   (b) 2,3-dimethylbutane
   (c) 3-methylpentane
   (d) 2,2-dimethylbutane
   (e) 4-ethyl-5-methylhex-1-ene
   (f) 3,3-dimethylbut-1-ene
   (g) 3,6-dimethylhept-3-ene
   (h) methylcyclobutane
   (i) 2-ethylbut-1-ene
   (j) 1,2-dimethylcyclohexane
   (k) 3-methylbut-1-ene
   (l) 2,3-dimethylcyclopentene

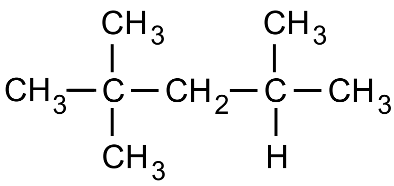
2. (a)



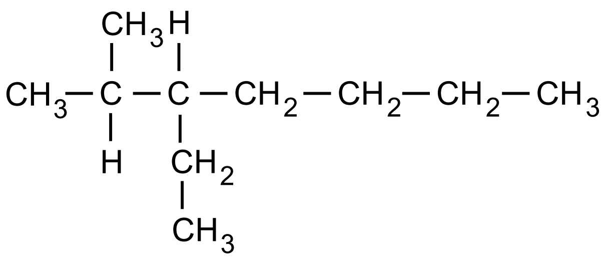
(b)



(c)

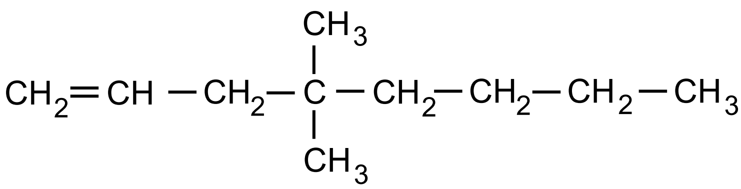


(d)

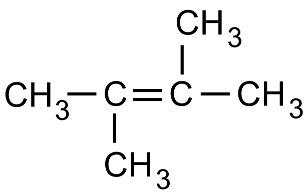


(e) $CH_3-CH_2-CH_2-CH=CH_2$

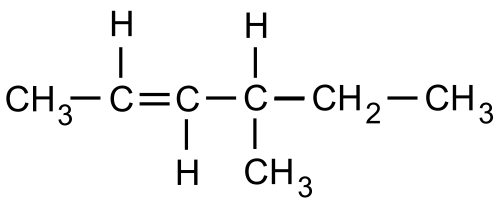
(f)



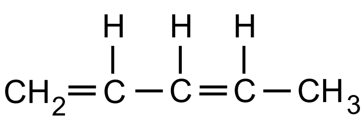
(g)



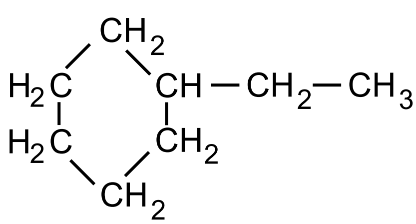
(h)

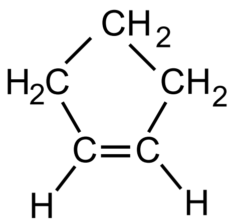


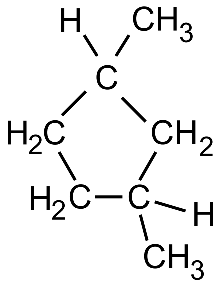
(i)



(j)



(k) 

(l) 

3. (a) ethane is C_2H_6 – C:H ratio = 2/6 = **0.33**
   (b) methylpropane is C_4H_{10} – C:H ratio = 4/10 = **0.4**
   (c) 3,3-dimethylhex-1-ene is C_8H_{16} – C:H ratio = 8/16 = **0.5**
   (d) methylcyclohexane is C_7H_{14} – C:H ratio = 7/14 = **0.5**
   (e) cyclopentene is C_5H_8 – C:H ratio = 5/8 = **0.625**
   (f) buta-1,3-diene is C_4H_6 – C:H ratio = 4/6 = **0.67**

4. (a) 3,3-dimethylpentane (b) 2,3,4-trimethylpentane
   (c) 2,3-dimethylpentane (d) dimethylpropane
   (e) but-1-ene (f) 4,4-dimethylpent-2-ene
   (g) methylpropene (h) 3,3-dimethylbut-1-ene

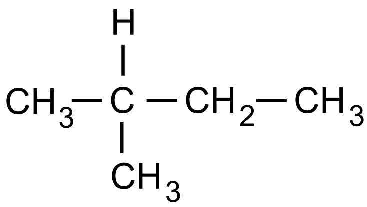
5. (a) $CH_3-CH=CH-CH_2-CH_2-CH_3$

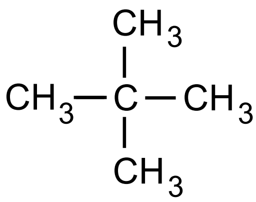
$CH_2=CH-CH_2-CH_2-CH_2-CH_3$

$CH_3-CH_3-CH=CH-CH_2-CH_3$

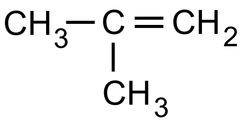
(b) $CH_3-CH=CH-CH=CH_2$ $CH_2=CH-CH_2-CH=CH_2$

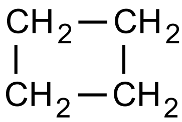
(c) $CH_3-CH_2-CH_2-CH_2-CH_3$

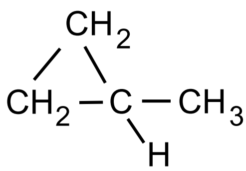




(d) $CH_3-CH_2-CH=CH_2$ $CH_3-CH=CH-CH_3$







Reactions of alkenes (revision)

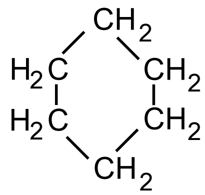
1. (a) Hydrocarbon **Y** is unsaturated with one carbon-carbon double bond. As a straight-chain hydrocarbon with four carbon atoms per molecule it is either but-1-ene or but-2-ene.

   (b) As unbranched hydrocarbon **Z** does not decolourise bromine solution immediately it is either an alkane or cycloalkane. With six carbon atoms per molecule it is either hexane or cyclohexane.

2. **Example**:

$CH_2{=}CH{-}CH_2{-}CH_2{-}CH_2{-}CH_3$

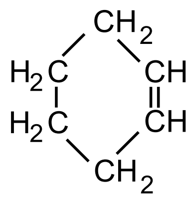
B **Example**:



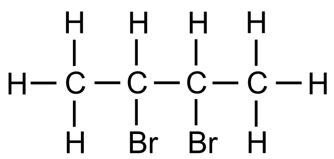
C **Example**:

$CH_2{=}CH{-}CH{=}CH{-}CH_2{-}CH_3$

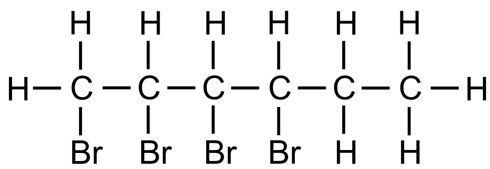
D **Example**:



3. (a) i)

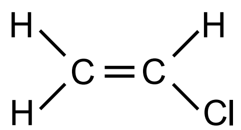


ii)



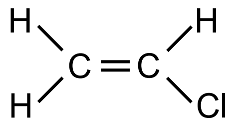
   (b) An addition reaction takes place. [The bromine atoms from the molecule are added across the double bond.]

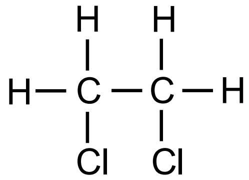
4. (a)

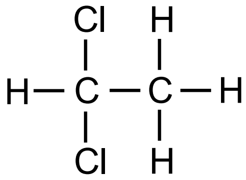


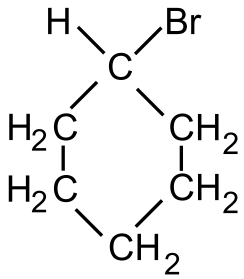
   (b) hydrogen chloride

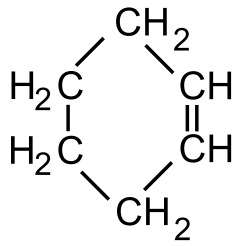
5. (a) an addition reaction

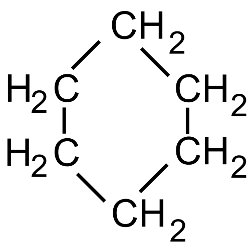
(b) i) 

ii) 

iii) 

6. (a) **P** 

Q 

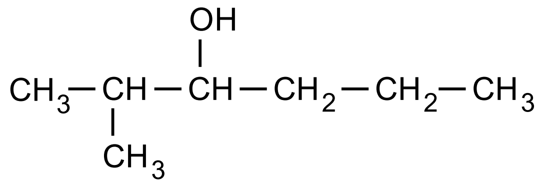
R 

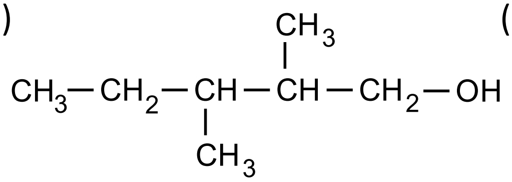
(b) hydrogen bromide

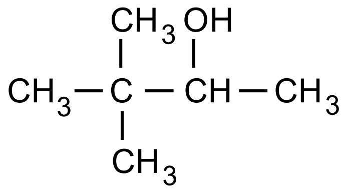
Alcohols

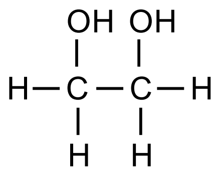
1. (a) ethanol (b) butan-2-ol
   (c) 2-methylbutan-2-ol (d) 4-methylpentan-2-ol
   (e) 3-methylpentan-3-ol (f) 3-methylbutan-2-ol

2. (a) $CH_3-CH_2-CH_2-CH_2-OH$

   (b) 

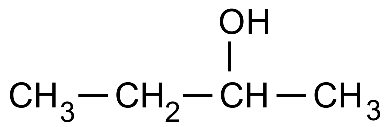
   (c) 

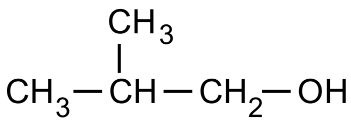
   (d) 

3. (a) 

   (b) A dihydric alcohol has two hydroxyl (–OH) groups in each molecule.

4. (a) $CH_3-CH_2-CH_2-CH_2-OH$

   (b) 

5. (a) ethanol
   (b) hydration
   [Do not confuse with hydrolysis in which the addition of atoms of water result in a splitting of the reactant molecule.]

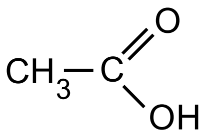
6. (a) i) $CH_3-CH_2-CH=CH_2$ $CH_3-CH=CH-CH_3$

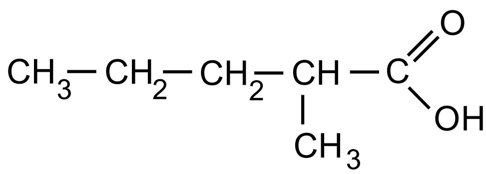
   ii) dehydration

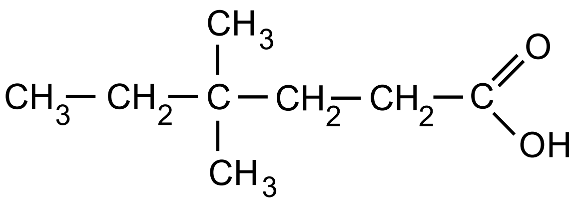
   (b) [Do not confuse with condensation in which the atoms that are eliminated to make water come from the one molecule and there is no joining up of molecules.]
   i) pentan-1-ol and pentan-3-ol
   ii) pentan-2-ol

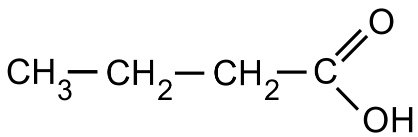
Carboxylic acids

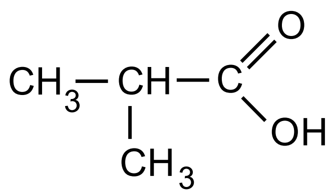
1. (a) methanoic acid (b) 3-methylbutanoic acid
   (c) 3-methylpentanoic acid (d) propanoic acid
   (e) 3,3-dimethylpentanoic acid (f) 2,3-dimethylbutanoic acid

2. (a)


   (b)


   (c)


3. (a)


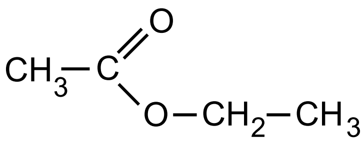
   (b)


4. (a) magnesium + ethanoic acid → magnesium ethanoate + hydrogen
   $Mg + 2\ CH_3COOH \rightarrow Mg(CH_3COO)_2 + H_2$
   [$Mg(CH_3COO)_2$ can be written showing ions as $Mg^{2+}(CH_3COO^-)_2$.]
   (b) sodium hydroxide + methanoic acid → sodium methanoate + water
   $NaOH + HCOOH \rightarrow NaHCOO + H_2O$
   [$NaHCOO$ can be written showing ions as Na^+HCOO^-.]
   (c) copper(II) oxide + propanoic acid → copper(II) propanoate + water
   $CuO + 2\ CH_3CH_2COOH \rightarrow Cu(CH_3CH_2COO)_2 + H_2O$
   [$Cu(CH_3CH_2COO)_2$ can be written showing ions as $Cu^{2+}(CH_3CH_2COO^-)_2$ and propanoic acid as C_2H_5COOH.]
   (d) potassium carbonate + butanoic acid → potassium butanoate + carbon dioxide + water
   $K_2CO_3 + 2\ CH_3CH_2CH_2COOH \rightarrow 2\ KCH_3CH_2CH_2COO + CO_2 + H_2O$
   [$KCH_3CH_2CH_2COO$ can be written showing ions as $K^+CH_3CH_2CH_2COO^-$ and butanoic acid as C_3H_7COOH.]

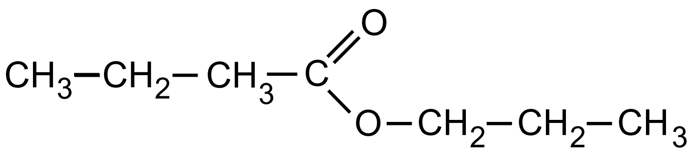
Esters (i)

1. (a) methyl ethanoate (b) methyl methanoate
   (c) propyl ethanoate (d) ethyl methanoate

2. (a)



   (b)



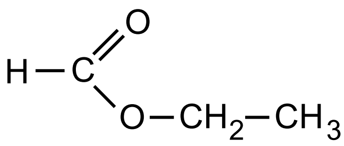
3. (a) ethyl methanoate (b) methyl propanoate
   (c) ethyl ethanoate (d) propyl methanoate

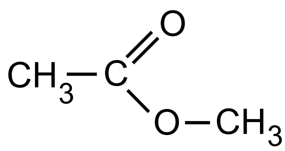
4. (a) ethanol and propanoic acid (b) methanol and ethanoic acid
   (c) ethanol and methanoic acid (d) methanol and butanoic acid

5. (a) methyl methanoate (b) methanol and methanoic acid

6. butan-2-ol and ethanoic acid

7. (a)



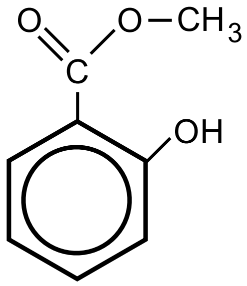


   (b) ethyl methanoate methyl ethanoate

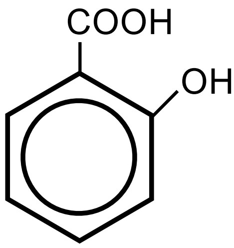
Esters (ii)

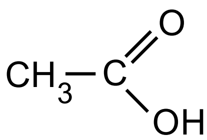
1. (a) a condensation reaction
   [It is also referred to as an esterification.]
   (b) **X** contains ethanol and ethanoic acid.
   Y is ethyl ethanoate.

2. (a)



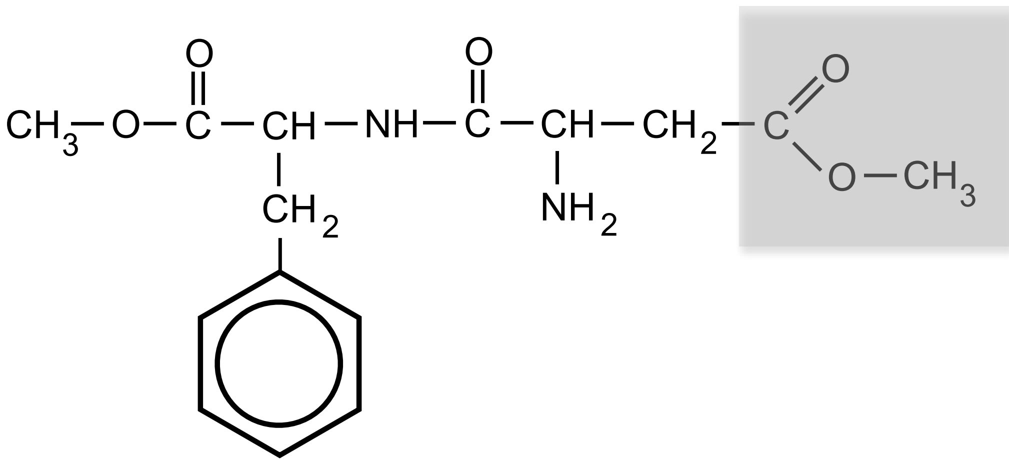
   (b) i) Hydrolysis involves the breakdown of a larger molecule to give smaller molecules due to the addition of the atoms present in water.
   [Do not confuse with a hydration reaction which also involves the addition of the atoms present in water, but does not involve the breakdown of a larger molecule.]
   ii)





   iii) Hydrolysis of aspirin by heat and moisture forms ethanoic acid.
   Ethanoic acid smells of vinegar.

3.



4. (a) 3. Add a few drops of concentrated sulphuric acid to the mixture in the test tube.
4. Place the test tube in a hot water bath.
(b) The paper soaked in water acts as a condenser, changing any evaporating substance back to liquid and returning to the reacting mixture.
(c) When the contents of the test tube are poured into the beaker containing sodium hydrogencarbonate solution, an oily layer of the ester will form on the surface.
(d) Sodium hydrogencarbonate solution is alkaline and will neutralise any unreacted acid.

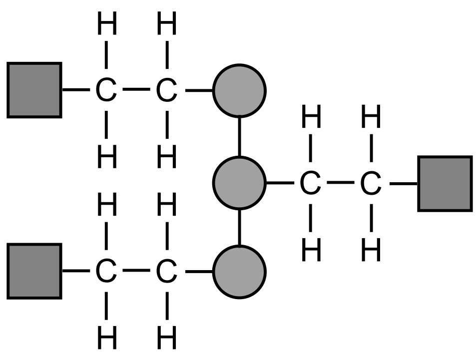
5. (a) Esters are commonly found in perfumes because they have attractive fragrances and evaporate relatively easily.
(b) i) Esters are made up of relatively non-polar molecules. As a result, they are insoluble in water, but are good solvents for many covalent compounds that are also insoluble in water.
ii) Esters are used as solvents for many paints, varnishes and glues and as nail-polish remover.

Fats and oils

1. (a) The main purpose of fats and oils in the diet is to provide energy. They are also essential for the transport and storage in the body of fat soluble / water insoluble vitamins.

   (b) The saturated fat molecules are more closely packed. As a result the intermolecular forces (London dispersion forces) are relatively strong and fats have relatively high melting points. The shape of the unsaturated oil molecules does not allow such close packing. Consequently the London dispersion forces are weaker and the melting points of oils are lower than fats.

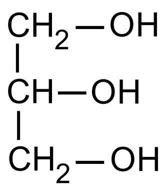
2. (a)



   (b) The melting point is increased by hardening.

   (c) The kind of chemical reaction that takes place during hardening is a (catalytic) **hydrogenation**.

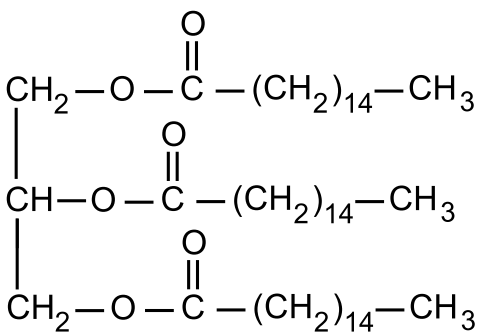
3. (a)



   (b) The ratio of glycerol molecules to fatty acid molecules is **1:3**.

4. (a) Triglycerides are **esters**.

   (b)



   (c) It is likely to be a **fat** because the carbon chains are saturated and will close pack.

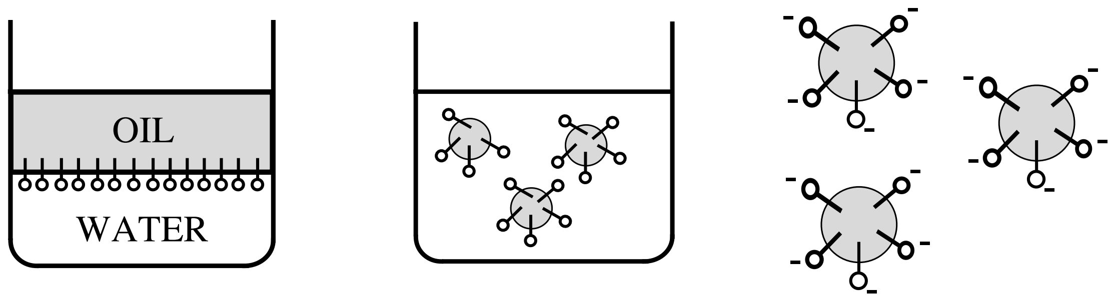
5. (a) The breakdown of tristearin (an ester) is a **hydrolysis** reaction.
   (b) i) saturated
   ii) The other product of the hydrolysis reaction is **glycerol** (**propane-1,2,3-triol**).

6. (a) The type of reaction that takes place when fats and oils are broken down is **hydrolysis**.
   (b) The second step of the soap making reaction is a **neutralisation** reaction. The fatty acid molecules produced by the hydrolysis of the fat or oil react with an alkali to produce a sodium salt of the fatty acid, i.e. soap.

7. (a) The compounds that are the main constituents of soap are sodium salts of long chain fatty acids.

The compounds are ionic. The negative ions have a long, non-polar, covalent carbon tail and a carboxylate head. The positive ion (Na^+) comes from the alkali used in the hydrolysis of a fat or oil.

   (b) The non-polar tails of the soap molecules are hydrophobic and dissolve in the non-polar oil. The hydrophilic heads of the soap dissolve in the water. On shaking the oil is broken up into tiny 'balls' and flushed away by the movement of the water.

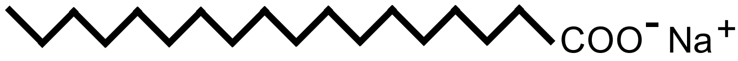


8. (a) Hydrophobic substances are insoluble in water, but readily soluble in non-polar solvents.
   (b) Hydrophilic substances are soluble in water.

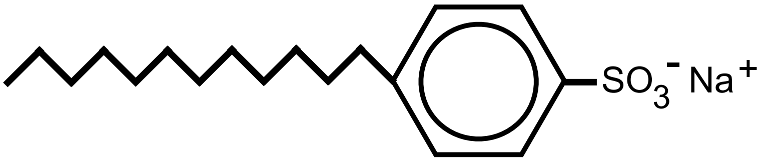
9. (a) Hard water is water containing a high concentration of calcium ions (Ca^{2+}) and/or magnesium ions (Mg^{2+}).
   (b) Hard water forms a scum with soap rather than a lather.
   (c) Detergents have soap-like structures but do not react with the calcium and/or magnesium ions in hard water to form insoluble salts.

10. (a) Both soap and detergent molecules have hydrophobic tails and hydrophilic heads.
The head of the negative ion in a detergent is different from that in a soap.

soap



detergent



(b) As a result, soap molecules react with calcium and/or magnesium ions in hard water to form a scum (insoluble salts) and not a lather.
Detergent molecules do not react with calcium and/or magnesium ions in hard water.

11. (a) An emulsion is a mixture of two or more liquids that are normally immiscible (unmixable).
(b) Egg yolk is an emulsifier. Part of the emulsifier molecule is polar and dissolves in the vinegar. Other parts of the molecule are non-polar and dissolve in the non-polar oil. The egg yolk therefore prevents the vinegar and oil in the mayonnaise from separating.

12. The compound has two polar hydroxyl (–OH) groups. This makes the compound soluble in water. The long carbon chains in the fatty acid part of the molecule are non-polar making the compound soluble in non-polar compounds like oils. These properties allow the compound to act as an emulsifier keeping the components of the ice cream from separating and giving it a smooth texture.