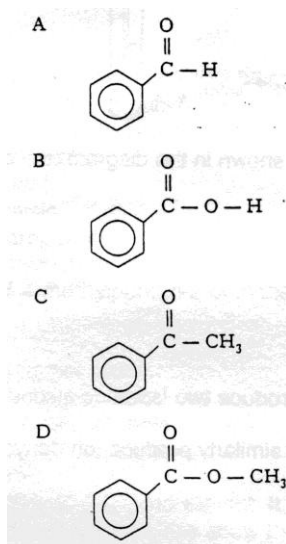


# CfE Higher Chemistry Homework

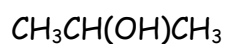
## Unit 2: Nature's Chemistry

### The Chemistry of Cooking and Oxidation of Food

1. Which of the following is an aldehyde?



2. Which is true of a compound with the following formula?



- A It is a primary alcohol
- B It can be oxidised to an aldehyde
- C It is a tertiary alcohol
- D It can be oxidised to a ketone.
3. Which process is used to convert methanol to methanal?
- A oxidation
- B condensation
- C hydration
- D hydrogenation

4. Which of the following alcohols can be oxidised to give a ketone?

- A 2-methylbutan-1-ol
- B 2,3-dimethylpentan-1-ol
- C 3-methylbutan-2-ol
- D 2-methylbutan-2-ol

5. Ethanol vapour is passed over hot aluminium oxide.

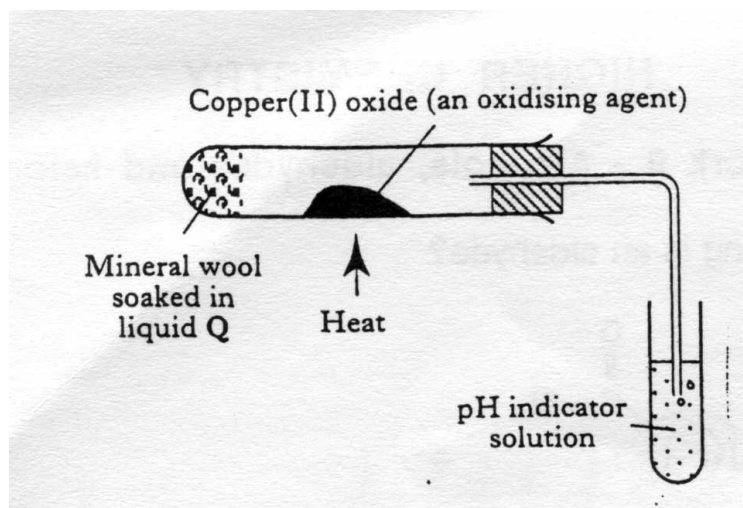
What kind of reaction occurs?

- A Hydrogenation
- B Dehydration
- C Hydrolysis
- D Dehydrogenation

6. After heating for several minutes as shown in the diagram, the pH indicator solution turned red.

Liquid Q could be,

- A propanone
- B paraffin
- C propan-1-ol
- D propan-2-ol



7. The dehydration of butan-2-ol can produce two isomeric alkenes, but-1-ene and but-2-ene. Which of the following alkanols can similarly produce, on dehydration, a pair of isomeric alkenes?

A propan-2-ol

B pentan-3-ol

C hexan-3-ol

D heptan-4-ol

8. What compound is formed by the oxidation of propan-2-ol?

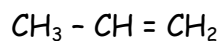
A  $\text{CH}_3\text{CH}_2\text{CHO}$

B  $\text{CH}_3\text{COCH}_3$

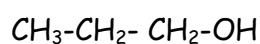
C  $\text{CH}_3\text{CH}_2\text{COOH}$

D  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

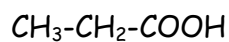
9.



reaction X



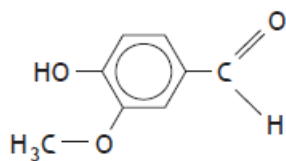
Reaction Y



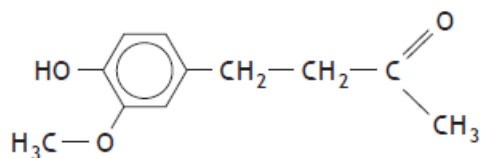
Which line in the table correctly describes reaction X and Y?

	Reaction X	Reaction Y
A	hydration	oxidation
B	hydration	reduction
C	hydrolysis	oxidation
D	hydrolysis	reduction

10. Vanillin and zingerone are flavour molecules.



vanillin



zingerone

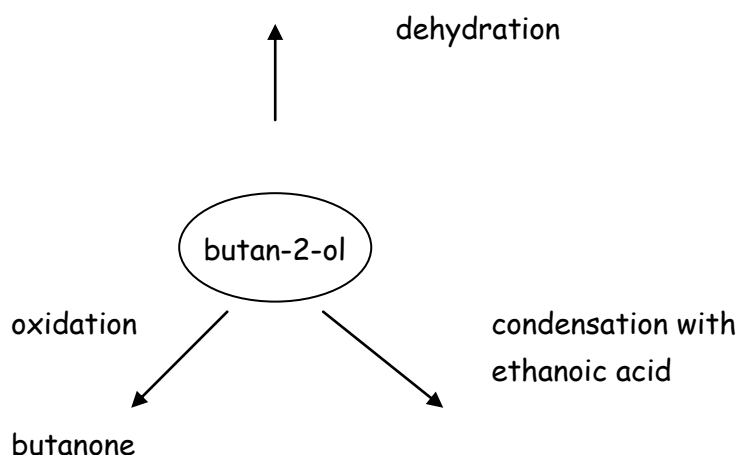
Which line in the table correctly compares the properties of vanillin and zingerone?

	<i>More soluble in water</i>	<i>More volatile</i>
A	vanillin	vanillin
B	vanillin	zingerone
C	zingerone	vanillin
D	zingerone	zingerone

11. Propanone is a widely used solvent. It can be made from propene.

Using full structural formulae show the steps involved in this preparation and name the reagent used in each step. (2)

12. Butan - 2-ol reacts in different ways



- (a) Name the two products formed by the dehydration of butan-2-ol (1)  
(b) Name a reagent which could be used to oxidise butan-2-ol to butanone. (1)

13. Although aldehydes and ketones have different structures, they both contain the carbonyl functional group.

(a) In what way is the structure of an aldehyde different from that of a ketone? (1)

(b) As result of this difference in structure, aldehydes will react with Fehling's (or Benedict's) solution and Tollens' reagent but ketones do not.

What colour change would be observed when propanal is heated with Fehling's (or Benedicts) solution? (1)

(c) In the reaction of propanal with Tollens' reagent, silver ions are reduced to form silver metal.

Complete the following ion-electron equation for the oxidation.



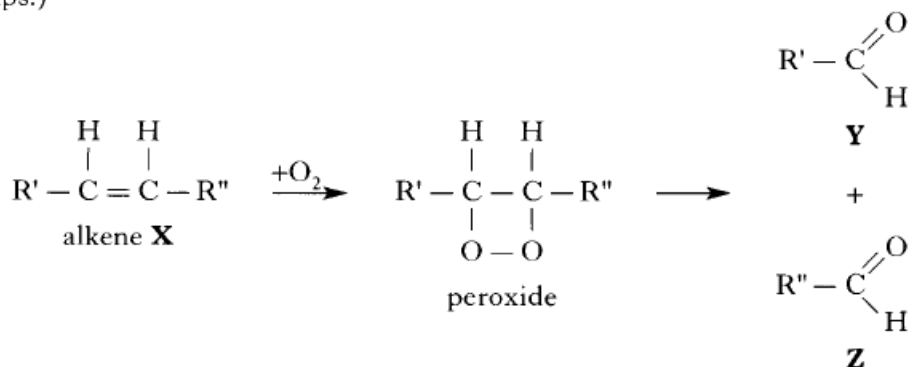
14. Cooking changes the appearance and composition of food.

Using your knowledge of chemistry, comment on the changes to food which may occur during cooking. (3)

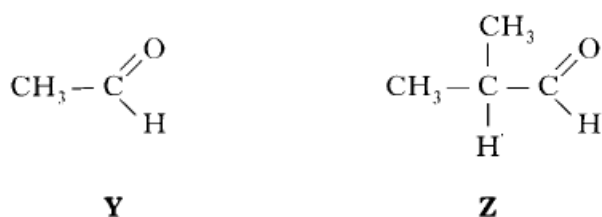
15. Alkenes can react with oxygen to produce unstable compounds called peroxides. These peroxides rapidly break down to produce compounds which have the same functional group.

For example alkene **X** reacts to form compounds **Z** and **Y**.

(In the following structural formulae **R'** and **R''** are used to represent different alkyl groups.)



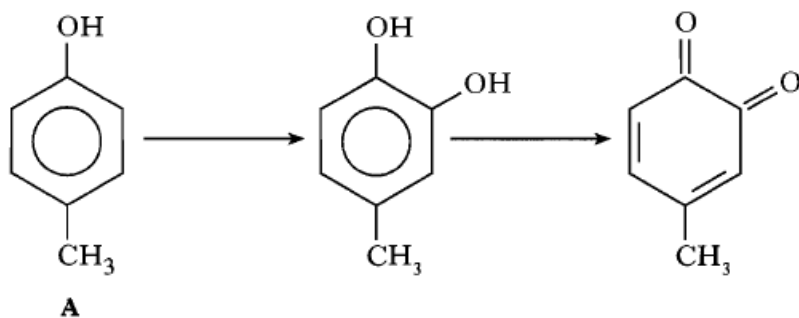
- (a) To which homologous series do both compounds **Y** and **Z** belong? (1)  
 (b) In one reaction alkene **X** produces the two compounds shown below.



Name alkene **X** in this reaction. (1)

16. Peeled apples turn brown due to the reaction of compounds called phenols.

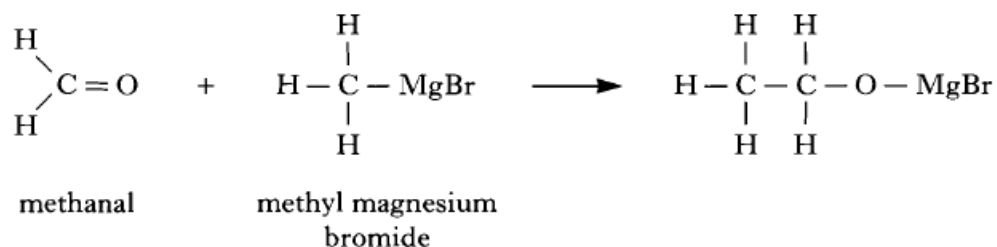
The first two steps in the reaction of one phenol, **A** are;



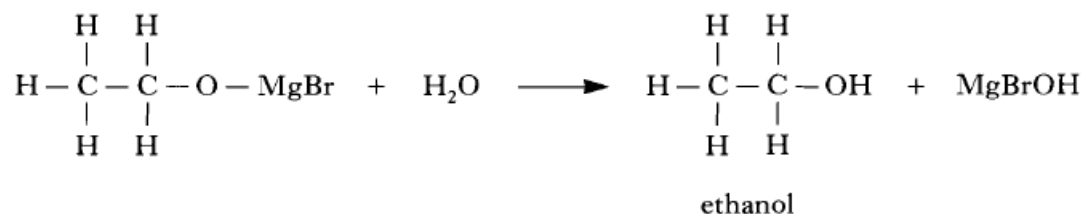
- (a) The same type of reaction takes place in both steps. Name this type of reaction. (1)
- (b) The molecular formula for **A** can be written as  $C_7H_xO$ . What is the value of  $x$ ? (1)
- (c) An enzyme called phenolase, present in apples, acts as a catalyst during the browning of apples. It has been discovered that covering a slice of apple with lemon juice stops it from browning. Suggest a reason for this. (1)

17. Alcohols can be prepared by the reaction of carbonyl compounds with methyl magnesium bromide. The reaction takes place in two stages.

Stage 1: Methyl magnesium bromide reacts with methanal in an addition reaction across the carbonyl group.

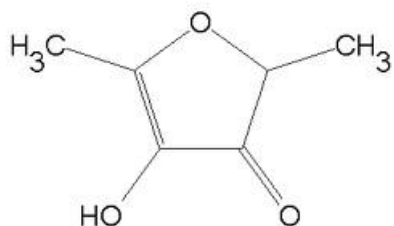


Stage 2: Reaction of the product with water produces ethanol

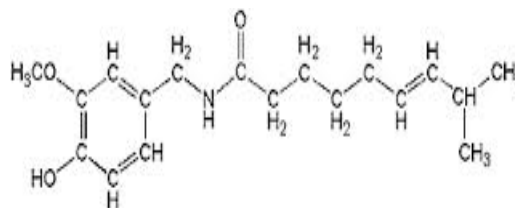


- (a) Suggest a name for the type of reaction which takes place in stage 2. (1)
- (b) Draw a structural formula for the product obtained if propanone had been used instead of methanal. (1)

18. The following compounds are found in foodstuffs.



Furaneol



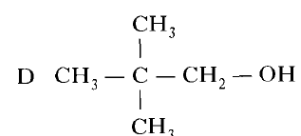
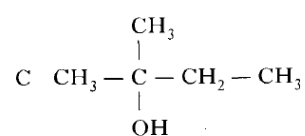
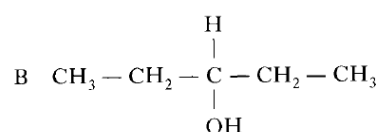
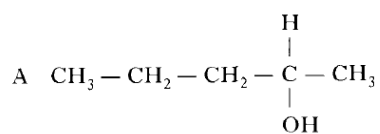
Capsaicin

- (a) Explain why furaneol is soluble in water but capsaicin is not. (1)
- (b) Capsaicin is found in chilli peppers and is responsible for the burning sensation you experience when you eat them. Milk is used to relieve the sensation as the milk dissolves the capsaicin.
- What substances present in milk allow the capsaicin to be dissolved? (1)

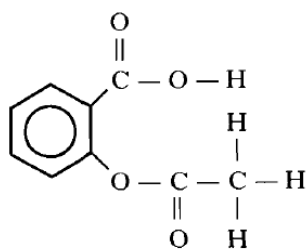


## Esters, Fats, Oils and Soaps

1. Which of the following structural formulae represents a primary alcohol?



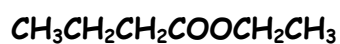
2. Aspirin is one of the most widely used pain relievers in the world. It has the structure:



Which **two** functional groups are present in an aspirin molecules?

- A Aldehyde and Ketone
- B Carboxyl and Ester
- C Ester and Aldehyde
- D Hydroxyl and Carbonyl

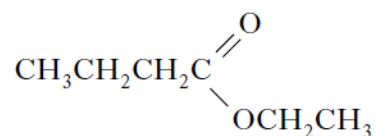
3. An ester has the following structural formula;



The name of this ester is

- A propyl propanoate
- B ethyl butanoate
- C butyl ethanoate
- D ethyl propanoate

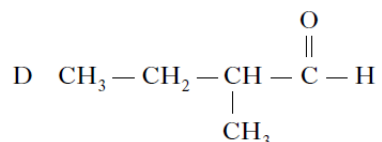
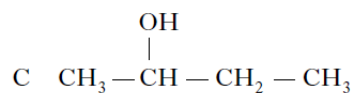
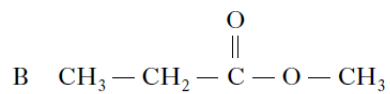
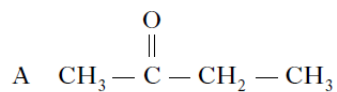
4. Rum flavour is based on the compound with the formula shown



It can be made from

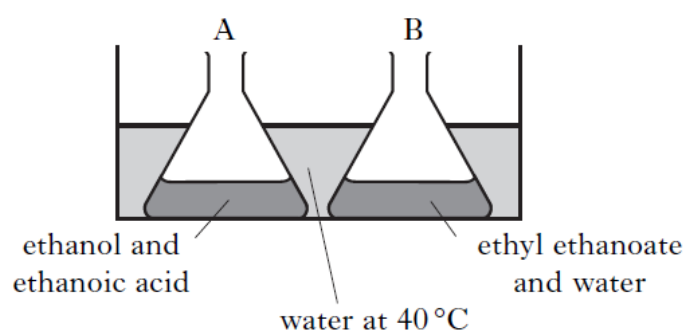
- A ethanol and butanoic acid
- B propanol and ethanoic acid
- C butanol and methanoic acid
- D propanol and propanoic acid

5. Which of the following compounds is hydrolysed when warmed with sodium hydroxide solution?



Q6

Two flasks, A and B, were placed in a water bath at 40 °C



After several days the content of both flasks were analysed.

Which results would be expected.

- A Flask A contains ethyl ethanoate, water, ethanol and ethanoic acid;  
Flask B is unchanged.
- B Flask A contains only ethyl ethanoate and water; Flask B is unchanged.
- C Flask A contains only ethyl ethanoate and water; Flask B contains ethyl ethanoate, water, ethanol and ethanoic acid.

- D     Flask A and Flask B contains ethyl ethanoate, water, ethanol and ethanoic acid.

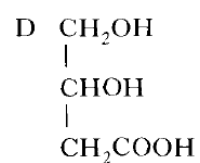
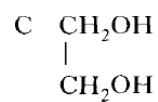
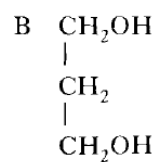
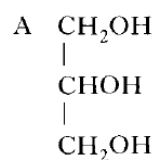
Q7

Which of the following is most likely to be used as flavourings?

- A      $\text{CH}_3\text{CH}_2\text{CHO}$   
B      $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$   
C      $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$   
D      $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_3$

Q8

Which of the following represents the structural formula for glycerol?



Q9

Fats have higher melting points than oils because comparing fats to oils;

- A Fats have more hydrogen bonds
- B Fat molecules are more saturated
- C Fat molecules are more loosely packed
- D Fats have more cross-links between their molecules.

Q10

In the formation of 'hardened' fats from vegetable oils, the hydrogen

- A causes cross-linking between chains

- B caused hydrolysis to occur
- C increases the carbon chain length
- D reduces the number of carbon - carbon double bonds

Q11.

Ethyl pentanoate is an ester formed in a condensation reaction between ethanol and pentanoic acid.

(a) Draw the full structural formula for ethyl pentanoate.

(1)

Ethyl pentanoate can be prepared in a laboratory in a process known as esterification.

(b)(i) Draw a labelled diagram of the assembled apparatus that could be used to prepare ethyl pentanoate in the laboratory

(2)

(ii) What is the purpose of the condenser (wet paper towel)?

(1)

(iii) Explain why a water bath is used to heat the reaction mixture?

(1)

(iv) State two further precautions that should be adopted when carrying out this experiment?

(1)

The test-tube (from part (b)(i)) containing the reaction mixture is removed from the hot water bath and its contents poured into a beaker containing sodium hydrogencarbonate solution.

I(i) Explain why the reaction mixture is added to a solution of sodium hydrogencarbonate.

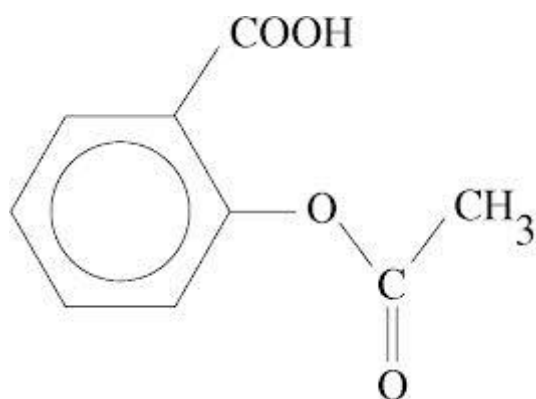
(1)

(ii) State two pieces of evidence that indicate that an ester has been formed

(2)

Q12.

A compound in the headache tablet aspirin has the following structure;



(a) What is meant by hydrolysis?

(1)

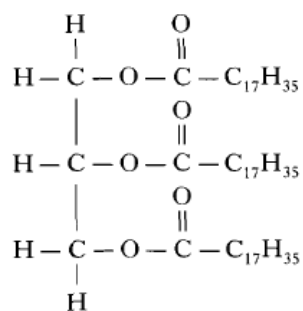
Headache tablets which are kept for many months, especially in hot and humid climates, often smell of vinegar (ethanoic acid)

(b) Draw the products of the hydrolysis of aspirin.

(2)

Q13

Fats and oils are ester molecules known as triglycerides. The structure of a fat molecule is shown below



(a) When this triglyceride is hydrolysed, a fatty acid is obtained. Name the other product obtained in this reaction.

(1)

(b) Oils are liquid at room temperature; fats are solids. Why do oils have lower melting points than fats.

(1)

A fatty acid is a long chained carboxylic acid. Examples of fatty acids are shown in the table below



Common name	Systematic name	Structure
stearic acid	octadecanoic acid	$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$
oleic acid	octadec-9-enoic acid	$\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$
linoleic acid	octadec-9,12-dienoic acid	$\text{CH}_3(\text{CH}_2)_4\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$

(c) Describe a test, with expected results, that could be used to distinguish between stearic acid and oleic acid.

(2)

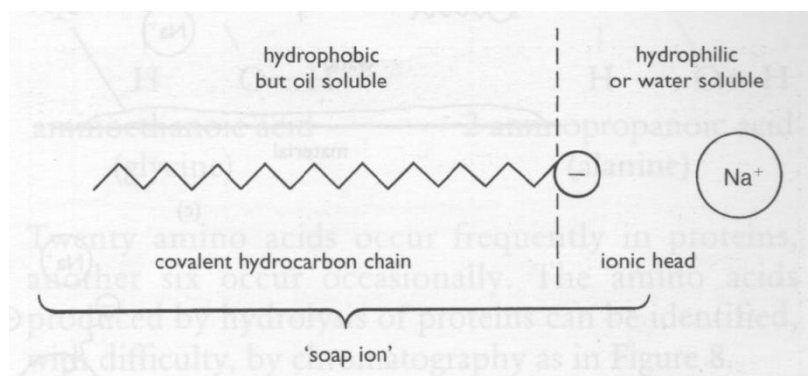
Stearic acid can be reacted with sodium hydroxide to make a salt of the fatty acid.

(d) Give a commercial use for salts of fatty acids.

(1)

Q14

The structure of a soap molecule is represented below



This representation of a soap molecule illustrates that soaps have two parts to them:

1. An ionic head which is water soluble
2. A covalent hydrocarbon tail that is soluble in oil or grease

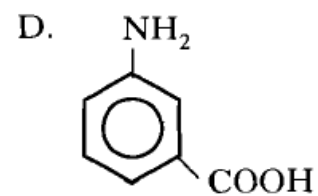
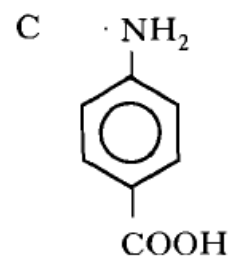
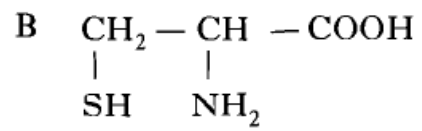
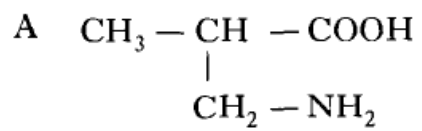
With the aid of a diagram and the above information, explain how soaps can clean grease from clothing such as your school shirt.

(3)

### Proteins

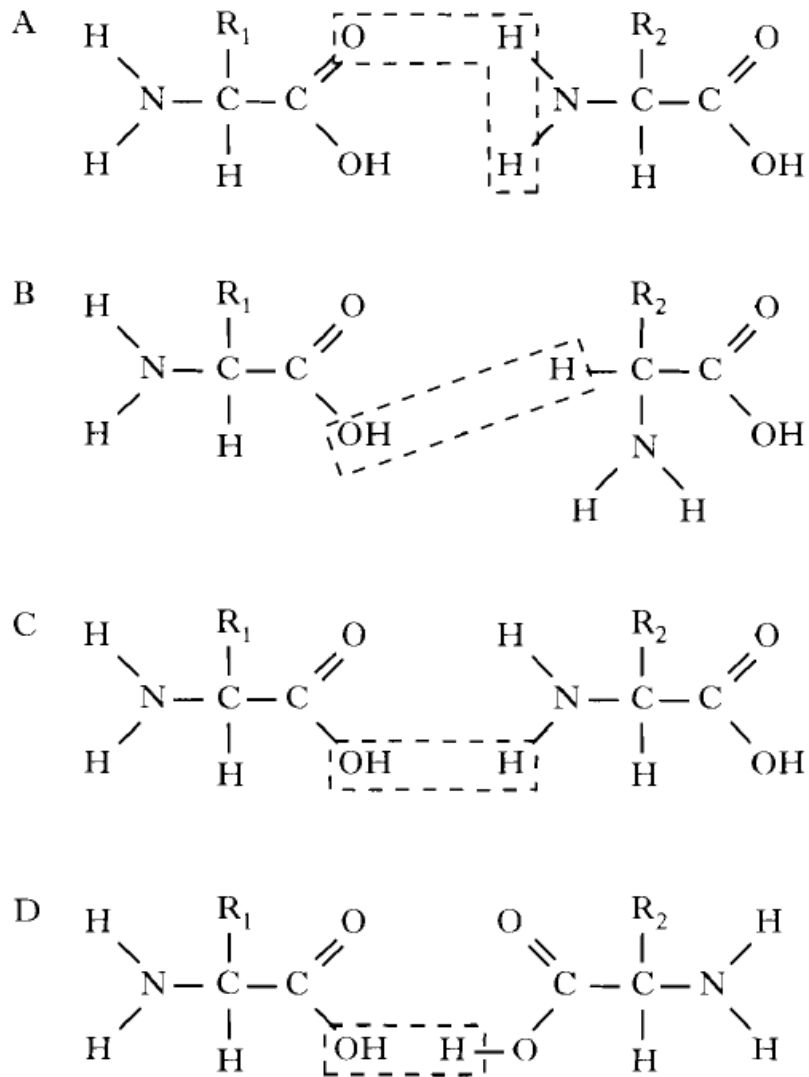
Multiple choice

1. Proteins can be classified as
  - a. Polyesters
  - b. Amino acids
  - c. Polyamides
  - d. Carboxylic Acids
  
2. In alpha amino acids the amino group is on the carbon atom adjacent to the acid group.  
Which of the following is an alpha-amino acid?



3. When two amino acids condense together, water is removed and an amide link is formed.

Which of the following represents the process?



4. Proteins are denatured under acidic conditions.  
During this denaturing, the protein molecule

- Changes shape
- Is dehydrated
- Is neutralised
- Is polymerised

5. The arrangement of amino acids in a peptide is



Where the letters V, W, X, Y and Z represent amino acids. On partial hydrolysis of the peptide, which of the following sets of dipeptides is possible?

- a. V-Y, Z-X, W-Y, X-W
- b. Z-X, V-Y, W-V, X-W
- c. Z-X, X-V, W-V, V-Y
- d. X-W, X-Z, Z-W, Y-V

6. The monomer units used to construct enzyme molecules are

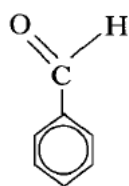
- a. Alcohols
- b. Esters
- c. Amino acids
- d. Fatty acids

7. Amino acids are converted into proteins by

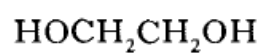
- a. Hydration
- b. Hydrolysis
- c. Hydrogenation
- d. Condensation

8. Identify the molecule which could be produced when a protein is hydrolysed

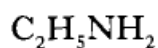
a.



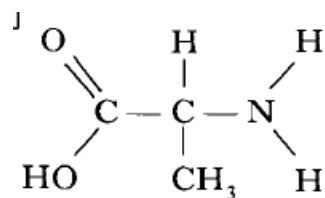
c.



b.

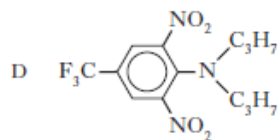
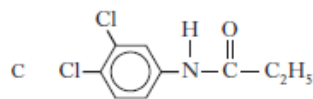
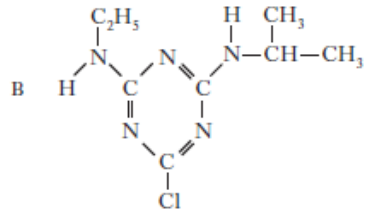
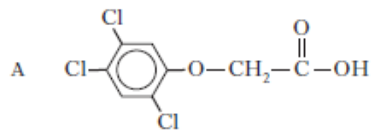


d.

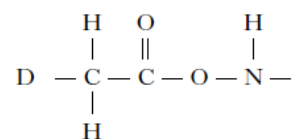
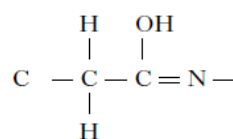
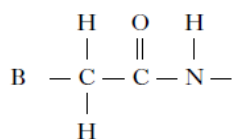
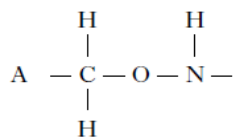


9. The following molecules are found in herbicides

Which of the following contain an amide link

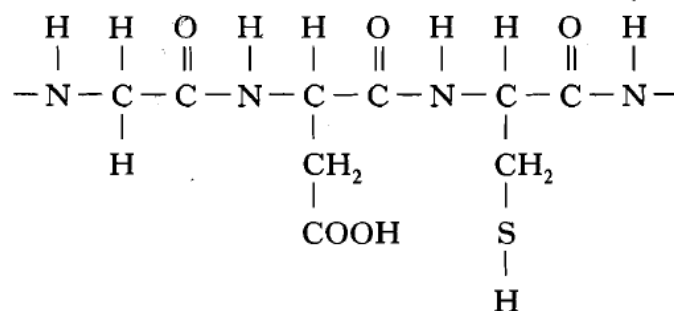


10. Which of the following is an amine?



## Section B

1. Part of a protein molecule is shown below. Draw the structural formula for one of the monomers produced on hydrolysis of the protein. (2)



2. Keratin,  
natural

polymer, is a protein found in hair. The hydrolysis of keratin produces different compounds

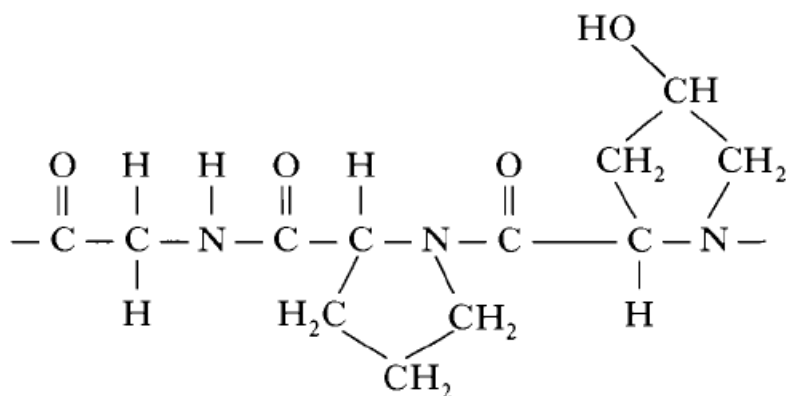
- a. What name is given to compounds like glycine, alanine and cysteine?
  - b. What is meant by a hydrolysis reaction?
  - c. Proteins are polyamides, what name is given to the link in a polyamide?
  - d. Draw the link present in a polyamide (4)
3. Explain what is meant by the term essential amino acid (2)
4. There are many different enzymes in the human body.
- a. Which four elements do all enzymes contain? (1)
5. Salivary amylase is an enzyme found in the human body which converts starch to maltose. The pH of saliva is about 7, which is close to the optimum temperature of an enzyme. Amylase stops functioning when it enters the stomach which has a pH of 2.  
What happens to the enzyme on entering the stomach which would cause it to stop functioning? (1)
6. Paracetamol is a widely used painkiller. The structure is shown below.  
Circle and name 2 functional groups present in this molecule.



(2)

7. Vitamin C is required by our bodies for producing the protein, collagen. The structure of collagen is formed from the protein bonding to form sheets that support skin and internal organs.

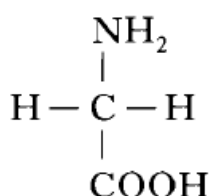
- Name the type of bonding which occurs between protein molecules? (1)
- Part of the structure of collagen is shown below. Draw a structural formula for an amino acid which could be obtained by hydrolysing this part of collagen.



(2)

8. Electrophoresis, widely used in medicine and forensics, involves the movement of ions in an electric field. The technique can be used to separate and identify amino acids produced by the breakdown of proteins.

- Name the type of chemical reaction which takes place during the breakdown of proteins. (1)
- The amino acid glycine has the following structure

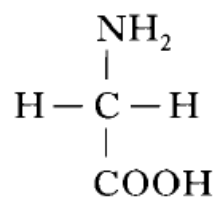


Draw 3 glycine molecules joined together. (1)

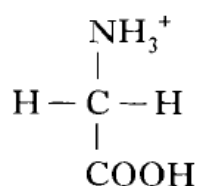
- The creation of proteins is an example of which type of chemical reaction? (1)



d. The amino acid glycine has the following structure



Like all amino acids, glycine exists as ions in solution and the charge on the ion depends on the pH of the solution. In solutions with low pH the glycine exists as a positively charged ion:



In solutions with a high pH value the glycine exists as a negatively charged ion?

Draw the structure of the negative ion.

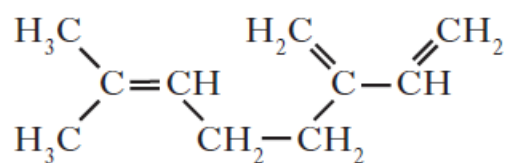
(1)

## Soaps, Fragrances and Skin Care

1. In which line of the table are fat, protein and soap correctly classified.

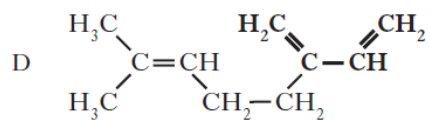
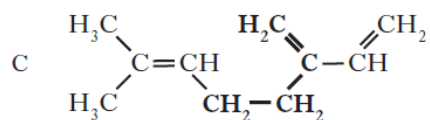
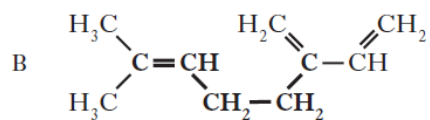
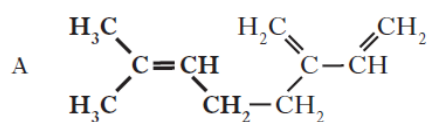
	Amides	Salts	Esters
A	Fat	Soap	Protein
B	Fat	Protein	Soap
C	Soap	Fat	Protein
D	Protein	Soap	Fat

2. Myrcene is a simple terpene

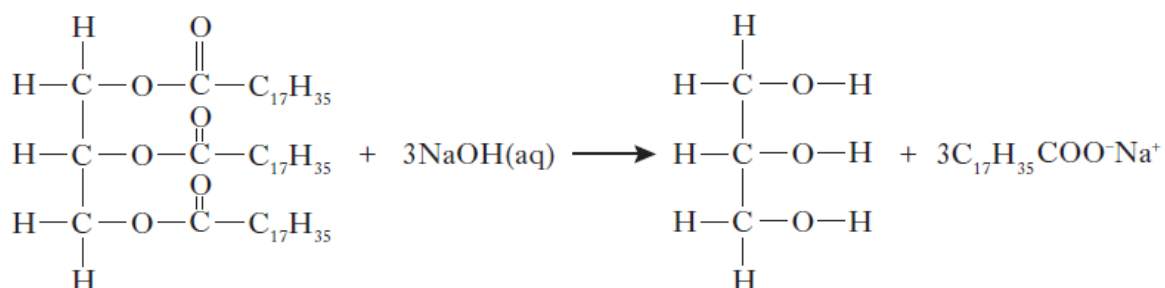


Terpenes contain at least one isoprene unit.

Which of the following correctly highlights an isoprene unit?



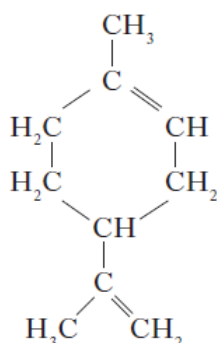
3. Soaps are produced from the following reaction



The reaction is an example of

- Condensation
- Esterification
- Hydrolysis
- Oxidation

4. Limonene is one of the terpene molecules responsible for the flavour of lemons.



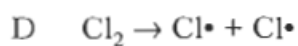
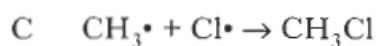
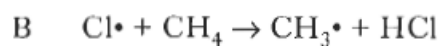
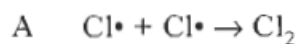
How many isoprene molecules are used in the production of one limonene molecule.

- 1
- 2
- 3
- 4

5. Which of the following substances could be used as a soap?

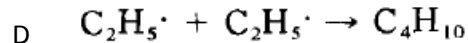
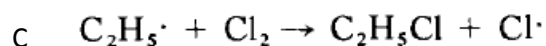
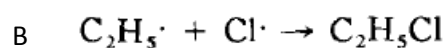
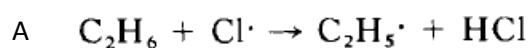
- Calcium Stearate
- Stearic Acid
- Potassium Stearate
- Ethyl Stearate

6. Which of the following represents a propagation step in a chain reaction?

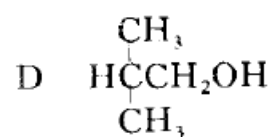
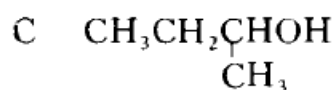
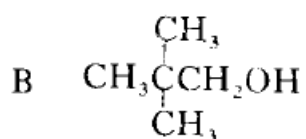
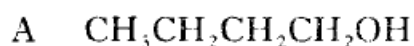


7. The reaction between chlorine and ethane to give chloroethane is a chain reaction.

Which of the following reactions will be "chain-stopping" (i.e. will not propagate the chain)



8. Which of the following can be oxidised to butanoic acid?



9. Free radical scavengers are

- a. Compounds which combines with free radicals to form stable molecules.
- b. Compounds which cause free radical chain reactions
- c. Stable compounds used in skin care products which are made of vitamins.
- d. Compounds which break covalent bonds to form radicals.

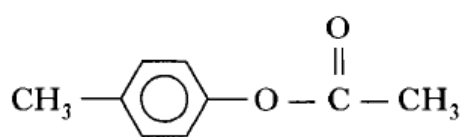
10. An essential oil is

- a. An oil which is essential in creating fragrance
- b. A concentrated extract of the aroma compounds from plants
- c. An unsaturated water soluble compound
- d. A synthetic inorganic compound.

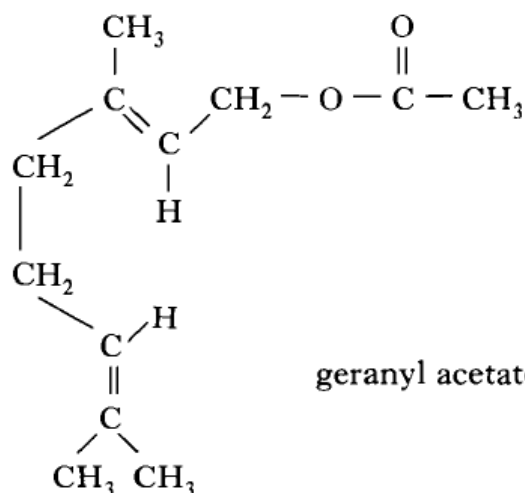
## Long Answer Questions!

1. Perfumes normally contain three components called the top note, the middle note and the end note.

The top note components of a perfume form vapours most easily. Two compounds found in top note vapours are



*p*-cresyl acetate

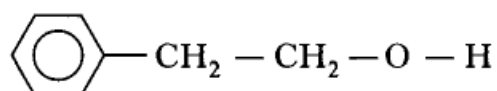


geranyl acetate

- a. With reference to the structure of these compounds why are they likely to have pleasant smells?
- b. Describe a chemical test which would distinguish between the two compounds and give the results.

The middle note compounds form vapours less readily than the top note. A typical compound of the middle note is

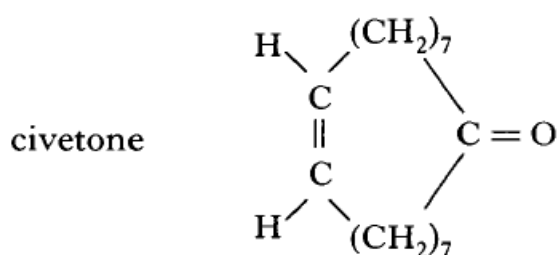
### 2-phenylethanol



- c. Due to Hydrogen bonding 2-phenylethanol forms a vapour less readily than *p*-cresyl acetate.

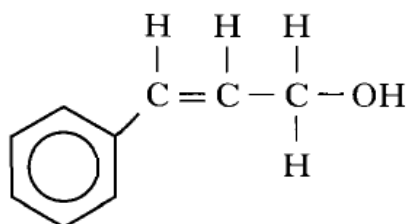
Draw another molecule of 2-phenylethanol and use a dotted line to show where a hydrogen bond exists between the two molecules

The end note of a perfume has a long lasting odour which stays with the user. An example of an end note compound is civetone.



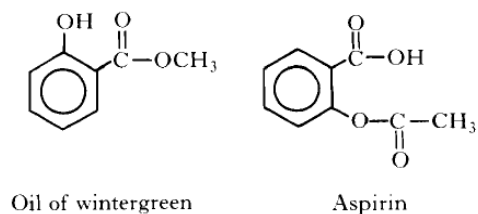
Draw the structure of the alcohol which would be formed by the reduction of civetone.

2. Synthetic perfumes are cheaper and easier to produce than natural perfumes.
- a. Cinnamyl alcohol smells pleasantly of hyacinths; it can be described as aromatic.



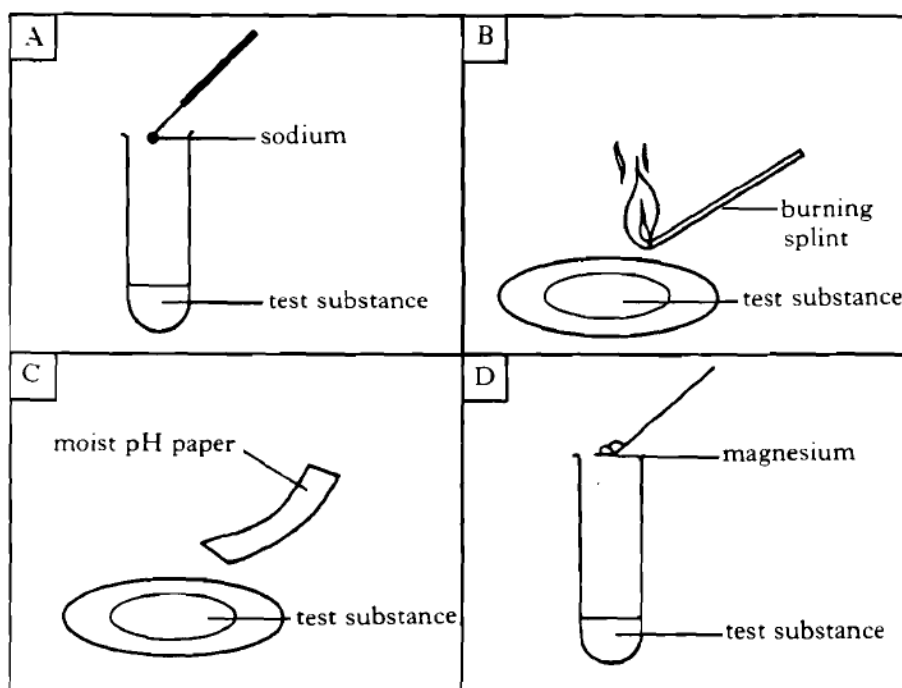
Give another term which could be used to describe this alcohol.

3. Oil of wintergreen and aspirin are used in medicine. The structures are shown below.



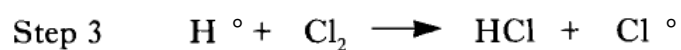
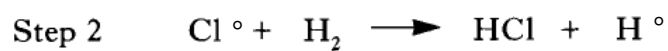
What term can be applied to aspirin but not oil of wintergreen?

4. A student carried out four tests on ethanol and ethanoic acids to compare the properties of the two homologous series, alcohols and carboxylic acids.
- Choose one test in which ethanol and ethanoic acid will give different results and state the results.
  - Choose one test in which ethanol and ethanoic acid will give similar results and state the result.





5. A mixture of hydrogen and chlorine gases reacts explosively when exposed to ultraviolet light. The reaction involves very reactive chlorine atoms (Cl) and hydrogen atoms (H).



- Explain why halogen radicals are produced rather than hydrogen radicals in the initiation reaction.
- Suggest why step 1 is speeded up when the mixture of gases is exposed to ultraviolet light.