SECTION 11 Chemistry of Carbon Compounds

Multiple-Choice Questions

Part 1: Organic reaction and Part 2: Plastic

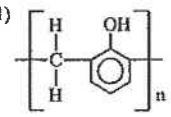
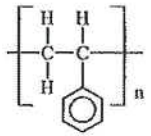
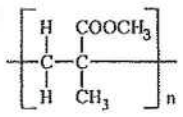
CE90_39

A glass of sweet wine is left on a dinning table. After two days, the wine becomes sour. Which of the following type of reactions accounts for this change?

A. oxidation
B. hydrolysis
C. fermentation
D. esterification

CE90_41

Which of the following polymers is/are made by condensation polymerization?

(1) 
(2) 
(3) 

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

CE91_30

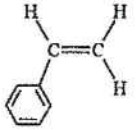
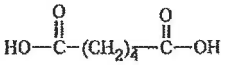
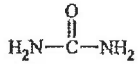
Propan-1-ol is refluxed with acidified potassium permanganate solution for a long time. Which of the following descriptions is/are correct?

(1) The reactants undergo esterification.
(2) Propanoic acid is formed.
(3) The permanganate is reduced.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE91_40

Which of the following compounds would react with each other to form a condensation polymer?

(1) 
(2) 
(3) 

A. (1) and (2)
B. (1) and (3)
C. (2) and (4)
D. (3) and (4)

CE92_06

0.01 mol of C_2H_5OH is burnt completely in oxygen. What are the numbers of moles of carbon dioxide and water formed respectively?

	carbon dioxide	water
A.	0.01	0.03
B.	0.02	0.03
C.	0.02	0.06
D.	0.04	0.06

CE92_20

Which of the following compounds does NOT react with propan-1-ol?

A. sodium
B. bromine water
C. acidified potassium permanganate solution
D. ethanoic acid

CE92_41

A compound, $C_2H_4O_2$, react with ethanol in the presence of concentrated sulphuric acid to form a product with a fruity smell.

Which of the following statements about this compound is/are correct?

(1) It can liberate carbon dioxide from sodium carbonate solution.
(2) It can decolourize acidified potassium permanganate solution.
(3) Its aqueous solution is an electrolyte.

A. (3) only
B. (1) and (2) only
C. (1) and (3) only
D. (1), (2) and (3)

CE92_47

1st statement	2nd statement
Polyester is a thermoplastic.	Polyester is formed by condensation polymerization.

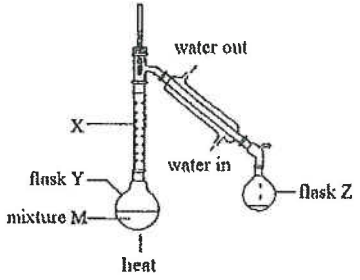
CE93_30

Directions: CE93_30 and CE93_31 refer to the following experiment:

A mixture of methyl propanoate and sulphuric acid was allowed to react by heating under reflux for some time until equilibrium was reached. The resulting mixture M was then transferred to flask Y and heated as shown below:

What is the function of the piece of apparatus labelled X?

A. to condense the products in M
B. to separate the products in M
C. to prevent the loss of the products in M due to evaporation
D. to prevent the loss of the reactants in M due to evaporation



CE93_31

The first fraction of the distillate collected in flask Z is mainly

A. methanol.
B. propan-1-ol.
C. methanoic acid.
D. propanoic acid.

CE93_43

Which of the following reagents can be used to distinguish between aluminium sulphate solution and lead(II) ethanoate solution?

A. barium chloride solution
B. sodium hydroxide solution
C. nitric acid
D. hydrochloric acid

CE94_19

Which of the following substances can turn an acidified solution of potassium permanganate colourless?

A. ethane
B. ethanol
C. ethanoic acid
D. ethyl ethanoate

CE94_42

Which of the following substances can be fermented to give an alcoholic drink?

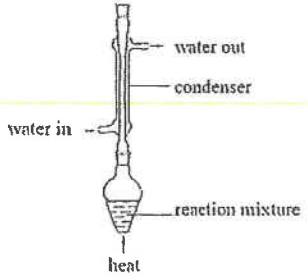
(1) grapes
(2) wheat
(3) potatoes

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE96_23

Directions: Q.23 and Q. 24 refer to the following experiment.

A reaction mixture containing acidified potassium dichromate solution and ethanol is heated using the set-up shown below:



In this experiment, the reaction mixture is undergoing

A. reflux.
B. distillation.
C. emulsification.
D. fractional distillation.

CE96_24

Which of the following statements concerning this experiment is correct?

A. The acidified potassium dichromate solution acts as a catalyst.
B. The reaction mixture gradually becomes brown.
C. Ethanol is reduced during the experiment.
D. Ethanoic acid is formed during the experiment.

CE96_41

Which of the following statements concerning propan-1-ol are correct?

(1) propan-1-ol can be used as a solvent.
(2) propan-1-ol can undergo polymerization.
(3) propan-1-ol can undergo esterification with ethanoic acid in the presence of concentration sulphuric acid.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE97_15

Which of the following substances, when mixed, would produce a precipitate?

A. chlorine water and potassium bromide solution
B. ethyl ethanoate and ethanol
C. iron(III) sulphate solution and aqueous ammonia
D. nitric acid and potassium hydroxide solution

CE97_20

When a glass of wine is left overnight, it becomes sour. Which of the following reactions is responsible for this change?

A. fermentation
B. oxidation
C. dehydration
D. esterification

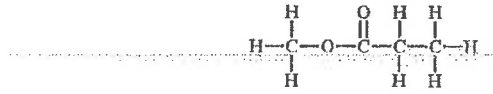
CE98_48

1st statement	2nd statement
The ethanol content of beer is less than that of red wine.	Beer is made by fermentation of barley while red wine is made by fermentation of grapes.

CE99_26

Directions: Q.26 and Q.27 refer to the following experiment:

Some concentrated sulphuric acid and pumice stones were added to an alkanol and an alkanoic acid. The mixture was heated under reflux for some time and the following compound was obtained:



Which of the following combinations is correct?

	Alkanol	Alkanoic acid
A.	methanol	ethanoic acid
B.	methanol	propanoic acid
C.	ethanol	ethanoic acid
D.	ethanol	propanoic acid

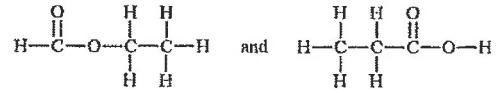
CE99_27

Which of the following statements concerning the experiment is correct?

A. Concentrated sulphuric acid acts as an oxidizing agent in the reaction.
B. The purpose of using pumice stones is to speed up the reaction.
C. A fractionating column should be used in the experimental set-up.
D. Heating under reflux can prevent the loss of reactants and products.

CE00_13

Consider the compounds represented by the two structures below:

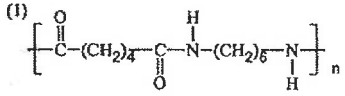
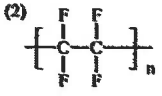
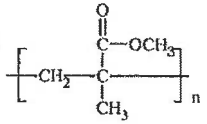

and

Which of the following statements concerning these compounds is correct?

A. Both compounds can turn wet blue litmus paper red.
B. Both compounds have the same odour.
C. Both compounds have the same molecular formula.
D. Both compounds have the same boiling point.

CE00_36

Which of the following polymers is/are made by condensation polymerization?

(1)

(2)

(3)


A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE01_21

Which of the following statements concerning ethanol and butan-2-ol is INCORRECT?

A. Both compounds can dissolve iodine.
B. Both compounds can be represented by the same general formula.
C. The boiling point of ethanol is higher than that of butan-2-ol.
D. Each compound can be obtained by catalytic hydration of the corresponding alkene.

CE01_25

The reaction involved in the preparation of ethanoic acid from ethanol is

A. an addition.
B. a condensation.
C. a redox.
D. a dehydration.

CE01_50

1st statement	2nd statement
The reaction of ethanoic acid with ethanol is a neutralization.	Water is one of the products formed in the reaction of ethanoic acid with ethanol.

CE04_17

The following paragraph was extracted from the laboratory report of a student on the preparation of an organic compound.

> $CH_3CH_2CO_2H$ and CH_3CH_2OH were heated with a small amount of concentrated H_2SO_4 in a test tube for a few minutes. The resultant mixture was then added to a beaker of cold water.

Which of the following statements concerning the experiment is correct?

A. The compound prepared was ethyl ethanoate.
B. Concentrated H_2SO_4 acted as an oxidizing agent.
C. The preparation involved a condensation.
D. When the resultant mixture was added to the cold water, a white precipitate was formed.

CE04_27

Ethane can be prepared by heating ethanol with excess concentrated sulphuric acid. The reaction involved can be represented by the equation:

$$CH_3CH_2OH \xrightarrow{\text{conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$$

The type of reaction involved in the preparation is

A. cracking.
B. condensation.
C. addition.
D. dehydration.

CE04_33

Which of the following processes is/are involved in the production of whisky?

(1) heating under reflux
(2) distillation
(3) fermentation

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE05_24

Which of the following health hazards are related to excessive drinking of spirits?

(1) liver damage
(2) stomach damage
(3) lung damage

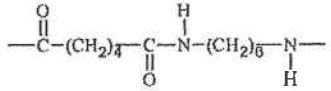
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE05_49

1st statement	2nd statement
Polyester is an addition polymer.	Polyester softens on heating.

CE06_43

The repeating unit of polymer X is shown below:



Which of the following statements about X is/are correct?

(1) X is an addition polymer.
(2) X is formed from two different monomers.
(3) X is a thermosetting plastic. [OUT]

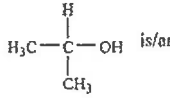
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

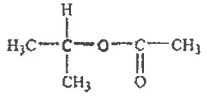
CE07_16

A mixture containing 25 cm^3 of $CH_3CH_2CH_2OH$, 25 cm^3 of CH_3COOH and 1 cm^3 of concentrated H_2SO_4 is heated under reflux. After some time, a pleasant smell is detected. Which of the following statements concerning this experiment is correct?

A. A redox reaction is involved.
B. The reaction cannot go to completion.
C. Concentrated H_2SO_4 acts as a reactant.
D. One of the products is ethyl propanoate.

CE07_23

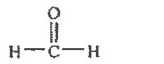
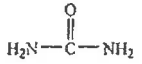
Which of the following statements concerning  is/are correct?

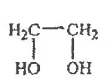
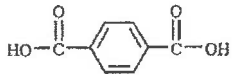
(1) It is neutral to litmus solution.
(2) Its systematic name is propanol.
(3) When it reacts with ethanoic acid, the ester formed is 

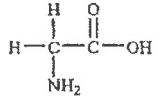
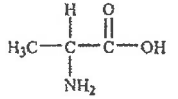
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE07_42

Which of the following pairs of compound can form condensation polymers?

(1)  

(2)  

(3)  

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE08_47

The empirical formula of an organic compound T is CH_2O. Effervescence occurs when T is added to sodium carbonate solution. T may be

(1) $HCOOCH_3$.
(2) $CH_3CH(OH)COOH$.
(3) $CH_3CH_2CH_2COOH$.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE09_12

An organic compound X has the molecular formula $C_3H_4F_2$. Which of the following statements concerning X is correct?

A. X has at least four possible structures.
B. X must be a saturated compound.
C. X turns acidified potassium dichromate solution from orange to green.
D. X can be used to make a thermosetting plastic by addition polymerization.

CE09_24

Which of the following substances can react with acidified potassium permanganate solution?

(1) propene
(2) potassium iodide solution
(3) sodium sulphite solution

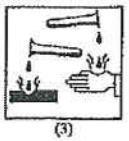
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_25

Which of the following hazard warning labels should be displayed on the reagent bottle of methanol?


(1)


(2)


(3)

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_27

Esters can be used to make

(1) perfumes,
(2) food additives,
(3) solvent for paint.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

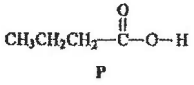
CE10_07

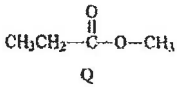
In an experiment, a mixture of ethanol and acidified potassium permanganate solution is heated under reflux to obtain ethanoic acid. Which of the following apparatus should be used in the experiment?

A. stopper
B. thermometer
C. fractionating column
D. water condenser

CE10_18

The structures of compounds P and Q are shown below:


P

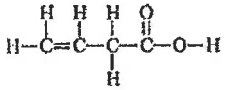

Q

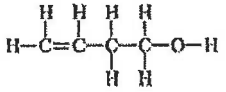
Which of the following statements is correct?

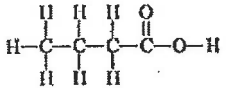
A. P and Q are both acids.
B. P is more volatile than Q.
C. P dissolves in water readily but Q does not.
D. P and Q both decolourlise bromine water rapidly.

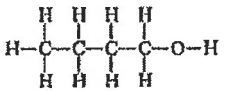
CE10_38

Compound E rapidly decolourises cold acidified potassium permanganate solution. When E is added to sodium hydrogencarbonate solution, effervescence occurs. Which of the following compounds may E be?

A. 

B. 

C. 

D. 

CE11_13

Propene reacts with bromine dissolved in organic solvent to give

A. 1-bromopropane.
B. 2-bromopropane.
C. 1,2-dibromopropane.
D. 1-bromopropane and 2-bromopropane.

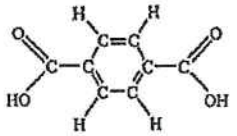
CE11_15

What is the chemical formula of the organic product formed from the reaction between ethanol and propanoic acid under suitable conditions?

A. $CH_3COOC_3H_7$
B. $C_2H_5COOCH_3$
C. $C_2H_5COOC_2H_5$
D. $C_3H_7COOC_2H_5$

CE11_34

The two compounds shown below undergo condensation polymerization under suitable conditions.


and $HO-CH_2-CH_2-OH$

What small molecule would be eliminated in this condensation polymerization?

A. H_2O
B. H_2O_2
C. CH_3OH
D. HCOOH

CE11_48

1st statement	2nd statement
Nylon has cross-links among the polymer chains.	Nylon is a condensation polymer.

CE11_39

In an experiment, a mixture of coconut oil and excess concentrated sodium hydroxide solution is heated for some time. Then a small amount of concentrated sodium chloride solution is added to the reaction mixture with stirring. A solid product is eventually formed. Which of the following statements concerning this experiment is correct?

A. The solid formed is glycerol.
B. This experiment involves emulsification.
C. The purpose of this experiment is to prepare a soapless detergent.
D. The purpose of adding concentrated sodium chloride solution is to salt out the product formed.

CE11_50

1st statement	2nd statement
Propane can change acidified potassium permanganate solution from purple to colourless.	Substitution reaction occurs when propane is added to acidified potassium permanganate solution.

Part 3: Soaps and Soapless detergents

CE90_37

Clothes stained with grease can be cleaned by detergents because detergents can

(1) decrease the surface tension of water.
(2) dissolve in both water and grease.
(3) emulsify greasy particles.

Which of the following combinations is correct?

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE90_38

Which of the following statements concerning the production of soap from vegetable oils and sodium hydroxide solution is/are correct?

(1) Sodium hydroxide acts as a catalyst.
(2) Glycerol is formed at the end of the reaction.
(3) The reaction between vegetable oils and sodium hydroxide solution is reversible.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE91_33

Which of the following statements is/are true for soapless detergents?

(1) All soapless detergents are not biodegradable.
(2) Soapless detergents form a scum with sea water.
(3) Soapless detergents are mainly manufactured from products of the petroleum industry.

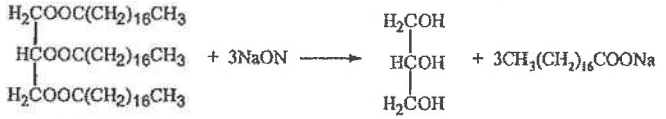
A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

CE91_49

1st statement	2nd statement
In the preparation of soap, sodium chloride is added after the reaction between oil and sodium hydroxide has been completed.	Sodium chloride can increase the solubility of soap.

CE92_23

Direction Q.22 and Q.23 refer to the making of soap as represented by the following reaction:



animal fat soap

Soap has a hydrophilic head and hydrophobic tail. Which of the following combination is correct?

	Hydrophilic head	Hydrophobic tail
A.	Na^+	$CH_3(CH_2)_{16}-$
B.	$-COO^-$	$CH_3(CH_2)_{16}-$
C.	Na^+	$CH_3(CH_2)_{16}COO^-$
D.	$CH_3(CH_2)_{16}COO^-$	Na^+

CE93_44

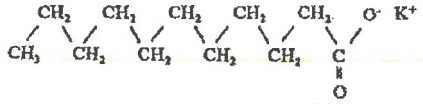
Which of the following statements is INCORRECT?

A. Tin is used for making food cans.
B. Sulphuric acid is used for making soap.
C. Ammonium chloride is used for making dry cells.
D. Chlorine is used for sterilizing drinking water.

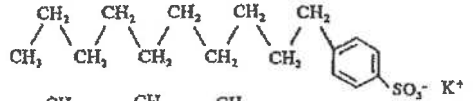
CE94_24

Directions: Q.24 and Q.25 refer to the structural formulae of the following three detergents:

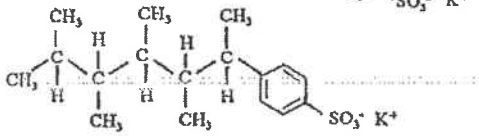
detergent I



detergent II



detergent III



Which of the above is/are soapless detergent(s)?

A. detergent I only
B. detergent III only
C. detergents I and II only
D. detergents II and III only

CE94_25

Which of the following statements concerning these detergents is correct?

A. The hydrocarbon tail of detergent III is hydrophilic.
B. Both detergents I and II form scum with seawater.
C. Detergent III causes more serious pollution problems than detergent I when discharged into rivers.
D. Both detergents II and III are made from fats.

CE96_28

Directions: Q.28 and Q.29 refer to the following experiment used to study the causes of hardness of water.

A student added some soap solution to four test tubes containing the same volume of different aqueous solutions of the same molarity. He shook the tubes and measured the minimum volume of soap solution needed to form a permanent lather. The results are tabulated below:

Aqueous solution	Minimum volume of soap solution needed to form a permanent lather / cm^3
Sodium chloride	0.6
Calcium chloride	9.3
Potassium chloride	0.9
Magnesium chloride	8.5

Which of the following apparatus would be most suitable for measuring the volume of soap solution?

A. 50 cm^3 burette
B. 50 cm^3 measuring cylinder
C. 25 cm^3 pipette
D. 10 cm^3 beaker

CE96_29

Which of the following substances is/are responsible for the hardness of water?

(1) sodium chloride
(2) calcium chloride
(3) potassium chloride
(4) magnesium chloride

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (4) only

CE97_35

Dilute ammonia solution is used in domestic glass cleaners because

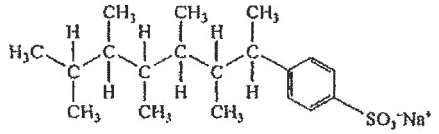
(1) it can saponify grease.
(2) it is non-corrosive.
(3) it contains ammonium ions which can emulsify grease.

Which of the above statements is/are correct?

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE98_15

A detergent has the following structure:



Which of the following statements concerning the detergent is correct?

A. Its hydrocarbon chain is hydrophilic.
B. It can be manufactured from vegetable oil.
C. It is readily degraded by micro-organisms.
D. It acts as an emulsifier in the cleaning process.

CE98_41

Which of the following problems are associated with the excessive use of soapless detergents?

(1) They can cause skin allergies.
(2) They form foam when discharged into rivers and lakes.
(3) They form scum when discharged into the sea.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE99_43

Which of the following statements concerning a soapless detergent are correct?

(1) It can be prepared by heating a cooking oil with sodium hydroxide solution.
(2) It acts as a wetting agent by reducing the surface tension of water.
(3) It acts as n emulsifying agent in the cleaning process.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE99_48

1st statement	2nd statement
Local tap water produces a scum with soap.	Water containing calcium ions can form an insoluble compound with soap.

CE00_18

Some potassium carbonate solution is added to a sample of tap water. The mixture then appears cloudy. Which of the following ions is probably present in the sample?

A. NH_4^+
B. Mg^{2+}
C. Br^-
D. SO_4^{2-}

CE00_41

Which of the following statements concerning soaps are correct?

(1) They are esters.
(2) They can reduce the surface tension of water.
(3) Their aqueous solutions are alkaline.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE01_16

Which of the following statements is correct for a soapy detergent but incorrect for a soapless detergent?

A. Its structure consists of a hydrophilic part and a hydrophobic part.
B. It forms a lather when shaken with distilled water.
C. It can be made by reacting a vegetable oil with an alkali.
D. It acts as an emulsifier in the cleaning process.

CE01_21

In a boiler using hard water, scale is deposited on its interior after a period of time. The scale consists mainly of metal carbonates. Which of the following substances can be used to remove the boiler scale?

A. soapless detergent
B. chlorine bleach
C. sodium hydroxide solution
D. vinegar

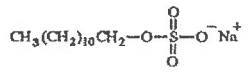
CE03_19

Soap was prepared by heating fat with sodium hydroxide solution for some time. Concentrated sodium chloride solution was then added to the resulting mixture. The purpose of adding concentrated sodium chloride solution is

A. to help the precipitation of soap.
B. to enhance the cleansing power of the soap.
C. to reduce the alkalinity of the soap.
D. to act as a preservative for the soap.

CE03_29

A detergent has the structure shown below:



Which of the following statements concerning this detergent is correct?

A. It is non-biodegradable.
B. It functions well in hard water.
C. It can be manufactured from vegetable oils.
D. The portion, $CH_3(CH_2)_{10}CH_2-$, is hydrophilic.

CE03_49

1st statement	2nd statement
Sodium carbonate can be used to soften hard water which contains calcium ions.	Sodium carbonate reacts with calcium ions in hard water to form a precipitate.

CE04_04

Which of the following substances is the poorest electrical conductor?

A. vinegar
B. household bleach
C. soap solution
D. antiseptic alcohol

CE04_22

The main chemical constituent of bleaching power is calcium hypochlorite. Which of the following statements concerning bleaching power is INCORRECT?

A. It works effectively with soaps in cleaning processes.
B. It can be used as a domestic sterilizing agent.
C. It reacts with acids readily to give chlorine.
D. It bleaches by oxidation.

CE04_49

1st statement	2nd statement
Sodium chloride is used in the manufacture of soap.	Sodium chloride helps the precipitation of soap from soap solution.

CE05_32

Which of the following substances is NOT used for the preparation of soaps?

A. vegetable oil
B. sodium hydroxide solution
C. concentrated sodium chloride solution
D. concentrated sulphuric acid

CE05_42

Which of the following statements concerning soaps are correct?

(1) Soaps are biodegradable.
(2) Soaps have good cleaning power in hard water.
(3) The structure of a soap particle consists of a hydrophilic part and a hydrophobic part.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE06_26

Which of the following statements concerning the cleansing actin of a detergent are correct?

(1) It reduces the surface tension of water.
(2) It acts as an emulsifying agent.
(3) It reacts with grease to form soluble products.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE06_42

Which of the following materials is/are used in the production of soap?

(1) petroleum fractions
(2) sodium hydroxide
(3) sulphuric acid

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

CE07_50

1st statement	2nd statement
Soapy detergent can be used to treat oil spillage on sea surface.	Soapy detergent can act as an emulsifying agent for oil.

CE08_35

Which of the following statements concerning a soapy detergent is correct?

A. It can increase the surface tension of water.
B. It contains a hydrophobic hydrocarbon chain.
C. It can be manufactured from petroleum products.
D. It contains a positive ionic part for carrying out emulsification.

CE09_45

Which of the following statements concerning soapy and soapless detergents are correct?

(1) They both are emulsifying agents.
(2) They both contain hydrophobic and hydrophilic parts.
(3) Soapy detergent is biodegradable while soapless detergent is non-biodegradable.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

CE09_50

1st statement	2nd statement
Discharge of synthetic detergents into rivers may cause rapid growth of algae.	Synthetic detergents may contain nutrients for the growth of algae.

CE10_41

The structure of a detergent is shown below:

$CH_3(CH_2)_{15}COO^-Na^+$

Which of the following statements concerning this detergent is correct?

A. It is non-biodegradable.
B. It forms scum in sea water.
C. It is manufactured from petroleum.
D. The hydrophilic part responsible for its cleansing action is Na^+.

CE11_47

Which of the following statements concerning soapy detergents and soapless detergents are correct?

(1) Soapy detergents can be made from fats whereas soapless detergents cannot.
(2) Soapy detergents form scum with sea water whereas soapless detergents do not.
(3) All soapy detergents are biodegradable whereas all soapless detergents are not.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

ASL08(I)_05

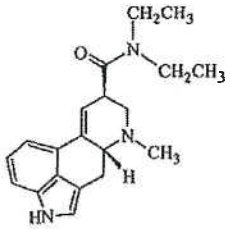
Which of the following compounds can be oxidized by acidified $Na_2Cr_2O_7(aq)$ at room temperature?

(1) CH_3CH_2OH
(2) CH_3COCH_3
(3) $(CH_3)_3COH$

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

ASL09(I)_03

Lysergic acid diethylamide (LSD) is a stimulant drug with the following structure:



Which one of the following statements about LSD is correct?

A. It has one chiral centre and possesses an amine functional group.
B. It has one chiral centre and possesses an alkene functional group.
C. It has two chiral centres and possesses an amide functional group.
D. It has two chiral centres and possesses a ketone functional group.

ASL13(I)_03

Which of the following pairs of substances react to give ammonia?

(1) $(NH_4)_2SO_4(s)$ and $Ca(OH)_2(s)$
(2) $NaNH_2(s)$ and $H_2O(l)$
(3) $CH_3CONH_2(aq)$ and $KOH(aq)$

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE11SP_26

Which of the following conversions is a substitution reaction?

A. $CH_3CH_2CH{=}CH_2 \longrightarrow CH_3Ch_2CHBrCH_3$
B. $CH_3CH_2CH_2CH_2OH \longrightarrow CH_3CH_2CH_2CHO$
C. $CH_3CH_2CHOHCH_3 \longrightarrow CH_3CH_2CHBrCH_3$
D. $CH_3CH_2CH_2CO_2H \longrightarrow CH_3CH_2CH_2CH_2OH$

DSE11SP_27

A compound with an ester functional group has a molecular formula of $C_4H_8O_2$. What is the number of possible structures of the compound?

A. 3
B. 4
C. 5
D. 6

DSE11SP_28

Which type of reaction is involved in converting propan-2-ol to propene?

A. Addition
B. Oxidation
C. Dehydration
D. Substitution

DSE11SP_30

Hydrogen, methane and butane are commonly used fuels. Which of the following statements is correct?

A. Hydrogen is a more environmental friendly fuel than butane.
B. Methane burns with a more sooty flame than butane.
C. Hydrogen, methane and butane all belong to the same homologous series.
D. On complete combustion, one mole of methane releases more carbon dioxide than one mole of butane.

DSE11SP_31

The following is a series of reactions starting from ethanol:

$$\text{ethanol} \xrightarrow{\text{reagent A}} \text{P} \xrightarrow{Na_2CO_3(aq)} CO_2(g) + \text{Q}$$

Which of the following correctly describes the reagent A and the product Q?

	Reagent A	Product Q
A.	Dehydrating agent	Ethene
B.	Dehydrating agent	Ethane
C.	Oxidizing agent	Sodium ethanoate
D.	Oxidizing agent	Ethanoic acid

DSE11SP_34

Which of the following statements is/are correct concerning the numbers of the homologous series of alkenes?

(1) Members of higher molecular mass are often used to make soap.
(2) The first few members are often used to make polymers.
(3) The members can commonly react with hydrogen halides to give halohydrocarbons.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE12PP_27

Consider the isomeric compounds shown below:

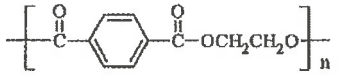
CH_3COCH_3 and CH_3CH_2CHO

Which of the following reagents can be used to distinguish between the two compounds?

A. Acidified potassium dichromate solution
B. Lithium aluminium hydride
C. Dilute sulphuric acid
D. pH indicator

DSE12PP_28

The structure of polymer X is shown below:



Which of the following statements about X is correct?

A. It possesses a ketone functional group.
B. It can undergo degradation in an acidic environment.
C. It has a giant covalent network structure.
D. It has a sharp melting point.

DSE12PP_33

Consider the following organic conversion:

$$(CH_3)_3COH \xrightarrow{X} (CH_3)_3Cl$$

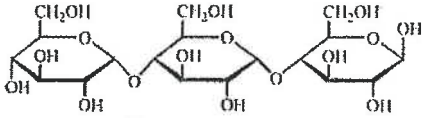
Which of the following reagents can X be?

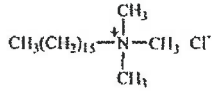
(1) $Cl_2(g)$
(2) $PCl_3(l)$
(3) Concentrated HCl(aq)

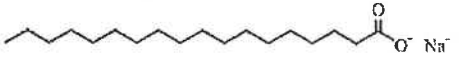
A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE12PP_34

Consider the following compounds: Which of these compounds can be used as active ingredients of detergents?

(1) 

(2) 

(3) 

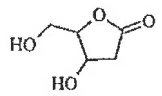
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE12PP_36

1st statement	2nd statement
The structural formula $H_2C=CF_2$ can represent two different compounds.	The rotation of the CF_2 group relative to the CH_2 group in $H_2C=CF_2$ is restricted by the C=C bond.

DSE12_28

The structure of an organic compound is shown below:



Which of the following statements is correct?

A. The compound does NOT show enantiomerism.
B. The molecular formula of the compound is $C_5H_6O_4$.
C. The compound contains a ketone group.
D. The compound can be oxidized by acidified $K_2Cr_2O_7$(aq).

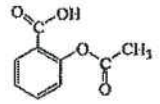
DSE12_29

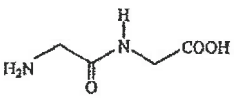
Which of the following statements concerning compound U ($CH_3CH_2CH=CHCH_2CH_2OH$) is correct?

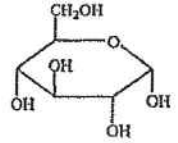
A. The empirical formula of U is C_5H_8O.
B. The systemic name of U is hex-4-en-ol.
C. U reacts with HCl to give a single product.
D. U can separately turn Br_2(aq) and acidified $KMnO_4$(aq) colorless.

DSE12_32

Which of the following structures represent(s) the active ingredient(s) in aspirin tablets?

(1) 

(2) 

(3) 

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE12_33

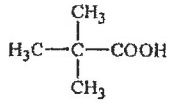
Which of the following compounds can be formed when $(CH_3)_2C(OH)CH_2CH_3$ is dehydrated?

(1) $(CH_3)_2C=CHCH_3$
(2) $(CH_3)_2CHCH=CH_2$
(3) $CH_2=C(CH_3)CH_2CH_3$

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE12_34

The structure of a compound is shown below:



Which of the following statements concerning the compound are correct?

(1) It can form a salt with aqueous ammonia.
(2) It can be reduced to an alkanol by using $LiAlH_4$.
(3) It can form an ester with methanol under suitable conditions.

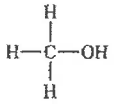
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE12_36

1st statement	2nd statement
2-Chlorobut-1-ene shows geometrical isomerism	2-Chlorobut-1-ene has a double bond.

DSE13_20

An organic compound has the following structure:



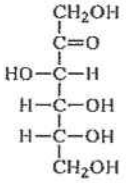
Which of the following statements about this compound is/are correct?

(1) It is immiscible with water.
(2) It is neutral to litmus solution.
(3) It burns with a non-luminous flame.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE13_29

The structure of fructose is shown on the right:

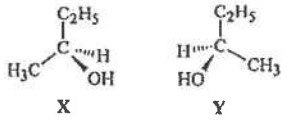


Which of the following statements about fructose is correct?

A. Its empirical formula is $C_6H_{12}O_6$.
B. It can turn acidified potassium dichromate solution from orange to green.
C. It is insoluble in water.
D. Its molecule has five chiral carbon centres.

DSE13_30

The three-dimensional structure of a molecule of compound X and that of compound Y are shown below:



X Y

Which of the following statements about X and Y is correct?

A. X and Y are identical.
B. X and Y are a pair of structural isomers.
C. A mixture of X and Y can be separated by fractional distillation.
D. X and Y have the same standard enthalpy change of combustion.

DSE13_31

Consider the compounds X and Y shown below:

X Y

Which of the following statements about X and Y is correct?

A. X and Y are a pair of geometrical isomers.
B. Both X and Y react with $H_2(g)$ in the presence of Ni(s).
C. X and Y react separately with Br_2 in CH_3CCl_3 to give the same organic product.
D. Both the polymerization of X and that of Y give the same addition polymer.

DSE13_32

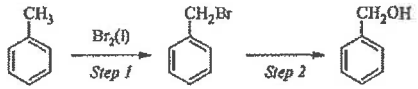
Which of the following statements about the action of sodium hydroxide solution on ethanamide is/are correct?

(1) Sodium ethanoate is formed in the reaction.
(2) In the reaction, sodium hydroxide act as catalyst.
(3) The reaction attains equilibrium if the reaction mixture is heated under reflex.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE13_34

Consider the following conversion of organic compounds:



Which of the following statements about the above conversion are correct?

(1) Excess $Br_2(l)$ should be used in *Step 1*.
(2) Light is needed in *Step 1*.
(3) The reagent used in *Step 2* can be KOH(aq).

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE13_35

In order to prepare 2-chloro-2-methylpropane, a mixture of 2-methylpropan-2-ol and concentrated hydrochloric acid is shaken vigorously.

$$(CH_3)COH \xrightarrow{\text{conc. HCl}} (CH)_3CCl$$

Which of the following statements about this preparation are correct?

(1) Two layers of liquids can be observed in the reaction mixture after shaking.
(2) The crude product should be washed with sodium carbonate solution.
(3) The unreacted 2-methylpropan-2-ol can be removed by simple distillation.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE14_27

Which of the following combinations concerning $CH_3CH{=}CHCH_2CH(C_2H_5)_2$ is correct?

	Number of geometrical isomers	Number of enantiomers
A.	2	4
B.	2	2
C.	0	2
D.	2	0

DSE14_28

Consider the following organic reactions where P, Q and R are the major organic products formed.

$$CH_3CH_2CH{=}CH_2 \xrightarrow{HBr(g)} P \xrightarrow{NaOH(aq)} Q \xrightarrow{K_2Cr_2O_7(aq)\,/\,H^+(aq)} R$$

Which of the following combinations is correct?

	P	Q	R
A.	$CH_3CH_2CHBrCH_3$	$CH_3CH_2CH(OH)CH_3$	$CH_3CH_2COCH_3$
B.	$CH_3CH_2CH_2CH_2Br$	$CH_3CH_2CH_2CH_2OH$	$CH_3CH_2CH_2CHO$
C.	$CH_3CH_2CH_2CH_2Br$	$CH_3CH_2CH{=}CH_2$	$CH_3CH_2CH(OH)CH_2OH$
D.	$CH_3CH_2CHBrCH_3$	$CH_3CH_2CH(OH)CH_3$	$CH_3CH_2CO_2H$

DSE14_32

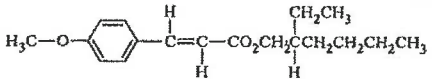
Which of the following statements concerning aspirin is/are correct?

(1) It undergoes esterification with ethanoic acid in the presence of an acid catalyst.
(2) It reacts with sodium carbonate solution to give a colorless gas.
(3) It can be used to reduce inflammation.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE14_33

A sunblock cream contains the compound below as the active ingredient:



Which of the following reagents can react with this compound?

(1) NaOH(aq)
(2) $PCl_3(l)$
(3) acidified $KMnO_4(aq)$

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE14_34

The structure of a detergent is shown below:

Which of the following statements concerning the detergent are correct?

(1) It has a cleaning function in hard water.
(2) Vigorous shaking it with oil and water can form a stable emulsion.
(3) It can be formed by reacting a certain vegetable oil with NaOH(aq).

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE15_26

How many geometrical isomers does $H_3C{-}CH{=}CH{-}CH{=}CH{-}CH_3$ have?

A. 0
B. 2
C. 3
D. 4

DSE15_29

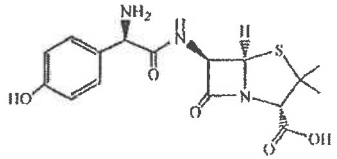
Consider the following conversion:

Which of the following combinations of reagents can achieve the above conversion?

A. NaOH(aq) and $CH_3OH(l)$
B. $CH_3OH(l)$ and $CH_3COOH(l)$
C. NaOH(aq), $H_2SO_4(aq)$ and $CH_3OH(l)$
D. $H_2SO_4(aq)$, NaOH(aq) and $CH_3COOH(l)$

DSE15_30

The structure of the antibiotic 'amoxicillin' is shown below:



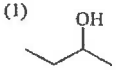
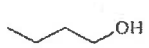
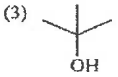
Which of the following functional groups is / are present in amoxicillin?

(1) ester
(2) amide
(3) hydroxyl

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE15_32

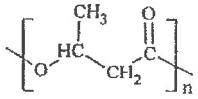
Which of the following compounds can react with acidified potassium dichromate solution to form a ketone?

(1) 
(2) 
(3) 

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE15_34

A polymer has the structure shown below:



Which of the following statements concerning the polymer is correct?

(1) Its intermolecular attraction is predominately hydrogen bond.
(2) The polymer chains can be broken in the presence of dilute hydrochloric acid.
(3) The polymer chains can be broken in the presence of dilute sodium hydroxide solution.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE16_28

Which of the following statements concerning but-1-ene and butan-1-ol is INCORRECT?

A. Both of the them can decolorize acidified $KMnO_4(aq)$.
B. Butan-1-ol can react with $PBr_3(l)$ while but-1-ene cannot.
C. Both of them can react with $H_2(g)$ in the presence of platinum.
D. But-1-ene can be obtained from heating butan-1-ol with $Al_2O_3(s)$

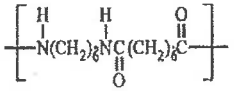
DSE16_29

The molecular formula of compound X is $C_4H_4O_4$. It has two –COOH groups. How many isomers may X have?

A. 5
B. 4
C. 3
D. 2

DSE16_31

Which of the following statements concerning nylon-6,6 is/are correct?

(1) It can be used to make ropes.
(2) The polymerization in forming it is a hydrolysis process.
(3) Its repeating unit is 

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE16_35

Soap can

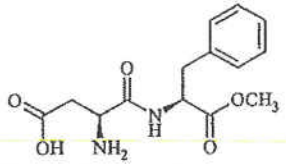
(1) be made from fats.
(2) emulsify oil particles.
(3) increase the surface tension of water.

Which of the following combinations is correct?

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE16_32

Aspartame is an artificial sweetener. The structure of it is shown below:



Which of the following statements concerning an aspartame molecule is/are correct?

(1) It has two ester groups.
(2) It has two chiral centres.
(3) It has two amide groups.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE17_18

The structures of organic compound A and B are shown below:

A B

Which of the following statements concerning the two compounds is/are correct?

(1) A and B belong to the same homologous series.

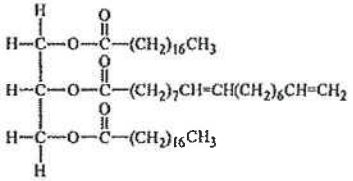
(2) A and B can be distinguished by acidified $KMnO_4$(aq).

(3) Complete combustion of 1.0 g of A and complete combustion of 1.0 g of B would form the same mass of CO_2(g).

A. (1) only B. (2) only

C. (1) and (3) only D. (2) and (3) only

DSE17_26



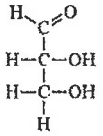
How many *cis-trans* isomers does this compound have?

A. 0 B. 2

C. 4 D. 8

DSE17_29

A compound has the following structure:



Which of the following statements concerning the compound is correct?

A. It can react with PCl_3.

B. It is insoluble in water.

C. It is optically inactive.

D. It has a ketone functional group.

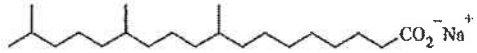
DSE17_33

The structures of three compounds are shown below:

(1)

(2)

(3)



Which of them can form a stable emulsion when shaken with oil and water vigorously?

A. (1) and (2) only B. (1) and (3) only

C. (2) and (3) only D. (1), (2) and (3)

DSE17_35

Which of the following processes can form ethanol?

(1) Heating ethanoic acid with $NaBH_4$

(2) Heating bromoethane with KOH(aq)

(3) Heating ethyl butanoate with NaOH(aq) under reflux

A. (1) and (2) only B. (1) and (3) only

C. (2) and (3) only D. (1), (2) and (3)

DSE17_36

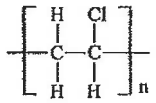
Consider the following statements and choose the best answer:

1st statement	2nd statement
Both $CH_3(CH_2)_3OH$ and $(CH_3)_3COH$ can react with acidified $K_2Cr_2O_7$(aq).	Both $CH_3(CH_2)_3OH$ and $(CH_3)_3COH$ have the same functional group.

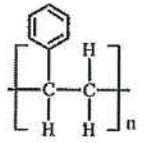
DSE18_27

Which of the following polymers is commonly used to make drainage pipes?

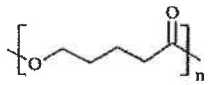
A.



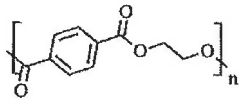
B.



C.



D.



DSE18_30

Consider the following conversion:

Which of the following combinations can achieve the above conversion?

	Reagent used in Step (I)	Reagent used in Step (II)
A.	Aqueous ammonia	Dilute sulphuric acid
B.	Aqueous potassium hydroxide	Dilute sulphuric acid
C.	Aqueous ammonia	Concentrated sulphuric acid
D.	Aqueous potassium hydroxide	Concentrated sulphuric acid

DSE18_31

Which of the following compounds CANNOT form condensation polymers?

(1) $H_2N(CH_2)_5CO_2H$
(2) $CH_3CO_2CH{=}CH_2$
(3) $CH_3CH(OH)CO_2H$

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

DSE18_34

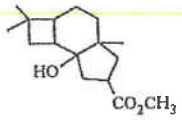
Which of the following statements concerning soap are correct?

(1) Soap is an ester.
(2) Soap can reduce the surface tension of water.
(3) Soap particles consists of both hydrophobic and hydrophilic parts.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE18_35

An organic compound has the following structure:



Which of the following statements concerning this compound are correct?

(1) It has an ester group.
(2) It contains at least one chiral centre.
(3) It reacts with acidified sodium dichromate solution to form a ketone.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

DSE19_23

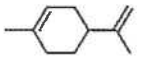
Which of the following statements concerning ethanol are correct ?

(1) It is flammable.
(2) It is soluble in water.
(3) It is more volatile than water.

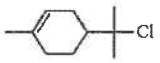
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

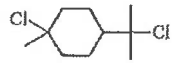
DSE19_29

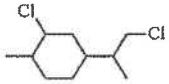
The structure of limonene is shown below :

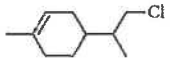


It reacts with excess HCl(g) to give Z as the major product. Which of the following is Z ?

A. 

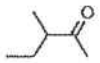
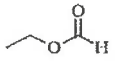
B. 

C. 

D. 

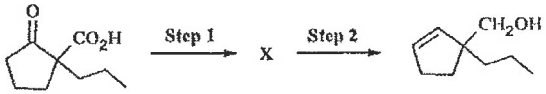
DSE19_31

Which of the following combinations is correct ?

	Structure	Systematic name
A.		3-ethylbutanone
B.		pentane-1,5-diamide
C.		ethyl methanoate
D.		pent-1-enal

DSE19_32

Consider the following conversion of organic compounds :



Which of the following combinations of steps is correct ?

	Step 1	Step 2
A.	$LiAlH_4$, dry ether; then $H^+(aq)$	NaOH(aq), heat
B.	$NaBH_4$, ethanol; then $H^+(aq)$	NaOH(aq), heat
C.	$LiAlH_4$, dry ether; then $H^+(aq)$	concentrated $H_2SO_4(l)$, heat
D.	$NaBH_4$, ethanol; then $H^+(aq)$	concentrated $H_2SO_4(l)$, heat

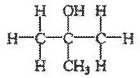
DSE19_36

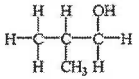
Consider the following statements and choose the best answer:

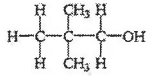
1st statement	2nd statement
CH_2=CHCH(CH_3)C_2H_5 can exhibit optical activity.	CH_2=CHCH(CH_3)C_2H_5 has one chiral centre.

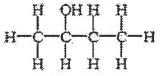
DSE2020:

27. Which of the following alkanols can form a ketone by warming with acidified sodium dichromate solution ?

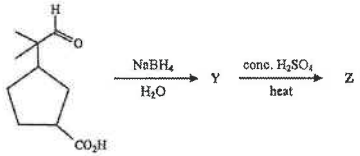
A. 

B. 

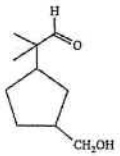
C. 

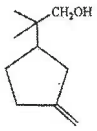
D. 

29. Refer to the following conversions :



Which of the following is a possible structure of Z ?

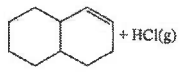
A. 

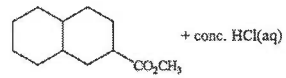
B. 

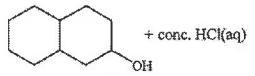
C. 

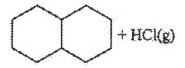
D. 

31. Which of the following pairs of reagents would NOT react with each other ?

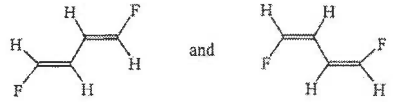
A. 

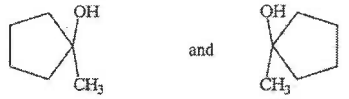
B. 

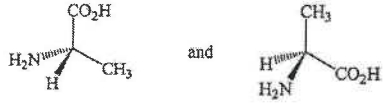
C. 

D. 

32. Which of the following pairs of compounds are isomers ?

(1) 

(2) 

(3) 

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

34. Which of the following statements concerning nylon-6,6 are correct ?

(1) Fishing net can be made from nylon-6,6.
(2) $H_2N(CH_2)_6NH_2$ is one of the monomers of nylon-6,6.
(3) The intermolecular attractions in nylon-6,6 are covalent bonds.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

36. Consider the following statements and choose the best answer :

1st statement	2nd statement
The rate of conversion from glucose to ethanol is increased by adding yeast.	The conversion from glucose to ethanol is catalysed by enzymes in yeast.

A. Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
B. Both statements are true but the 2nd statement is NOT a correct explanation of the 1st statement.
C. The 1st statement is false but the 2nd statement is true.
D. Both statements are false.

DSE2021:

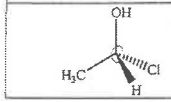
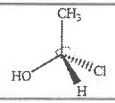
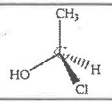
29. Consider the following reaction :

$HOOCCH_2COCH_2CHO \xrightarrow{NaBH_4(aq)} Y$

What is Y ?

A. $HOOCCH_2COCH_2CH_2OH$
B. $HOOCCH_2CH(OH)CH_2CHO$
C. $HOOCCH_2CH(OH)CH_2CH_2OH$
D. $HOCH_2CH_2CH(OH)CH_2CH_2OH$

30. Consider the information shown in the table below :

Structure of the molecules of the liquid in		
bottle A	bottle B	bottle C
		

Which of the following liquids have identical boiling point ?

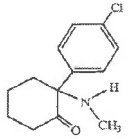
A. liquids in bottle **A** and bottle **B** only
B. liquids in bottle **A** and bottle **C** only
C. liquids in bottle **B** and bottle **C** only
D. liquids in bottle **A**, bottle **B** and bottle **C**

34. Which of the following mixtures would NOT separate into two liquid layers after heating under reflux for a period of time ?

(1) $HCOOCH_2CH_3(l)$ and excess NaOH(aq)
(2) $CH_3CH_2CH_2Cl(l)$ and excess concentrated NaOH(aq)
(3) $CH_3CH_2CHO(l)$ and excess acidified $K_2Cr_2O_7(aq)$

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

35. The diagram below shows the structure of a compound.



Which of the following statements concerning the compound are correct ?

(1) It has an amide group.
(2) Its structure has only one chiral carbon.
(3) It can be converted to an alcohol by using an appropriate reducing agent.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

36. Consider the following statements and choose the best answer :

1st statement	2nd statement
Methyl ethanoate and ethyl methanoate have similar chemical properties.	Methyl ethanoate and ethyl methanoate are isomers.

A. Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
B. Both statements are true but the 2nd statement is NOT a correct explanation of the 1st statement.
C. The 1st statement is false but the 2nd statement is true.
D. Both statements are false.

Structural Questions

Part 1: Organic reaction

CE90_01a

The table below describes some reactions of liquid propan-1-ol:

EXPERIMENT	RESULT
1. Propan-1-ol is heated with acidified potassium permanganate solution.	Substance X is formed. X produces effervescence with sodium carbonate solution.
2. A mixture of propan-1-ol and substance X is heated with concentrated sulphuric acid.	A sweet smelling liquid Y is formed.
3. Propan-1-ol is heated and the vapour passes over heated broken porcelain.	Gas Z is produced.

(i) Name X.
Write an ionic equation for the reaction of X with sodium carbonate solution.
(ii) Write an equation for the formation of Y.
Suggest TWO functions of the concentrated sulphuric acid in experiment 2.

(4 marks)

CE90_03b

The formula of a weak alkanoic acid can be represented by
$C_nH_{2n+1}CO_2H$ (where n is an interger).

A sample of the alkanoic acid weighing 0.355 g was dissolved in about 20 cm^3 of water in a conical flask. The solution was then titrated against a 0.180 M sodium hydroxide solution. A total of 22.40cm^3 of the alkali was required for complete neutralization.

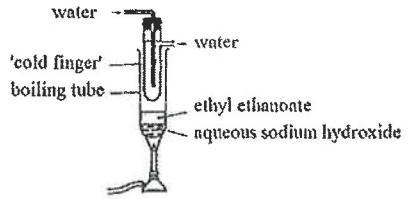
(i) Explain the meaning of the term 'weak acid'.
(ii) Describe how the end-point in this titration can be determined.
(iii) Calculate
(1) the number of moles of sodium hydroxide used for the titration.
(2) the relative molecular mass of the alkanoic acid.
(iv) (1) Deduce the molecular formula of the alkanoic acid.
(2) Draw TWO molecular structures for the alkanoic acid.

(Relative atomic masses: H = 1.0, C =12.0, O = 16.0)

(12 marks)

CE90_05b

A student heated a mixture of aqueous sodium hydroxide and ethyl ethanoate for some time using the following set-up:



(i) (1) Name the type of reaction that took place. Write an appropriate equation for the reaction.

(2) What would be observed when the reaction was complete?

(3) Give an industrial application of this type of reaction.

(ii) What is the function of the 'cold finger'?

(iii) State a potential hazard in the set-up shown above.

(iv) The quantity of the products obtained in this experiment was much less than that expected.

(1) Give an explanation for this.

(2) Draw a labelled diagram of a completely different set-up to illustrate how the quantity of the products can be increased by using the *same quantities of reactants*.

(9 marks)

CE92_03a

Fermentation of cooked rice produced an alcoholic drink which contains about 8% of ethanol.

(i) Describe briefly how such fermentation can be carried out in the laboratory.

(ii) How can the alcoholic drink be concentrated so as to raise its ethanol content to about 30%?

(iii) Some alcoholic drinks become sour when exposed to air for some time. Suggest a reason for this.

(iv) State one health hazard and one social problem associated with the excessive taking of alcoholic drinks.

(8 marks)

CE94_06b

The following paragraph was taken from a student's laboratory report:

'A mixture if ethanol, ethanoic acid and several drops of concentrated sulphuric acid was heated under reflux form some time. The resulting mixture was then cooled and poured into a beaker containing some saturated sodium chloride solution.'

(i) Draw a labelled diagram of the experimental set-up used for heating the mixture under reflux.

(ii) Why is it necessary

(1) to use concentrated sulphuric acid in the above experiment?

(2) to heat the mixture under reflux?

(iii) What would be observed when the resulting mixture was poured into the saturated sodium chloride solution?

(7 marks)

CE95_07b

The following flow diagram shows the conversion of a compound X to an acid Y.

$$X \longrightarrow \text{Ethanol} \xrightarrow{\text{oxidation}} Y$$

X can rapidly decolourize a solution of bromine in 1,1,1-trichloroethane.

(i) What is X? Name the industrial process by which X is converted to ethanol.

(ii) Write a chemical equation for the reaction between X and bromine.

(iii) (1) Give the systematic name of Y.

(2) Draw a labelled diagram of the laboratory set-up for the conversion of ethanol to Y.

(iv) Ethanol can be detected in the breath of a drunken driver. Suggest ONE chemical test to show the presence of ethanol in his breath and state the observable change produced by the test.

(9 marks)

CE96_02

The relative molecular mass of an alkanol X is 60.0. X contains 60% of carbon by mass.

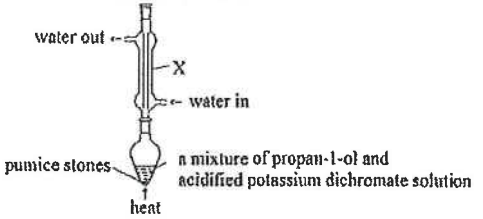
(a) Calculate the number of moles of carbon in one mole of X and hence deduce the molecular formula of X.

(b) Draw ONE possible structure of X and give its systematic name.

5 marks)

CE98_09a

A student used the following set-up to prepare propanoic acid:



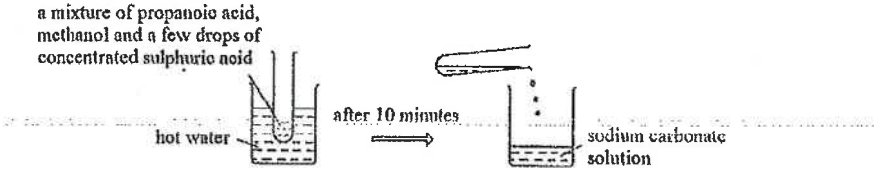
(i) Name apparatus X.

(ii) Explain why some pumice stones were added to the reaction mixture before heating.

(iii) Write the chemical equation for the reaction involved.

(iv) Suggest a method to obtain propanoic acid from the reaction mixture.

The student used the propanoic acid obtained to carry out the following experiment:



(v) Why is a water bath, instead of a naked flame, used for heating the test tube and its contents?

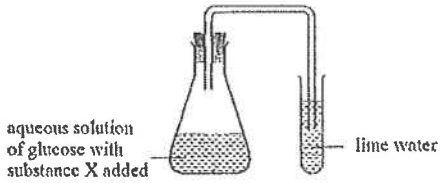
(vi) (1) State TWO observable changes when the contents of the test tube were added to the sodium carbonate solution.

(2) Give the systematic name of the carbon compound formed in the experiment.

(8 marks)

CE99_06b

(i) A teacher prepared an ethanol solution by fermentation of glucose using the following set-up.

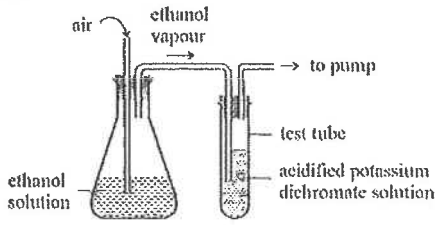


(1) Suggest what X may be.

(2) Explain why the lime water turned milky during the fermentation process.

(3) Write the chemical equation for the fermentation of glucose.

(ii) The teacher used the ethanol solution obtained in (i) to carry out the following experiment on a redox reaction:



(1) State the observable change in the test tube.

(2) Explain, in terms of oxidation number, whether potassium dichromate was oxidized or reduced.

(3) Give the structural formula of the product formed from ethanol in the reaction.

(iii) Suggest ONE reason for each of the following statements:

(1) Drinking a small quantity of wine may be good for health.

(2) Excessive drinking of alcoholic beverages may cause health problems.

(10 marks)

CE02_03c

Consider the substances listed below:

ammonia, manganese(IV) oxide, potassium hydroxide,
sodium benzoate, sodium dichromate, sodium nitrate

(c) Which substance is used in breathalysers to detect the presence of ethanol in the breath of suspected drunk drivers? State the expected observation in the breathalyser if a positive result is obtained.

(2 marks)

CE02_06c

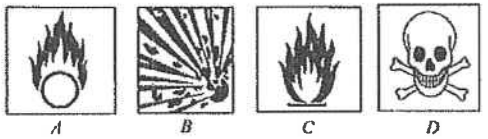
Ethyl ethanoate is an ester. It can be prepared by heating mixture of ethanoic acid and ethanol under reflux in the presence of a catalyst.

(i) What is the catalyst used in the preparation?

(ii) Draw a labelled diagram of the set-up used for heating the mixture under reflux.

(iii) Ethyl ethanoate is commonly used as a solvent. Explain why ethyl ethanoate can dissolve iodine but cannot dissolve sodium iodide.

(iv) Which ONE of following hazard warning labels should be displayed on a bottle of ethyl ethanoate?

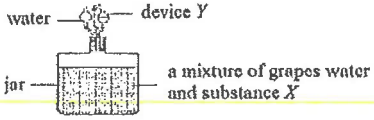


(v) Draw the structure of another ester which has the same molecular formula as ethyl ethanoate, and give its systematic name.

(9 marks)

CE03_08a

A mixture of grapes, water and substance *X* is used to produce wine in the set-up shown below:



(i) The wine contains ethanol.

(1) State ONE substance in grapes that can be converted to ethanol. Write the chemical equation for the reaction involved.

(2) Suggest what *X* may be. State its function in the production of ethanol.

(ii) State TWO functions of device *Y*.

(iii) (1) Explain why the concentration of ethanol in the wine cannot exceed a certain level (about 18% by volume).

(2) Suggest a reason to increase the concentration of ethanol in the wine to a level higher than 18% by volume.

(iv) Explain why a glass of wine turns sour upon standing in air.

(9 marks)

CE04_08c

A policeman suspected a car driver to have drunk an excessive amount of alcoholic drinks, and used a dichromate breathalyser to conduct a test on the driver's breath. The result was positive.

(i) State the principle underlying the test of ethanol using a dichromate breathalyser.

(ii) The driver claimed that he had just rinsed his mouth using ethanol-containing mouthwash. Without using other instruments, suggest how the policeman could check whether the driver's claim was valid or not. Explain your answer.

(4 marks)

CE04_09b

An ester can be prepared by heating an alkanol with an alkanoic acid under reflux in the presence of concentrated sulphuric acid.

(i) Draw a labelled diagram to show the set-up used in heating the reaction mixture under reflux.

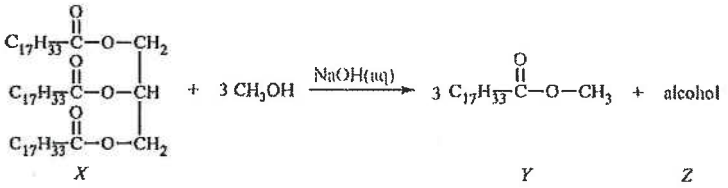
(ii) Suggest ONE reason why it is necessary to heat the mixture under reflux.

(3 marks)

CE05_11

Vegetables oils are esters formed from carboxylic acids with long carbon chains. Although vegetable oils have high calorific values comparable to diesel, they are not used directly as fuel in cars. One of the reasons is due to their high viscosity. By heating with methanol in the presence of sodium hydroxide solution, vegetable oils can be converted to less viscous esters, methyl carboxylates. These methyl carboxylates can be used to substitute diesel as fuel in cars.

(a) The equation below shows the conversion of vegetable oil X to methyl carboxylate Y and alcohol Z:



X Y Z

(i) Draw the structure of Z.

(ii) Suggest why Y is less viscous than X.

(iii) Sodium hydroxide solution acts as a catalyst in this conversion. What is the meaning of the term 'catalyst'?

(iv) Y and Z are immiscible liquids. Suggest a method to separate Y and Z from their mixture.

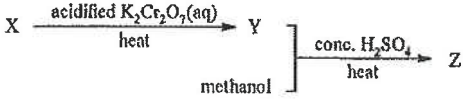
(5 marks)

(b) The term 'biodiesel' refers to the methyl carboxylates obtained from vegetable oils. Suggest TWO reasons why biodiesel is considered a more environmentally-friendly fuel than diesel.

(2 marks)

CE06_02

X, Y and Z are organic compounds. The flow diagram below shows the conversion of X to Z.



(a) Z has a pleasant smell and its molecular formula is $C_4H_8O_2$. Draw the structure of Z.

(1 mark)

(b) To which homologous series does Y belong?

(1 mark)

(c) Give the systematic name of X.

(1 mark)

(d) State the expected observation when X reacts with acidified potassium dichromate solution.

(1 mark)

(e) State the function of concentrated sulphuric acid in the reaction of Y with methanol.

(1 mark)

CE07_12

Organic compound Z contains carbon, hydrogen and oxygen only. Analysis of Z gives the following results:

(I) 1.0 g of Z contains 0.401 g of carbon, 0.068 g of hydrogen and 0.531 g of oxygen.

(II) 1.0 g of Z, upon complete vapourisation, occupies 400 cm^3 at room temperature and pressure.

(III) There are no observable changes when potassium carbonate solution is added to Z.

(IV) Brown colour of bromine remains unchanged when several drops of bromine in organic solvent are added to Z.

(Molar volume of gas at room temperature and pressure = 24 dm^3)

(a) Calculate the empirical formula of Z.

(2 marks)

(b) Deduce the molecular formula of Z.

(2 marks)

(c) (i) Suggest a possible structure of Z. Explain your answer.

(ii) Give the systematic name for the compound represented by the structure you suggested in (i).

(4 marks)

CE11_10b

A type of breathalyser for investigating drink-driving consists of a chemical cell. The breath of the driver is allowed to get into contact with one of the electrodes of the cell. If the breath contains ethanol, the ethanol would be converted to ethanoic acid at this electrode and an electric current would be produced.

(i) Explain whether the above mentioned electrode acts as the anode or cathode of the chemical cell.

(ii) Write a half equation for the change occurring at this electrode.

(iii) Explain how this type of breathalyser could estimate the amount of ethanol in the breath of the driver.

(3 marks)

CE11_12

The chemical properties of hexane (C_6H_{14}) and hex-1-ene (C_6H_{12}) are different. Design experiments to show how they differ in their reactions with oxygen in air and their reactions with bromine. Explain the differences concerned.

(6 + 3 marks)

Part 2: Plastic

CE94_03

The following diagrams show some items made of synthetic polymers.

Electric switch Plastic bag Shirt

(b) Name one synthetic polymer which is suitable for making the plastic bag.

(d) Terylene, the polyester fibre used for making the shirt is synthesized from ethane-1,2-diol, $HOCH_2CH_2OH$ and benzene-1,4-dicarboxylic acid, $HOOCC_6H_4COOH$.

(i) Name the type of polymerization involved in the synthsis of terylene.

(ii) Write a repeating unit of terylene.

(6 marks)

CE07_08

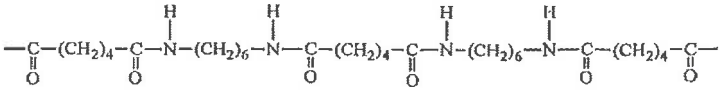
(a) Teflon is a plastic that can be used to make artificial hip joints. Teflon is an addition polymer of linear structure consisting of carbon and fluorine only. The ratio of the number of carbon atoms to the number of fluorine atoms in the polymer is 1 : 2.

(i) Draw a portion of the teflon structure with 10 carbon atoms.

(ii) Write the repeating unit of teflon, and suggest a possible monomer of teflon.

(3 marks)

(b) Nylon is a polymer that can be used to make carpets. A portion of the nylon structure is shown below:



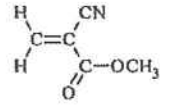
(ii) Suggest one reason why recycling of used carpets to recover nylon is difficult.

(iii) State one disadvantage of disposing of nylon carpets by incineration.

(3 marks)

CE08_08

The active ingredient of a superglue has the following structure:



Superglue can join objects together quickly through the polymerization of the active ingredient in the presence of water vapour.

(a) Name the type of polymerization that the active ingredient undergoes.

(1 mark)

(b) Write a chemical equation for the polymerization involved.

(1 mark)

(c) Assuming that the active ingredient comes from esterification of two compounds, write the structural formulae of these two compounds.

(2 marks)

(d) In addition to putting back the cap for the superglue that remains after use, what storage method could help extend the lifetime of the superglue?

(1 mark)

CE08_09

Outline the steps showing how a sample of ethyl ethanoate ($CH_3COOCH_2CH_3$) can be prepared and isolated in the laboratory by using ethanol, concentrated sulphuric acid, 0.1 M potassium dichromate solution, quickfit apparatus, heating source, and other common apparatus.

(Diagrams, chemical equations, and detailed descriptions in setting up of apparatus are NOT required.)

(6 + 3 marks)

CE09_05

Motor vehicles in some countries use gasohol as fuel. Gasohol is a mixture of ethanol and petrol. Two methods of obtaining ethanol are shown below.

Method 1: heavy oil $\xrightarrow{\text{Process A}}$ ethene $\xrightarrow{\text{Process B}}$ ethanol

Method 2: cane sugar $\xrightarrow{\text{Fermentation}}$ ethanol

(a) Name Process A and state its principle.

(2 marks)

(b) Process B can be represented by the following word equation.

ethene + steam ⟶ ethanol

Name the type of reaction involved.

(1 mark)

(c) The concentration of the ethanol obtained from Method 2 is quite low. Suggest how the concentration of the ethanol obtained from this method can be increased.

(1 mark)

(d) State one advantage of using gasohol over using each of the following substances as a fuel in motor vehicles.

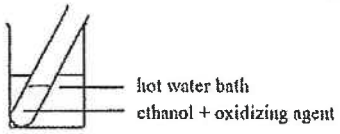
(i) ethanol

(ii) petrol

(2 marks)

CE09_08

A student attempted to oxidize ethanol to ethanoic acid using the set-up shown below.



(a) Suggest an oxidizing agent that can be used.

(1 mark)

(b) State one advantage of using a hot water bath over direct heating with a Bunsen burner carrying out the experiment.

(1 mark)

(c) The student failed to obtain ethanoic acid even after a long period of time. The student then used Quickfit apparatus to perform the experiment. After some time, ethanoic acid was finally obtained.

(i) Draw a labelled diagram to show how to set up Quickfit apparatus for carrying out the experiment.

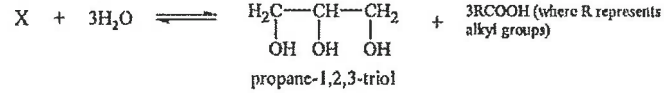
(ii) Explain why ethanoic acid could finally be obtained.

(4 marks)

Part 3: Soaps and Soapless detergents

CE91_01b

A vegetable oil, X, can undergo reversible hydrolysis in the presence of sulphuric acid as given by the following equation:



propane-1,2,3-triol

(i) Write the structural formula of X.

(ii) What is the function of sulphuric acid in this reaction?

X can be hydrolysed more effectively by using sodium hydroxide solution instead of sulphuric acid, and the products are propane-1,2,3-triol and Y.

(iii) Name this process.

(iv) Write the structural formula of Y.

When a solution of Y is slowly added, with stirring, to a mixture of peanut oil and water, a milky solution is obtained.

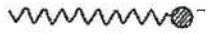
(vi) Based on the structural formula of Y, explain why a milky solution is formed.

(vii) Name the process leading to the formation of the milky solution and suggest one domestic application of this process.

(10 marks)

CE93_01c [Same as DSE12_14, DSE19_15]

(i) The structure of a typical anionic detergent can be represented by:



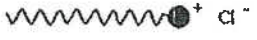
where ∿∿∿ represents a hydrocarbon tail

and ● $^-$ represents an anionic part attached to the hydrocarbon tails.

(1) Using the above representation, draw a diagram to show how the detergent can suspend an oil droplet in water.

(2) A table cloth stained with oil can be cleaned using the detergent in water. Explain the cleaning action with reference to your diagram in (1).

(ii) Scientists have also developed cationic detergents for special cleaning purposes. The structure of a typical cationic detergent is shown below:



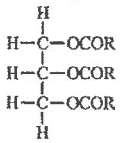
Can anionic and cationic detergents be used together? Explain your answer.

(6 marks)

CE94_05a

A domestic drain cleaner named 'RAINBOW' contains concentrated sulphuric acid as the active ingredient. A student carried out the following experiment to determine the concentration of sulphuric acid in 'RAINBOW'.

(v) If 'RAINBOW' is poured into drains blocked with fat, the fat can be removed. Assuming the formula of fat is



(R represents an alkyl group),

explain how 'RAINBOW' can remove the fat.

(2 marks)

CE95_02

In each of the following groups of substances, there is ONE substance which is different from the others in terms of their properties. In each group, identify the substance which is different from the others and explain your choice.

(c) milk of magnesia, soap, vinegar, window cleaner

(2 marks)

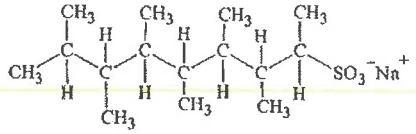
CE95_09a

Sodium hydroxide can be used as a raw material in the manufacture of both soapy and soapless detergents.

(i) Briefly describe how a soapy detergent can be prepared from a vegetable oil in a school laboratory.

(ii) The formula of a certain soapy detergent is C_nH_{2n+1} and its formula mass is between 300 and 310. Calculate the value of n.

(iii) The structure of a certain soapless detergent is shown below:



(1) What other raw materials, apart from sodium hydroxide, are required in the manufacture of this soapless detergent?

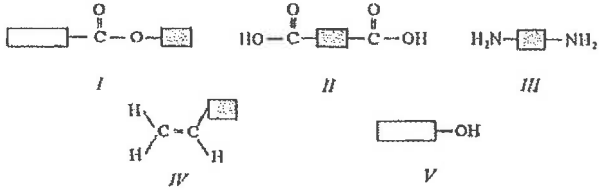
(2) Give ONE advantage and ONE disadvantage of using this soapless detergent for domestic cleaning compared with using a soapy detergent.

(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0, Na = 23.0)

(10 marks)

CE97_07b

The structures of five compounds, I, II, III, IV and V, are shown below:



In the above structures,  represents a saturated hydrocarbon chain containing 1 to 6 carbon atoms and  represents a saturated hydrocarbon chain containing 12 to 20 carbon atoms.

(iii) Upon heating with sodium hydroxide solution, one of these compounds produces a soapy detergent.

(1) What is this compound?

(2) Draw the structure of the soapy detergent produced.

(3) Briefly explain the emulsifying action of the detergent when it is used to remove greasy dirt.

(6 marks)

CE00_06c

Explain the following statements:

(ii) Detergents can be used to clean up oil spillage in the sea.

(2 marks)

CE01_06a

Soap powder usually contains washing soda, a hydrated form of sodium carbonate, which can help reduce the hardness of water.

(i) Explain why soap does not function well in hard water.

(ii) With the help of an ionic equation, explain why washing soda can help reduce the hardness of water.

(4 marks)

CE02_09a

Ammonia is weak alkali. It is used as an active ingredient in domestic glass cleaners.

(i) (1) Write a chemical equation to represent the ionization of ammonia in water.

(2) Explain why an alkaline solution can help remove oily dirt on glass.

(ii) Suggest, with explanation, a precaution necessary when using such glass cleaners.

(4 marks)

CE07_13

Discuss the similarities and differences between soapy detergents and soapless detergents with reference to their raw materials, structures and properties.

(6 + 3 marks)

CE09_12

The procedures in an experiment are summarized below.

A mixture of castor oil and sodium hydroxide solution was heated gently with stirring for 15 minutes. After cooling down the mixture, a white solid X was obtained upon adding a colourless solution Y. X was then separated out and washed with distilled water.

A small amount of X was put in a test tube containing a mixture of water and a few drops of oil. The contents of the test tube were thoroughly shaken and the observation was recorded.

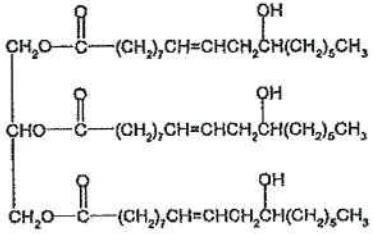
(a) Name the type of reaction involved when the mixture of castor oil and sodium hydroxide solution was heated.

(1 mark)

(b) Suggest what Y would be.

(1 mark)

(c) The structure of a main ingredient of castor oil is shown below.



Suggest a structure of X.

(1 mark)

(d) State the expected observation while shaking the test tube. Explain your answer.

(3 marks)

(e) Suggest a title for the experiment that reflects its objectives.

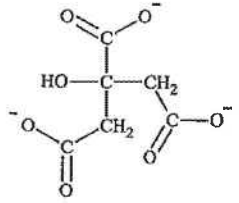
(2 marks)

(f) If X is dissolved in water to form an aqueous solution, what would be observed in shaking a mixture of this solution and lime water?

(1 mark)

CE11_11

(a) Citrate ions can improve the cleaning abilities of soapy detergents in hard water in a way similar to carbonate ions. The structure of a citrate ion is shown below:



(i) Explain why citrate ions can improve the cleaning abilities of soapy detergents in hard water.

(ii) Phosphate ions can also improve the cleaning abilities of soapy detergents in hard water. However, phosphate ions have a negative effect on the environment. What is this negative effect?

(3 marks)

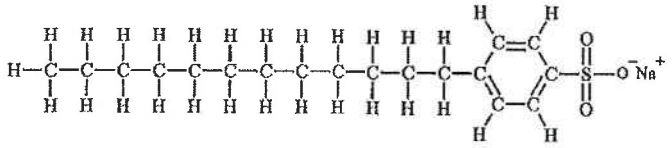
(b) In acidic environments, the soapy detergent $CH_3(CH_2)_{14}COO^-Na^+$ loses its cleaning function because it forms an insoluble organic acid.

(i) Write the structural formula of the organic acid formed.

(ii) With the help of an ionic equation, explain why sodium carbonate can improve the cleaning abilities of soapy detergents in acid environments.

(3 marks)

(c) The structure of a commonly-used detergent is as follows:



Suggest THREE advantages of this detergent.

(3 marks)

AL96(II)_07b

In an experiment, 25 g of $(CH_3)_3COH$ react with 36 g of HCl to give 28 g of $(CH_3)_3CCl$.

(i) Find the limiting reactant of the reaction, showing clearly your calculation.

(1.5 marks)

(ii) Calculate the percentage yield of $(CH_3)_3CCl$.

(1.5 marks)

(iii) Name the type of the reaction.

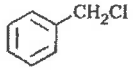
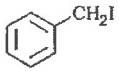
(1 mark)

AL96(II)_07c

Suggest a chemical tet to distinguish one compound from the other in each of the following pairs. Your answer should include the reagents used and the observation expected.

(i)  and

(2 marks)

(ii)  and 

(2 marks)

AL96(II)_08b

The following compounds can exist in isomeric forms:

(i) butenedioic acid, and

(ii) 2-aminopropanoic acid.

In each casem state the type of isomerism and draw suitable representation for the isomers.

(4 marks)

AL98(I)_04

Alcohol **E** has the structure $CH_3CH(OH)C_2H_5$

(a) (i) Draw a three-dimensional representation of **E**.

(1 mark)

(ii) What type of isomerism can be exhibited by **E**?

(1 mark)

(b) (i) Draw the structures of three structural isomers of **E**, all of which are alcohols.

(1.5 marks)

(ii) Describe how the reagent Zn/concentrated HCl can be used to distinguish **E** from the three structural isomers.

(1.5 marks)

(c) On treatment with dilute H_2SO_4(aq), **E** gives mainly two isomeric compounds. **F** and **G**, both of which have the formula C_4H_8. On treatment with bromine, both **F** and **G** give a product **H** with formula $C_4H_8Br_2$.

(i) Draw structures for **F**, **G**, and **H**.

(3 marks)

(ii) What is the isomeric relationship between **F** and **G**?

(1 mark)

AL98(I)_05

Consider the reaction of butanone (C_4H_8O) **J** shown in the reaction scheme below:

$$\text{butanone } (C_4H_8O)\ \mathbf{J} \xrightarrow{2,4\text{-}C_6H_3(NO_2)_2NHNH_2} \mathbf{R}\ \text{(a red precipitate)}$$

(a) Give structure for compound **R**.

(1 mark)

(b) (i) **S** is a structural isomer of **J**. **S** also reacts with $2,4\text{-}C_6H_3(NO_2)_2NHNH_2$ to give a red precipitate. Draw the structure of **S**.

(1 mark)

(ii) How may **J** and **S** be identified by making use of their reacts with $2,4\text{-}C_6H_3(NO_2)_2NHNH_2$?

(1 mark)

AL98(I)_08a

Show how you would

(i) determine whether a sample of $C_2H_5CH(OH)CH_3$ is in the (+) form or (±) form.

(1 mark)

(ii) distinguish between C_6H_5COCl and C_6H_5COBr using a chemical test.

(1 mark)

ASL99(I)_05

Consider the compounds **V**, **W**, **X**, **Y** and **Z** below.

$CH_3CH_2CH_2CH_2OH$	$CH_3CH(OH)CH_2CH_3$	$(CH_3)_3COH$
V	**W**	**X**
$CH_3CH_2CH_2CHO$	$CH_3CH_2CH_2CO_2H$	
Y	**Z**	

(a) Which compound can be converted to butanone in one step? Give the reagent(s) used in the conversion.

(2 marks)

(b) Suggest a chemical test to distinguish between **V** and **Y**.

(2 marks)

(c) Under suitable conditions, **W** and **Z** react to give a product with a pleasant smell. State the conditions for the reaction and give the structure of the product.

(2 marks)

ASL99(II)_11 (modified)

Compound **R** has the following structure:

$$(CH_3)_2CHCH{=}CHCH_3$$

(a) Give the systematic name of **R**.

(1 mark)

(b) **R** exists in two isomeric forms.

(i) Draw the structure of each isomer.

(2 marks)

(ii) State the type of isomerism involved.

(1 mark)

(c) Under suitable conditions, **R** can be converted to cyclic compound **S** with a relative molecular mass of 78.1. **S** has the following composition by mass:

C 92.3% and H 7.7%

(i) Deduce the molecular formula of **S**.

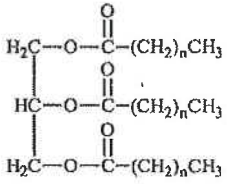
(2 marks)

(ii) Draw a possible structure of **S**.

(1 mark)

ASL99(II)_13 (modified)

Compound **U** is a natural fat. **U** has the following structural formula:



(when n is a positive integer)

(a) State the functional group in **U**.

(1 mark)

(b) In an experiment, 8.51 g of **U** was heated under reflux with 100.0 cm^3 of 2.00 M sodium hydroxide solution until **U** was completely hydrolyzed. The resulting solution was allowed to cool to room temperature.

(i) Draw a labelled diagram of the set-up used for heating **U** and the sodium hydroxide solution under reflux.

(2 marks)

(ii) Write a balanced equation for the hydrolysis reaction.

(1 mark)

(iii) 10.0 cm^3 of the resulting solution was withdrawn with a pipette and titrated against 0.53 M hydrochloric acid with phenolphthalein as indicator. 27.5 cm^3 of the hydrochloric acid was required to reach the titration end point. Calculate the value of n in the structural formula of **U**.

(3 marks)

(iv) The resulting solution after reflux can be used to make soap. The solution was first concentrated by heating and then a saturated sodium chloride solution was added.

(I) State the observable change upon the addition of the saturated sodium chloride solution.

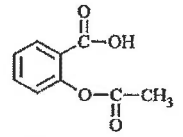
(1 mark)

(II) Explain why a saturated sodium chloride solution was used.

(1 mark)

ASL00(I)_06

Aspirin, a painkiller, has the following structure:



(a) Name all functional groups in aspirin.

(2 marks)

(b) Upon heating with sodium hydroxide solution, aspirin gives a mixture containing two organic compounds, **X** and **Y**. When excess hydrochloric acid is added to the mixture, **X** gives a white precipitate, **Z**, while **Y** does not have any apparent reaction. Draw the structures of **X**, **Y** and **Z**.

(3 marks)

(c) Under suitable conditions, **Z** reacts with methanol in a mole ratio of 1:1 to give oil of wintergreen which is an ester. Draw the structure of oil of wintergreen.

(1 mark)

AL01(I)_08

In an experiment to prepare propanal from propan-1-ol,

$$CH_3CH_2CH_2OH \xrightarrow[\text{heat}]{Cr_2O_7^{2-}/H_3O^+} CH_3CH_2CHO$$

a side-product *N* ($C_6H_{12}O_2$) was formed.

(a) What is *N*? Suggest how N is formed.

(2 marks)

(b) Suggest one method to separate propanal from a mixture of propanal and *N*.

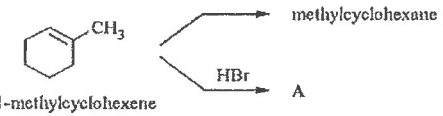
(1 mark)

(c) Suggest two methods to confirm the identity of propanal.

(2 marks)

ASL01(II)_10

Consider the reactions of 1-methylcyclohexene shown below:



(a) (i) Give the reagent(s) and conditions for the conversion of 1-methylcyclohexene to methylcyclohexane.

(2 marks)

(ii) Suggest a chemical test to distinguish between 1-methylcyclohexene and methylcyclohexane.

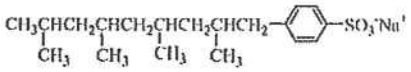
(2 marks)

(b) For the reaction of 1-methylcyclohexene with HBr, draw the structure of the major product A.

(1 mark)

ASL01(II)_12

A synthetic detergent has the following structure:



With reference to its structure, explain why

(a) the detergent can be used to remove oily dirt,

(3 marks)

(b) the detergent is not environmentally friendly.

(2 marks)

ASL02(I)_03

Compound X has the following composition by mass:

C 55.8%, H 7.0%, O 37.2%

(a) Deduce the empirical formula of X.

(2 marks)

(b) The relative molecular mass of X lies between 82 and 90. What is the molecular formula of X?

(2 marks)

(c) X reacts with sodium carbonate solution to give carbon dioxide. Draw all possible structures of X.

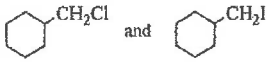
(3 marks)

ASL02(II)_11

For each of the following pairs of compounds, suggest a chemical test to distinguish one compound from the other. In each case, state the expected observation and write the relevant chemical equation(s).

(a) $CH_3(CH_2)_3OH$ and $(CH_3)_3COH$

(2 marks)

(b) 

(4 marks)

ASL03(I)_02

Arrange the following compounds in order of increasing boiling point. Explain your answer.

$CH_3(CH_2)_2CH_3$, $CH_3(CH_2)_3Cl$, $CH_3(CH_2)_3OH$, $CH_3(CH_2)_3CH_3$

(5 marks)

ASL03(II)_09

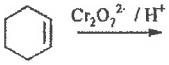
Outline a synthetic route, in not more than three steps, to accomplish each of the following conversions. For each step, give the reagent(s), the conditions and the structure of the organic product.

(a) $CH_3CH_2CH_2Cl \longrightarrow CH_3CH_2-\overset{O}{\overset{\|}{C}}-OH$ (3 marks)

(b) $CH_3CH{=}CH_2 \longrightarrow CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ (3 marks)

ASL03(II)_12

Hexanedioic acid, also known as adipic acid, is used in the manufacture of nylon-6,6. The acid is commonly synthesized from cyclohexene using method (I) or method (II) outlined below:

(I) 

(II) 

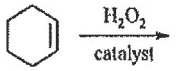
(a) Draw the structure of adipic acid.

(1 mark)

(b) Both methods, (I) and (II), are considered as environmentally unfriendly. Explain.

(2 marks)

(c) Nowadays, some chemists recommend using method (III) below to synthesize adipic acid.

(III)  $\xrightarrow[\text{catalyst}]{H_2O_2}$ adipic acid

Suggest two advantages of using this method to synthesize adipic acid.

(2 marks)

(d) Nylon-6,6 is a polymer of adipic acid and hexane-1,6-diamine. Draw the repeating unit of nylon-6,6.

(1 mark)

ASL04(II)_10

Preparation of benzoic acid ($C_6H_5CO_2H$) involves heating methyl benzoate ($C_6H_5CO_2CH_3$) with excess sodium hydroxide solution under reflux for some time. The resultant mixture contains sodium benzoate and methanol.

(a) Draw a labelled diagram for the set-up used for heating methyl benzoate with sodium hydroxide solution under reflux.

(2 marks)

(b) Suggest how a crude sample of benzoic acid can be obtained from the resultant mixture.

(2 marks)

(c) The crude sample of benzoic acid can be purified by recrystallization from hot water. Outline the procedures in the recrystallization process.

(2 marks)

(d) In an experiment, 3.0 g of methyl benzoate gave 1.9 g of benzoic acid. Calculate the percentage yield of benzoic acid.

(2 marks)

ASL05(I)_03

The reaction of ethanoic acid with methanol gives an ester.

(a) Write the chemical equation for the above reaction.

(1 mark)

(b) Account for the following observation:

'The reaction of ethanoic acid (CH_3CO_2H) with methanol labelled with oxygen-18 ($CH_3{}^{18}OH$) always gives ester molecules with a mass of 76, compared with $^{12}C = 12$.'

(2 marks)

ASL05(I)_06

Compound A has the following composition by mass:

C 81.8%, H 6.1% and O 12.1%

Its relative molecular mass is in the range of 130 to 140.

(a) Calculate the molecular formula of A.

(3 marks)

(b) A is an aromatic compound. It gives positive results when treated with Tollen's reagent. Deduce all functional groups present in A.

(3 marks)

(c) State a type of isomerism that A can exhibit. Illustrate your answer with the appropriate structures.

(2 marks)

ASL05(I)_07

A brand of baby diaper uses polyacrylamide and sodium polyacrylate as water absorbing materials. The structure of the two polymers are shown below:

polyacrylamide sodium polyacrylate

(a) Draw the structure of monomer of polyacrylamide.

(1 mark)

(b) Suggest a synthetic route, with not more than three steps, for the transformation of propenoic acid to sodium polyacrylate.

(2 marks)

(c) Account for the water absorbing property of the following materials:

(i) Polyacrylamide

(2 marks)

(ii) Sodium polyacrylate

(2 marks)

(d) Apart from their use in diapers, suggest one other application of such water absorbing materials in daily life.

(1 mark)

ASL05(II)_09

Arrange the following compounds B, C and D in order of increasing boiling point, and explain your answer.

$CH_3(CH_2)_3CH_3$, $CH_3(CH_2)_3OH$ and $CH_3CH_2COCH_3$
B C D

(3 marks)

ASL05(II)_09

You are provided with four unlabeled bottles each containing one of the following colorless liquids:

1-bromopropane, butan-1-amine, cyclohexene, propanone

Outline a scheme of tests to distinguish the four liquids from one another.

(6 marks)

ASL05(II)_10

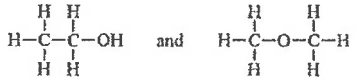
Explain why each of the following methods of preparation are NOT appropriate. In each case, suggest an appropriate method for the preparation.

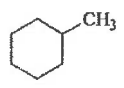
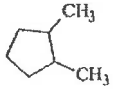
(c) Prepare CH_3CHO by heating CH_3CH_2OH with acidified $Na_2Cr_2O_7(aq)$ under reflux.

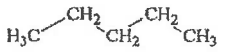
(3 marks)

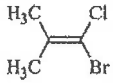
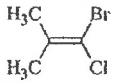
ASL06(I)_01

For each pair of molecules shown below, classify their relationship as 'identical molecule', 'structural isomers' or 'geometrical isomers'.

(a)  and

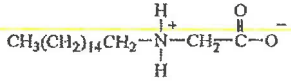
(b)  and 

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

(d)  and 

ASL06(I)_08 (modified)

Some baby shampoos contain a detergent with the following structure:



(a) Explain the cleaning principle of the detergent.

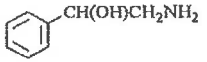
(3 marks)

(b) With the help of chemical equations, explain why the detergent shows both acidic and alkaline properties.

(3 marks)

AL06(II)_05b

Compound B is a strong stimulant. Its structural formula is as follows:



(i) In fact, the above structural formula can represent two stereoisomers.

(I) Draw three-dimensional structures of the two stereoisomers.

(2 marks)

(II) State a physical property which is different for two stereoisomers.

(1 mark)

(ii) It is known that among the two stereoisomers, only B has stimulant activity while the other one does not. Why?

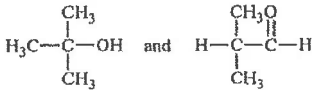
(1 mark)

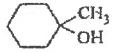
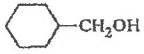
(iii) A person is suspected to have taken stimulant B. A urine sample of the person is sent for analysis. Suggest a method to establish whether B is present in the urine sample.

(2 marks)

ASL06(II)_09

Suggest a chemical test to distinguish one compound from the other in the following pairs. Explain why the test is suitable.

(a)  and (3 marks)

(b)  and  (3 marks)

ASL06(II)_10

Aromatic compounds P, Q and R are esters with the same molecular formula $C_8H_8O_2$.

(a) A mixture of P and aqueous NaOH was heated under reflux for an hour. Excess dilute H_2SO_4 was then added to the resulting mixture and a white precipitate ($C_7H_6O_2$) was formed. Suggest the structure of P and write an equation for the reaction of P with aqueous NaOH.

(2 marks)

(b) A mixture of Q and aqueous NaOH was heated under reflux for an hour. Excess dilute H_2SO_4 was then added to the resulting mixture. Upon warming, a smell of vinegar was detected. Deduce the structure of Q with the help of chemical equations.

(4 marks)

(c) Propose one possible structure of R.

(1 mark)

ASL07(I)_07

Oseltamivir is an antiviral drug against the avian virus H5N1. It is also known by the brand name Tamiflu.

(a) Mark each chiral centre with an asterisk on the structure of oseltamivir shown on the right.

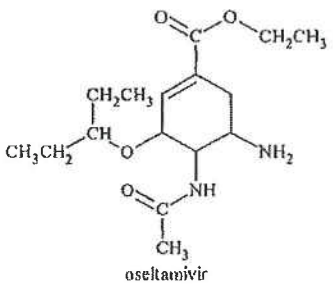
(1 mark)

(b) Besides the ether linkage, how many functional groups are there in oseltamivir? Name two of these functional groups.

(2 marks)

(c) Given that ether linkage are not affected by alkalis, write the structure of the organic products formed when oseltamivir is heated with excess NaOH(aq).

(2 marks)



oseltamivir

ASL07(II)_02

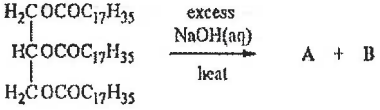
Outline a synthetic route, with no more than three steps, to accomplish each of the following transformation. For each step, give the reagent(s), conditions and structure of the organic product.

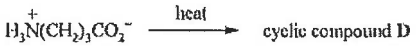
$$CH_3CHO \longrightarrow CH_3CONH_2$$

(2 marks)

ASL08(I)_06

Give the structure of the organic products A, B and D in the following reactions:

(a) 

(b) 

ASL08(II)_01

Deduce the structure of isomeric compounds A and B, with formula C_6H_{12}, that have the following characteristics:

Compound	Characteristics
A	It has a pair of enantiomers. It loses its chiral centre after hydrogenation over Pt.
B	It reacts with Br_2 to give a single compound. It reacts with HBr to give a single achiral compound.

(6 marks)

ASL08(II)_02 (modified)

Upon irradiation of visible light, 0.450 g of 2,4-dimethylpentane undergoes monochloro-substitution to give 0.200 g of 1-chloro-2,4-dimethypentane (**D**), 0.167 g of 2-chloro-2,4-dimethypentane (**E**) and 0.117 g of 3-chloro-2,4-dimethypentane (**F**).

(a) Draw the structure of 2,4-dimethylpentane.

(1 mark)

(b) Calculate

(i) the overall percentage yield for the monochlorinated products formed, and

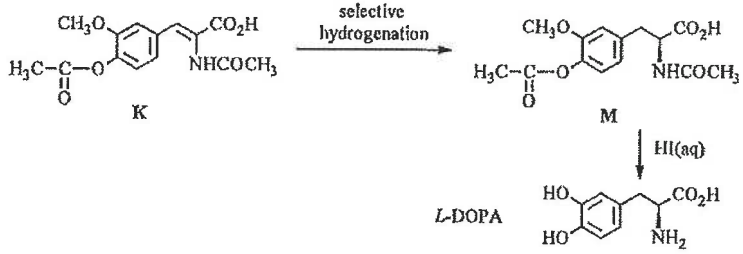
(1 mark)

(ii) the mole ratio of **D**, **E** and **F** formed. (Assign a value of 1.0 to the monochlorinated product which has the lowest yield.)

(2 marks)

AL09(II)_05b (modified)

L-DOPA is an effective drug for Parkinson's disease. The synthesis of *L*-DOPA involves the selective hydrogenation of compound K to compound M, which is then hydrolyzed to give *L*-DOPA.



(i) M has a stereoisomer, N. N is not used to synthesize *L*-DOPA.

(I) Draw the structure of N.

(1 mark)

(II) Name the type of stereoisomerism.

(1 mark)

(III) State ONE difference in physical property between M and N.

(1 mark)

(ii) (I) Explain why the hydrogenation of K over platinum gives M and N in a mole ratio of 1 : 1. [For reference only]

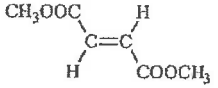
(2 marks)

(II) Suggest a way to achieve the above selective hydrogenation.

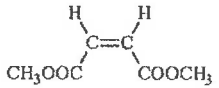
(1 mark)

ASL10(I)_06

Dimethyl fumarate can be found in most leather products since it is commonly used as a mould inhibitor. However, it was banned in Europe for all kinds of consumer goods in March 2009 because it was found to cause skin allergies. Compound A is an isomer of dimethyl fumarate. The structures and melting points of these two compounds are given below:



dimethyl fumarate
m.p. 102 °C



A
m.p. −19 °C

(a) Name the type of isomerism involved.

(1 mark)

(b) Explain why the melting point of A is lower than that of dimethyl fumarate.

(2 marks)

ASL10(II)_04

(a) At room temperature, acyclic organic compound D (relative molecular mass: 58) is a volatile liquid. It has the following composition by mass:

C, 62.1%; H, 10.3%; O, 27.6%

Calculate the empirical formula of D.

(3 marks)

(b) D does not react with cold acidified $K_2Cr_2O_7$(aq). Deduce ONE possible structure of D.

(1 mark)

ASL11(I)_06

Consider compounds F and G as shown below:

F G

(a) Give the systematic name of F.

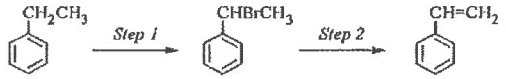
(1 mark)

(b) Suggest a synthetic route with *no more than three steps* to convert F to G.

(2 marks)

ASL11(II)_07

Ethylbenzene can be converted to phenylethene, which is also known as styrene, via the following synthetic route:



(a) Suggest reagent(s) and reaction conditions for *Step 1*.

(1 mark)

(b) *Step 2* is carried out by heating the (1-bromo)ethylbenzene from *Step 1* with a mixture of $(CH_3)_3CO^-K^+$ and $(CH_3)_3COH$. Name the type of reaction involved.

(1 mark)

(c) Styrene undergoes polymerization to give polystyrene (PS).

(i) Draw the repeating unit of PS.

(1 mark)

(ii) Suggest reagent(s) and reaction conditions for the polymerization.

(1 mark)

ASL12(I)_06

Based on the information given below, deduce the possible structure of compounds B and D:

(1) Compound B ($C_6H_{10}O_2$) is optically active.

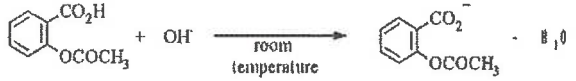
(2) B reacts with H_2(g), in the presence of Ni(s), to give an optically inactive compound D.

(3) When treated with excess $NaHCO_3$(aq), 1 mol of D gives 1 mol of CO_2(g).

(5 marks)

ASL12(I)_10

A commercial aspirin sample E was known to contain about 90% by mass of aspirin, while the rest was an inert binder. Based on the following reaction, a student designed an experiment and performed it at room temperature to determine the percentage by mass of aspirin in E.



The student added 2.25 g of E to 25.00 cm^3 of 3.05 mol dm^{-3} NaOH(aq), and then back titrated the excess NaOH(aq) with 2.50 mol dm^{-3} HCl(aq). The volume of HCl(aq) used was 23.10 cm^3.

(a) Suggest an indicator for the titration.

(1 mark)

(b) From the students' experimental results, calculate the percentage by mass of aspirin in E. Suggest why the calculated percentage by mass of aspirin deivates grealy from 90%.
(Relative molecular mass of aspirin = 180.0)

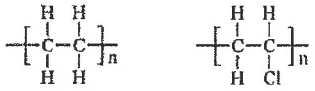
(4 marks)

(c) Suggest ONE improvement to the design of the experiment to find the percentage by mass of aspirin in E.

(1 mark)

ASL12(II)_07 (modified)

Polyethene (PE) and polyvinyl chloride (PVC) are two of the most commonly used synthetic polymers.



PE PVC

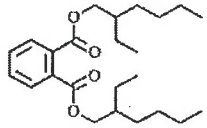
(a) Suggest reaction conditions for the formation of PE from its monomer.

(1 mark)

(b) Explain why PVC is more rigid than PE.

(2 marks)

(c) Plasticiers are often added to PVC to make it more flexible and processable. Bis(2-ethylhexyl)phathalate (DEHP) is one of the commonly used plasticisers.



DEHP

(i) DEHP is an oily liquid. It can be dispered in water by an emulsifying agent to give a stable cloudy mixture. Suggest an explanation for the formation of the cloudy mixture.

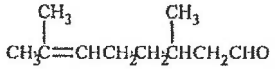
(2 marks)

(ii) It was reported that DEHP had been illegally used in clouding agents for beverages. Suggest ONE method for detecting DEHP in beverage samples.

(1 mark)

ASL12(II)_08

A naturally occurring organic compound has the following structure:



(a) On the above structure, circle the chiral carbon centre(s) in this compound.

(1 mark)

(b) Suggest a systematic name for this compound.

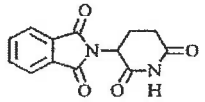
(1 mark)

(c) Give the structure of the major organic product(s) formed when this compound reacts with HCl(g).

(1 mark)

ASL13(I)_06

Thalidomide exhibits enantiomerism. Racemic thalidomide was a drug widely used to prevent morning sickness in pregnant women as one of its enantiomers is an effective sedative. However, by 1962, the other enantiomer of thalidomide was found to have caused more than 10,000 cases of birth defects in babies worldwide.



** Racemic thalidomide = a mixture of pair of enantiomers of thalidomide in mole ratio 1 : 1

(a) Mark, on the above structure of thalidomide, the chiral centre with an asterisk.

(1 mark)

(b) Suggest why the two isomers of thalidomide give different biological effect.

(2 marks)

ASL13(II)_06

The structural formula of $CH_3(CH_2)_7CH{=}CH(CH_2)_7CO_2H$ can represent two isomeric compounds.

(a) Draw appropriate structural representations for these two isomers.

(2 marks)

(b) Suggest how these two isomers can be differentiated.

(2 marks)

ASL13(II)_08

From the information given below, deduce ONE possible structure for compound **D**.

(1) **D** has a relative molecular mass of 72.0, and has the following composition by mass:

C, 66.7%; H, 11.1%; O, 22.2%

(2) **D** exhibits optical isomerism.

(3) **D** can turn acidified $K_2Cr_2O_7$(aq) from orange to green.

(7 marks)

DSE11SP_12

Ethyl ethanoate is an ester. It can be prepared by heating a mixture of ethanoic acid and ethanol under reflux in the presence of a catalyst.

(a) What is the catalyst used in the preparation?

(1 mark)

(b) Draw a labelled diagram of the set-up used for heating the mixture under reflux.

(2 marks)

(c) Ethyl ethanoate is commonly used as a solvent. Explain why ethyl ethanoate can dissolve iodine but cannot dissolve sodium iodide.

(3 marks)

(d) Draw the structure of another ester which has the same molecular formula as ethyl ethanoate, and give its systematic name.

(2 marks)

DSE11SP_13

Outline a synthetic route, in not more than three steps, to accomplish each of the following conversions. For each step, give the reagent(s), the conditions and the structure of the organic product.

(a) $CH_3CH_2CH_2Cl \longrightarrow CH_3CH_2\overset{O}{\overset{\|}{C}}-OH$ (3 marks)

(b) $CH_3CH{=}CH_2 \longrightarrow CH_3\overset{O}{\overset{\|}{C}}-CH_3$ (3 marks)

DSE12PP_02

(a) Wine in an opened bottle will become unpalatable if left to stand for some time. Suggest why this is so.

(1 mark)

(b) One common way of preserving wine in an opened bottle is to inject argon, a gas which is chemically unreactive, into the bottle and then stopper the bottle.

(i) Explain why argon is chemically unreactive.

(1 mark)

(ii) State the principle behind the use of argon in preserving wine.

(1 mark)

(iii) Helium gas is also chemically unreactive. Suggest why helium is NOT used for preserving wine in an opened bottle.

(1 mark)

(c) Another way of wine preservation involves pumping air out from an opened bottle of wine and then stoppering the bottle. Suggest ONE possible drawback of preserving wine in this way.

(1 mark)

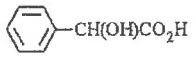
DSE12PP_11

Outline a synthetic route, with *no more than three steps*, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions and structure of the organic product.

(3 marks)

DSE12PP_12

The structural formula shown below can represent two compounds with the same melting point and same solubility in water.



(a) (i) Draw a three-dimensional structure for each of the two compounds.

(2 marks)

(ii) State ONE difference in physical properties of these compounds.

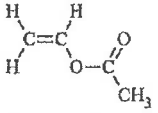
(1 mark)

(b) Both compounds can undergo polymerization under suitable conditions. Draw the repeating unit of the polymer formed from one of these compounds.

(1 mark)

DSE12_02

Poly(ethenyl ethanoate) is a polymer. Its monomer is ethenyl ethanoate with the structure shown below:



(b) Draw the structure of poly(ethenyl ethanoate).

(1 mark)

(c) Ethyl ethanoate is an organic solvent.

(i) Draw the structure of ethyl ethanoate.

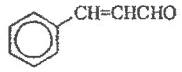
(1 mark)

(ii) Suggest a chemical test to show to distinguish between ethenyl ethanoate and ethyl ethanoate.

(2 marks)

DSE12_12

Cinnamon, which can be used as a flavoring, contains cinnamaldehyde (C_9H_8O). The structure of cinnamaldehyde is shown below:



(a) Draw the *trans*-isomer for the above structure.

(1 mark)

(b) Explain why ethyl ethanoate is a better solvent than water for dissolving cinnamaldehyde.

(1 mark)

(c) In an experiment to extract cinnamaldehyde from cinnamon, a solution containing only ethyl ethanoate and cinnamaldehyde is obtained after a series of steps. In order to separate these two compounds, simple distillation can be carried out. Draw a diagram for the set-up involved, and label the name of the distillate collected.
(Boiling point : cinnamaldehyde = 248 °C, ethyl ethanoate = 77 °C)

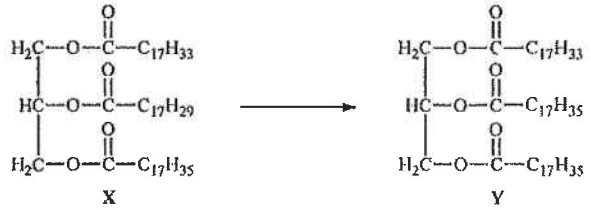
(2 marks)

(d) Outline a synthetic route, with no more than three steps, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.

(2 marks)

DSE12_14 [Same as CE93_01]

The diagram below shows the conversion of an oil molecule X to a fat molecule Y.



X Y

(a) (i) Given that all alkyl groups in both X and Y are straight chains, label the chiral carbon(s) by using '*' in the above diagram.

(1 mark)

(ii) With reference to (i), explain whether a change in optical activity is involved in the above conversion.

(1 mark)

(b) One of the products in the alkaline hydrolysis of Y has a cleansing property. Explain the cleaning property of this product.

(4 marks)

DSE12_15 (Similar to ASL03(II)_08a)

Use electron diagrams to illustrate, step by step, how CH_4 reacts with Br_2 under sunlight to form CH_3Br.
(Show electrons in the outermost shells only.)

(3 marks)

DSE13_03

Compound W contains carbon, hydrogen and oxygen only. The relative molecular mass of W is 88.0. Complete combustion of 1.32 g of W gives 2.64 g of carbon dioxide and 1.08 g of water.

(a) Deduce the molecular formula of W.
(relative atomic masses : H = 1.0, C = 12.0, O = 16.0)

(3 marks)

(b) Given that W has only one functional group, draw TWO possible structures of W.

(2 marks)

DSE13_04

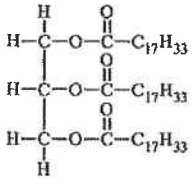
The structure of a dibasic acid with chemical formula $H_2C_2O_4$ is shown below:

(a) Give the systematic name of this dibasic acid.

(1 mark)

DSE13_14

An unsaturated fat F is a component of a vegetable oil. The structure of F is shown below:



(a) State the reagents needed for converting F to a saturated fat.

(1 mark)

(b) Vegetable oils can be used to make soap.

(i) Write the chemical equation involved for the formation of soap from F.

(1 mark)

(ii) In the presence of an acid, the soap formed in (i) can react with methanol to give compound G, which can be used as a biodiesel. Draw the structure of G.

(1 mark)

(c) With reference to their relative molecular masses and physical properties, explain why G can be used as a fuel for cars, but F cannot.

(2 marks)

DSE13_15

Consider the conversions of organic compounds shown below:

$$\underset{\text{X}}{CH_3CH_2COCH_2CH_3} \xrightarrow{R} \underset{\text{Y}}{CH_3CH_2CH(OH)CH_2CH_3} \xrightarrow{\text{dehydrating agent}} \underset{\text{Z}}{\text{a mixture of alkene}}$$

(a) Suggest a chemical test to distinguish between X and Y.

(2 marks)

(b) Suggest what reagent R might be.

(1 mark)

(c) The mixture Z contains two alkene with the same structural formula. Draw the respective structures of these two alkenes, and state their isomeric relationship.

(2 marks)

(d) The alkenes in (c) can react with HCl to form an optically active chloroalkane. Write the structural formula of this chloroalkane.

(1 mark)

DSE13(II)_02a

(ii) Cellulose is a condensation polymer of glucose.
The relative molecular mass of cellulose generally ranges from 2.5×10^5 to 1.0×10^6. Suggest why the relative molecular mass of cellulose falls into a wide range.

(1 mark)

DSE14_02

Draw the structure of ethane-1,2-diol, and suggest whether it is soluble in water.

(3 marks)

DSE14_12

Benzamide, benzoic acid and benzyl bromide are commonly used organic compounds. Their structures are shown below:

(a) In an experiment, benzoic acid is prepared from benzamide in two step:

Step 1: Benzamide is added to excess 1M NaOH(aq) and then mixture is heated gently. An organic compound X is formed.

Step 2: The resulting mixture is then treated with reagent Y until no more solid benzoic acid is given out.

(i) Name the type of reaction involved in Step 1.

(1 mark)

(ii) Draw the structure of X.

(1 mark)

(iii) Suggest what Y would be.

(1 mark)

(iv) Suggest why X is more soluble than benzoic acid in water.

(1 mark)

(v) Describe briefly how a dry benzoic acid sample can be obtained after Step 2.

(1 mark)

(b) Outline a synthetic route, with no more than three steps, to accomplish the conversion of benzoic acid to benzyl bromide. For each step, given the reagent(s), reaction conditions (as appropriate) and structure of the organic product.

(3 marks)

DSE14_14

Butter contains a small amount of triglyceride of butanoic acid.

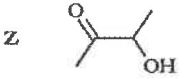
(a) Draw the structure of triglyceride of butanoic acid.

(1 mark)

(b) An organic acid Q is an isomer of butanoic acid. State the systematic name of Q.

(1 mark)

(c) The structure of Z, another isomer of butanoic acid, is shown below:



(i) Using '*', label ALL chiral centre(s) in the above structure of Z.

(1 mark)

(ii) Suggest a chemical test to show how to distinguish between Q and Z.

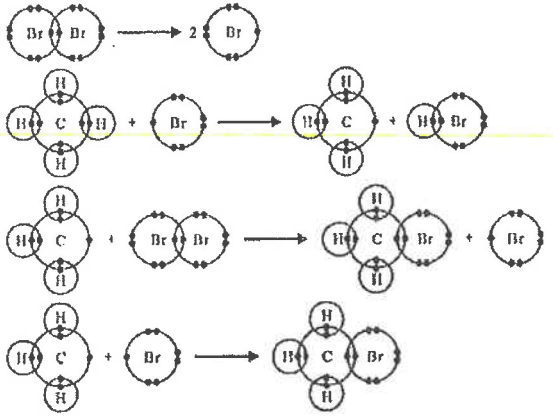
(2 marks)

(d) Margarine, a butter substitute, can be made from vegetable oils. What chemical reaction is involved in the production of margarine from vegetable oils?

(1 mark)

DSE15_06

The steps involved in the reaction of methane with bromine forming CH_3Br can be shown by the following diagram. Only electrons in the outermost shells are shown.



(a) Name the type of the reaction for the formation of CH_3Br from methane and bromine.

(1 mark)

(b) State the condition needed for the reaction to occur.

(1 mark)

(c) State the expected observation for the reaction.

(1 mark)

(d) With reference to its electronic structure, explain why the species 

has a high reactivity.

(1 mark)

(e) The reaction of methane with bromine can also form other single-carbon-containing organic compounds.

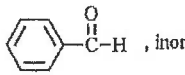
(i) Suggest one such compound.

(1 mark)

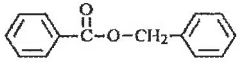
(ii) Suggest a condition so that the reaction of methane with bromine can form more CH_3Br but less other organic compounds.

(1 mark)

DSE15_12

You are provided with  , inorganic reagents and organic solvents.

Outline a synthetic route, with no more than three steps, to obtain the following compound:



For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.

(3 marks)

DSE15_13

Using $C_2H_5CH(OH)CH_3$ as an example, write a paragraph to illustrate 'enantiomerism'. Suitable diagram(s) should be included in your answer.

(4 marks + 1 mark)

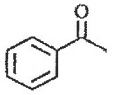
DSE16_12

Outline a synthetic route, with *no more than three steps*, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.

(3 marks)

DSE16_13

The structure of acetophenone is shown below:



Heating a mixture of acetophenone and $NaBH_4$ in methanol solvent under reflux can give two isomeric compounds **P** and **Q**. **P** and **Q** have the same melting point and same solubility in methanol.

(a) Draw a labelled diagram of the set-up for heating the mixture under reflux.

(2 marks)

(b) Suggest another reagent that can also react with acetophenone in a suitable solvent to give **P** and **Q**.

(1 mark)

(c) What kind of isomers are **P** and **Q**?

(1 mark)

(d) State one different physical property between **P** and **Q**.

(1 mark)

(e) Suggest a chemical test to show how acetophenone and **P** can be distinguished.

(2 marks)

DSE17_03

Answer the following questions.

(a) Explain why propene can form a polymer, but propane cannot.

(1 mark)

(b) Explain why $HO_2C(CH_2)_4CO_2H$ can form a polymer with $H_2N(CH_2)_6NH_2$, but $CH_3(CH_2)_4CO_2H$ cannot.

(2 marks)

DSE17_09

Four unlabeled reagent bottles each contains one of the colorless liquids listed below:

$HOCH_2CH_2CH_2OH$ $CH_3CO_2CH_3$ $CH_3CH_2CO_2H$ $CH_2{=}CHCO_2H$

Suggest chemical tests to distinguish the four liquids.

(4 marks + 1 mark)

DSE17_12

Consider the following conversions:

$$C_5H_{10}O \xrightarrow{} C_5H_{12}O \xrightarrow{HBr} \text{3-bromopentane}$$

A: optically active

B: optically inactive

C

(a) Write the structural formula of C.

(1 mark)

(b) (i) Deduce the structural formula of B.

(2 marks)

(ii) Name the type of reaction for the conversion of B to C.

(1 mark)

(c) (i) Deduce the structural formula of A. Label on this structural formula all chiral centre(s), if any, by using '*'.

(2 marks)

(ii) State the reagent(s) required for the conversion of A to B.

(1 mark)

DSE17_13

Outline a synthetic route, with *no more than three steps*, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and the structure of the organic product.

(3 marks)

DSE18_04

Petroleum is an important source of hydrocarbons.

(b) D, E and F are isomeric alkene containing four carbon atoms. D and E are *cis-trans* isomers.

(i) Draw the structure of E (*trans*-isomer).

(1 mark)

(ii) State the systematic name of one possible structure of F.

(1 mark)

(c) Ethene and ethane are hydrocarbons.

(i) Suggest how ethene can be converted to ethane.

(1 mark)

(ii) Suggest a chemical test to distinguish between ethane and ethene.

(2 marks)

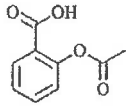
DSE18_10

Outline a synthetic route, with no more than three steps, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.

(3 marks)

DSE18_12

Aspirin is a pain-killer. Its structure is shown below:



(a) State one medical application of aspirin other than pain-killing.

(1 mark)

(b) Explain why a suspension of aspirin and water can become clear when sodium hydrogencarbonate powder is added.

(2 marks)

(c) Heating aspirin with excess dilute aqueous acid under reflux will give two organic products.

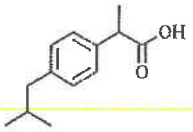
(i) Draw the structures of these two organic products.

(2 marks)

(ii) Explain why the conversion of aspirin to thee two organic products can hardly reach 100% even though the mixture of aspirin and dilute acid is heated under reflux for a long time.

(1 mark)

(d) Ibuprofen is also a pain-killer. Its structure is shown below:

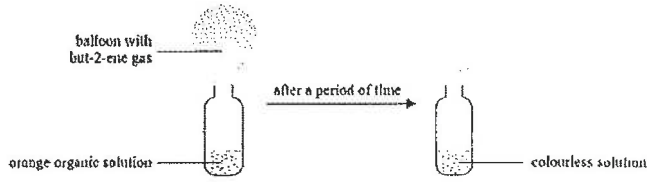


There exists enantiomerism in ibuprofen. Draw the three-dimensional structures for the pair of enantiomers.

(2 marks)

DSE19_03a

An experiment was carried out as shown below:



(i) Suggest what the orange organic solution may be.

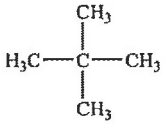
(1 mark)

(ii) With the help of a chemical equation, explain the colour change in the solution.

(2 marks)

DSE19_05

The structure of a compound is shown below :



Reacting with a reagent under certain conditions, it can give two compounds with the same molecular formula $C_5H_{10}Cl_2$ but different structures.

(a) Suggest what the reagent is.

(1 mark)

(b) State the condition needed for the reaction to occur at room temperature.

(1 mark)

(c) Name the type of the reaction involved.

(1 mark)

(d) (i) Draw the structure of ONE of these two compounds and give its systematic name.

(2 marks)

(ii) Draw the structure of the other compound.

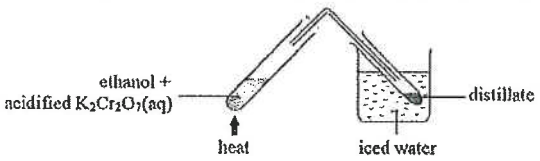
(1 mark)

(iii) These two compounds are isomers. State the type of isomerism exhibited by them.

(1 mark)

DSE19_13

(a) It was intended to prepare ethanoic acid from ethanol by the following set-up. However, the distillate collected mainly contained another organic product X but not ethanoic acid.



(i) What is X ?

(1 mark)

(ii) Explain why the distillate collected mainly contained X but not ethanoic acid.

(1 mark)

(b) Ethanoic acid can be converted to an unsubstituted amide.

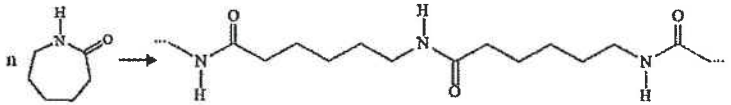
(i) Give the systematic name of this amide.

(1 mark)

(ii) Suggest what reagent and condition are needed for this conversion.

(1 mark)

(c) The following shows the formation of a polymer from an amide:



a portion of the polymer formed

(i) Draw the repeating unit of the polymer formed.

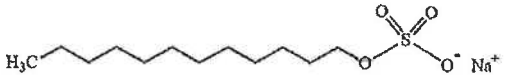
(1 mark)

(ii) There is a view which suggests that the above polymerisation does not involve condensation. Give a reason to support this view.

(1 mark)

DSE19_15 [Same as CE93_01, DSE12_14]

With reference to the structure of sodium lauryl sulphate (SLS) below, explain why it has cleansing properties.



(4 marks + 1 mark)

DSE20_05bi

5. The molecular formula of an organic compound W is $C_4H_6O_4$. It is soluble in water.

(a) When a piece of magnesium ribbon is placed into an aqueous solution of W, hydrogen gas evolves. According to this observation, suggest a functional group that W may contain. (1 mark)

(b) It is known that one mole of W can completely react with two moles of NaOH.

(i) Draw TWO possible structures of W.

b(i)+(ii)+(iii) = 6 marks

DSE20_10

10. The structure of a compound **Y** is shown below :

$H_2C{=}CHCH_2OH$

(a) **Y** can be prepared from reacting 3-chloropropene with an appropriate reagent.

(i) Write a chemical equation for this reaction.

(ii) Name this type of reaction. (2 marks)

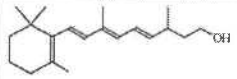
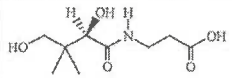
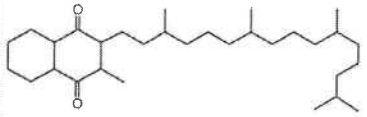
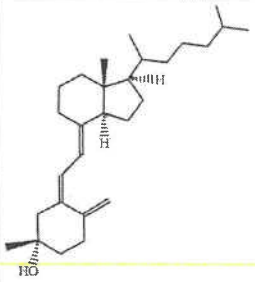
(b) On heating under reflux, a compound **L** reacts with KOH(aq) to give **Y** and $CH_3COO^-K^+$.

(i) Suggest the structural formula of **L**.

(ii) Draw a labelled diagram to show the set-up for this reaction. (3 marks)

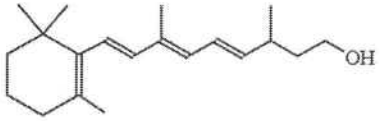
(c) Under suitable conditions, **Y** can form a polymer. Write the repeating unit of the polymer. (1 mark)

DSE20_11 11. The structures of some compounds are shown below :

Compound	Structure
W	
X	
Y	
Z	

(a) Which one of **W**, **X**, **Y** or **Z** is a tertiary alcohol ?

(b) Label all chiral centre(s), if any, by using '*' on the structure of **W** below.



11. (c) Heating **X** under reflux in 2 M NaOH(aq) can form an **optically active** organic compound **U** and an **optically inactive** organic compound **V**. Draw the respective structures of **U** and **V**.

U :

V : (2 marks)

(d) Consider the following reagents :

$Br_2(aq)$ acidified $K_2Cr_2O_7(aq)$ $Na_2CO_3(aq)$

(i) Suggest which one of the reagents can be used to perform a chemical test, in order to distinguish **X** from **W**, **Y** and **Z**.

(ii) State the observation in the test involved in (i). Explain your answer. (3 marks)

DSE21_04(d)

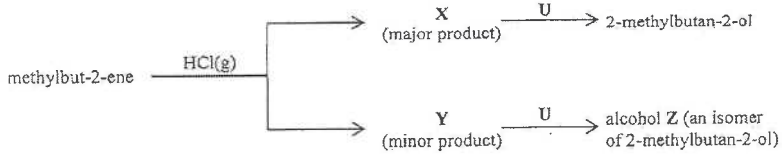
4. (d) Compound **Y** is a structural isomer of butane.

(i) Draw one possible structure of **Y**.

(ii) Which of decane, butane and **Y** would have the highest boiling point ? Explain your answer.

DSE21_11

11. Methylbut-2-ene reacts with HCl(g) to give **X** as the major product as predicted from Markovnikov's rule. During the reaction, another product **Y** (minor product) can also be formed. Refer to the following organic conversions :



(a) State the Markovnikov's rule.

(b) Draw the structure of **X**.

(c) **X** reacts with **U** to give 2-methylbutan-2-ol. What is **U** ?

(d) (i) **Y** has one chiral centre. Draw a three-dimensional diagram for the structure of an enantiomer of **Y**.

11. (d) (ii) **Y** is optically active. What is meant by the term 'optically active' ?

(e) **Y** reacts with **U** to give alcohol **Z**. Suggest a chemical test to show how **Z** and 2-methylbutan-2-ol can be distinguished.

DSE21_13

*13. Using nylon-6,6 as an example, illustrate the meaning of condensation polymerisation. Your answer should also include the structural feature of the monomers.

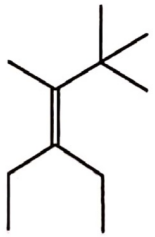
(5 marks)

24. Consider the following statements and choose the best answer :

1st statement	2nd statement
Ethene and but-1-ene have the same standard enthalpy change of combustion.	Ethene and but-1-ene have the same empirical formula.

A. Both statements are true and the 2nd statement is a correct explanation of the 1st statement.
B. Both statements are true but the 2nd statement is NOT a correct explanation of the 1st statement.
C. The 1st statement is false but the 2nd statement is true.
D. Both statements are false.

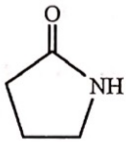
27. The structure of an organic compound is shown below :



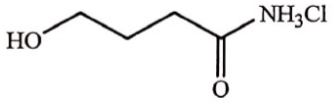
Which of the following combinations concerning whether *cis-trans* isomerism and enantiomerism can occur in the compound is correct ?

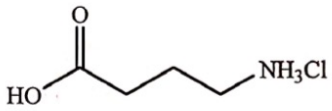
	***cis-trans* isomerism**	**enantiomerism**
A.	No	No
B.	Yes	Yes
C.	Yes	No
D.	No	Yes

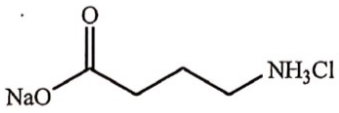
29. The structure of an organic compound is shown below :

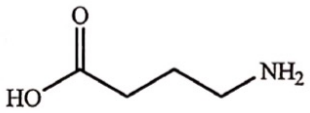


When it is heated with excess NaOH(aq), followed by the addition of excess HCl(aq), a major organic product **Z** is formed. Which of the following is **Z** ?

A. 

B. 

C. 

D. 

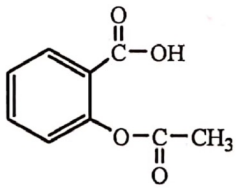
30. When 0.40 mol of $SO_2(g)$ and 0.60 mol of $O_2(g)$ are placed in a 1.0 dm^3 evacuated flask, the following reaction occurs.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

When chemical equilibrium is attained at a certain temperature, the flask is found to contain 0.30 mol of $SO_3(g)$. What is the equilibrium constant K_c for the reaction at this temperature ?

A. 20 mol^{-1} dm^3
B. 6.7 mol^{-1} dm^3
C. 2.0 mol^{-1} dm^3
D. 0.050 mol^{-1} dm^3

33. The structure of aspirin is shown below :



Which of the following statements about aspirin are correct ?

(1) It has an ester group.
(2) It can reduce inflammation.
(3) It has a higher solubility in $Na_2CO_3(aq)$ than in pure water.

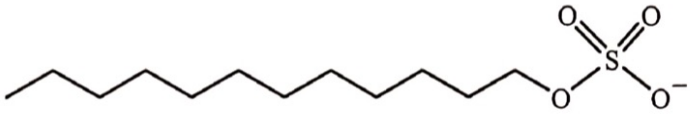
A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

34. Which of the following compounds can be used as a monomer for condensation polymerisation ?

(1) $H_2C=CHCH_2CH_2CH=CH_2$
(2) $HOOCCH_2CH_2CH_2CH_2COOH$
(3) $HOCH_2CH_2CH_2CH_2CH_2CH_2OH$

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

35. The structure of a detergent is shown below :



Which of the following statements concerning this detergent are correct ?

(1) It is a soapless detergent.
(2) It can act as an emulsifying agent.
(3) It can increase the surface tension of water.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

9. At a certain temperature, the equilibrium constant K_c for the following reaction is 2.25×10^{-2} mol dm^{-3}.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g) \qquad \Delta H > 0$$

In an experiment, 0.84 mol of $PCl_5(g)$, 0.16 mol of $PCl_3(g)$ and 0.16 mol of $Cl_2(g)$ were initially introduced in a closed container of a fixed volume of 4.0 dm^3, and the system was allowed to attain equilibrium at that temperature.

(a) (i) Calculate the reaction quotient Q_c for the system under the initial conditions.

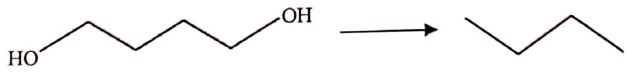
(ii) Explain whether the concentration of $PCl_5(g)$ would increase or decrease just after the reaction started.

(4 marks)

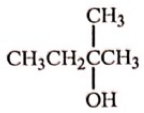
(b) Explain whether K_c would increase, decrease or remain unchanged if the temperature of the equilibrium mixture is increased.

(2 marks)

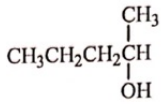
12. Outline a synthetic route, with NO MORE THAN THREE STEPS, to accomplish the following conversion. For each step, give the reagent(s), reaction conditions (as appropriate) and structure of the organic product.



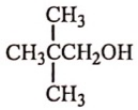
11. Compounds **P**, **Q** and **R** are structural isomers having the molecular formula of $C_5H_{12}O$. Their structures are shown below :



P



Q



R

(a) Give the systematic name of **P**.

(1 mark)

(b) Heating **Q** with acidified $K_2Cr_2O_7(aq)$ under reflux will give an organic product.

(i) Draw a labelled diagram to show the set-up for this reaction.

(ii) State the expected observation for this reaction.

(iii) Write the structural formula of the organic product.

(4 marks)

(c) **W** is an organic compound containing five carbon atoms. Under suitable conditions, **R** can be prepared from the reduction of **W**.

(i) Suggest the structural formula of **W**.

(ii) Suggest a reducing agent required for the reaction.

(2 marks)

(d) Compound **S** is an optically active secondary alcohol. It is also a structural isomer of compounds **P**, **Q** and **R**. Write the structural formula of **S**.

(1 mark)

Marking Scheme

MCQ

Part 1: Organic reaction and Part 2: Plastic

CE90_39	A	CE90_41	A	CE91_30	D	CE91_40	C
CE92_06	B	CE92_20	B	CE92_41	C	CE92_47	B
CE93_30	B	CE93_31	A	CE93_43	D	CE94_19	B
CE94_42	D	CE96_23	A	CE96_24	D	CE96_41	B
CE97_15	C	CE97_20	B	CE98_48	B	CE99_26	B
CE99_27	D	CE00_13	C	CE00_36	A	CE01_21	C
CE01_25	C	CE01_50	C	CE04_17	C (49%)	CE04_27	D (62%)
CE04_33	D (66%)	CE05_24	A (88%)	CE05_49	C (43%)	CE06_43	B (45%)
CE07_16	B (35%)	CE07_23	C (48%)	CE07_42	D (21%)	CE08_47	B (31%)
CE09_12	A (34%)	CE09_24	D	CE09_25	A (82%)	CE09_27	D (47%)
CE10_07	D (83%)	CE10_18	C (63%)	CE10_38	A (54%)	CE11_13	C (73%)
CE11_15	C (53%)	CE11_34	A (69%)	CE11_48	C (46%)	CE11_39	D (62%)
CE11_50	D (56%)						

Part 3: Soaps and Soapless detergents

CE90_37	D	CE90_38	B	CE91_33	B	CE91_49	C
CE92_23	B	CE93_44	B	CE94_24	D	CE94_25	C
CE96_28	A	CE96_29	D	CE97_35	A	CE98_15	D
CE98_41	A	CE99_43	C	CE99_48	C	CE00_18	B
CE00_41	C	CE01_16	C	CE02_21	D	CE03_19	A (67%)
CE03_29	B (53%)	CE03_49	A (45%)	CE04_04	D (46%)	CE04_22	A (59%)
CE04_49	A (58%)	CE05_32	D (72%)	CE05_42	B (79%)	CE06_26	A (63%)
CE06_42	B (54%)	CE07_50	C (63%)	CE08_35	B (67%)	CE09_45	A (45%)
CE09_50	A (82%)	CE10_41	B (64%)	CE11_47	A (57%)		
ASL08(I)_05	A	ASL09(I)_03	C	ASL13(I)_03	D	DSE11SP_26	C
DSE11SP_27	B	DSE11SP_28	C	DSE11SP_30	A	DSE11SP_31	C
DSE11SP_34	D	DSE12PP_27	A	DSE12PP_28	B	DSE12PP_33	D
DSE12PP_34	C	DSE12PP_36	C	DSE12_28	D (47%)	DSE12_29	D (79%)
DSE12_32	A (66%)	DSE12_33	B (65%)	DSE12_34	D (58%)	DSE12_36	C (62%)
DSE13_20	D (58%)	DSE13_29	B (56%)	DSE13_30	D (65%)	DSE13_31	B (70%)
DSE13_32	A (41%)	DSE13_34	C (56%)	DSE13_35	A (31%)	DSE14_27	D (62%)
DSE14_28	A (67%)	DSE14_29	B (55%)	DSE14_32	D (48%)	DSE14_33	D (49%)
DSE14_34	A (63%)	DSE15_26	C (14%)	DSE15_29	C (60%)	DSE15_30	D (85%)
DSE15_32	A (68%)	DSE15_34	C (62%)	DSE16_28	C (58%)	DSE16_29	C (26%)
DSE16_31	A (34%)	DSE16_35	A (64%)	DSE16_32	B (66%)	DSE17_18	B (50%)
DSE17_26	B (60%)	DSE17_29	A (66%)	DSE17_33	C (88%)	DSE17_35	C (43%)
DSE17_36	C (45%)	DSE18_27	A (57%)	DSE18_30	D (83%)	DSE18_31	B (43%)
DSE18_34	C (55%)	DSE18_35	A (59%)	DSE19_23	D	DSE19_29	B
DSE19_31	C	DSE19_32	C	DSE19_36	A		
DSE20_27	D	DSE20_29	C	DSE20_31	D	DSE20_32	A
DSE20_34	A	DSE20_36	A				

Structural Questions

Part 1: Organic reaction

CE90_01a

(i) propanoic acid [1]

$CO_3^{2-} + 2H^+ \longrightarrow CO_2 + H_2O$ [1]

(ii) $CH_3CH_2COOH + CH_3CH_2CH_2OH \rightleftharpoons CH_3CH_2COOCH_2CH_2CH_3 + H_2O$ [1]

OR, $CH_3COOH + CH_3CH_2CH_2OH \rightleftharpoons CH_3COOCH_2CH_2CH_3 + H_2O$

function of concentrated sulphuric acid (conc. H_2SO_4):

1. catalyst
2. speeds up the reaction [1]

CE90_03b

(i) A weak acid is partially (slightly) ionized [1]

to produce hydrogen ions. [1]

OR, $C_nH_{2n+1}COOH \rightleftharpoons C_nH_{2n+1}COO^- + H^+$

(ii) A few drops of phenolphthalein [1]

changes from colourless to pink. [1]

(iii) (1) moles of NaOH used $= 0.18 \times 22.4 \times 10^{-3} = 0.004032$ [1]

(2) $C_nH_{2n+1}COOH + NaOH \longrightarrow C_nH_{2n+1}COONa + H_2O$

moles of $C_nH_{2n+1}COOH$ = mole of NaOH used = 0.004032 [1]

relative molecular mass mass of $C_nH_{2n+1}COOH = \dfrac{0.355}{0.004032} = 88.05$ [2]

(iv) (1) molecular mass $C_nH_{2n+1}COOH = 88.5$

$12n + 2n + 1 + 12 + 16 \times 2 + 1 = 88.5, \quad n = 7$ [1]

So, the molecular formula is C_3H_7COOH [1]

(2) $CH_3CH_2CH_2COOH$ [1]

$CH_3CH(CH_3)COOH$ [1]

CE90_05b

(i) (1) hydrolysis [1]

$CH_3COOCH_2CH_3 + NaOH \longrightarrow CH_3COONa + CH_3CH_2OH$ [1]

OR, $CH_3COOC_2H_5 + OH^- \longrightarrow CH_3COO^- + CH_3CH_2OH$

(2) fruity smell not detected [1]

OR, two layers become one miscible layer

(3) to make soap / soapy detergents [1]

(ii) to condense the reactions / products (or acts as a condenser) [1]

OR, cold finger is to prevent the loss of volatile reagents / products.

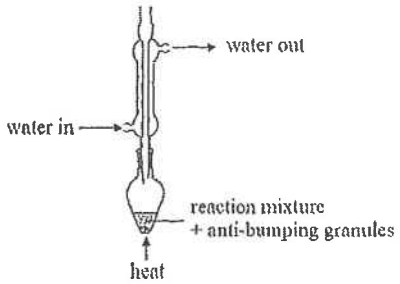
(iii) ethyl ethanoate / ethanol / reactants / products may catch fire from the direct-flame (or inflammable) [1]

OR, spurting out of chemicals during heating

(iv) (1) some reactants (or products) vapourized [1]

OR, the cold finger is an ineffective / poor condenser

(2) [2]



CE92_03a

(i) Rice and yeast solution is put into a conical flask then stoppered it. [1]
Stand it in room condition. [1]
After a few days, ethanol is formed. [1]

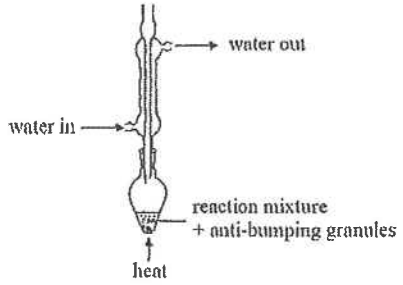
(ii) By distillation or fractional distillation. [1]

(iii) Ethanol is oxidized by air to form ethanoic acid. [1]

(iv) Health hazard: excessive intake of ethanol will damage the liver. [1]
Social problem: cause careless driving [1]

CE94_06b

(i) [3]



deduct mark for no indication of heat / closed system / incorrect labelling the direction of water flow

(ii) (1) Conc. H_2SO_4 is a catalyst. [1]
(2) For heat: to increase the rate of reaction and [1]
For reflux: to reduce the loss of volatile reactants and products. [1]

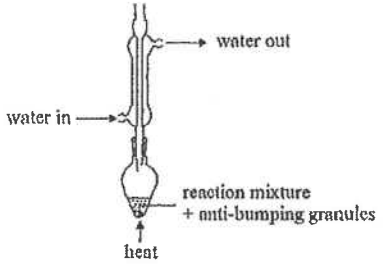
(iii) Two layers of liquid are formed. [1]
OR, pleasant smell is detected.

CE95_07b

(i) ethene / CH_2=CH_2 / C_2H_4 [1]
catalytic hydration [1]

(ii) CH_2=CH_2 + Br_2 ⟶ CH_2BrCH_2Br [1]

(iii) (1) ethanoic acid [1]
(2) [3]



deduct marks for wrong reagents / no indication of heat / closed system / labelling the direction of water flow

(iv) Pass the breath into acidified potassium dichromate (solution). [1]
The colour of the solution will change from orange to green. [1]

CE96_02

(a) moles of C in 1 mole of X = $\frac{60 \times 60\%}{12} = 3$ [1]
The general formula of alkanol is $C_nH_{2n+1}OH$ [1]
Thus, molecular formula of X is C_3H_7OH or C_3H_8O [1]

(b) CH_3–CH_2–CH_2–OH, propan-1-ol [1]

OR, $CH_3-\underset{\underset{OH}{|}}{CH}-CH_3$ propan-2-ol [1]

CE98_09a

(i) condenser [1]

(ii) to prevent bumping (or to ensure uniform heating) [1]

(iii) [1]
$CH_3CH_2CH_2OH \xrightarrow{[O]} CH_3CH_2COOH$

(iv) fractional distillation [1]

(v) The methanol in the reaction mixture is flammable. [1]

(vi) (1) Any TWO of the following: [2]
- effervescence / gas bubbles give out
- two layers of liquids resulted
- pleasant / sweet smell is detected

(2) methyl propanoate [1]

CE99_06b

(i) (1) yeast / enzyme [1]

(2) Fermentation of glucose produces carbon dioxide which reacts with $Ca(OH)_2$ in lime water to give insoluble calcium carbonate. [2]

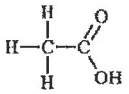
(3) $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$ [1]

(ii) (1) acidified potassium dichromate solution changes from orange to green. [1]

(2) Oxidation number of Cr in $Cr_2O_7^{2-}$ is +6.

Oxidation number of Cr in Cr^{3+} is +3. [1]

$Cr_2O_7^{2-}$ is reduced because oxidation number of Cr decreases. [1]

(3)  [1]

(iii) (1) drinking a small quantity of wine can reduce the proneness to heart attack. [1]

(2) Excessive drinking can cause brain damage / depression / hepatitis / damage of the liver / stomach ulcer / cancer of mouth, throat and gullet. [1]

CE02_03c

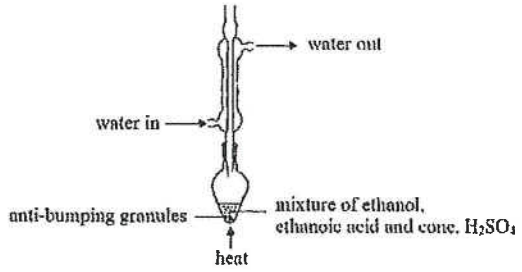
Sodium dichromate [1]

It changes from orange ($Cr_2O_7^{2-}$) to green (Cr^{3+}). [1]

CE02_06c

(i) concentrated sulphuric acid / conc. H_2SO_4 [1]

(ii) [2]



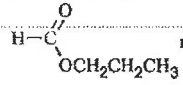
(iii) Iodine has a simple molecular structure. Attraction between I_2 molecules is weak van der Waals' forces. [1]

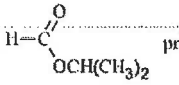
Sodium iodide has an ionic structure. Attraction between Na^+ and I^- ions is strong ionic bond. [1]

Strength of inter-particle attraction in ethyl ethanoate is comparable to that in iodine. [1]

(iv) flammable / C [1]

(v) Any ONE of the following:

 methyl propanoate

 propyl methanoate [2]

CE03_08a

(i) (1) glucose [1]

$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$ [1]

(2) yeast. [1]

Yeast provides enzymes for fermentation of glucose. [1]

(ii) Prevent air from entering the jar otherwise ethanol produced will be oxidized. [1]

Prevent building up of pressure in the jar. [1]

(iii) (1) When the concentration of ethanol exceeds 18%, the yeast will not function and fermentation will stop. [1]

(2) distillation [1]

(iv) Ethanol in the wine undergoes oxidation to give ethanoic acid which is sour. [1]

CE04_08c

(i) Ethanol can reduce $Cr_2O_7^{2-}$ (orange) to Cr^{3+} (green). [2]

(1 mark for reduction / oxidation; 1 mark for colour change)

(ii) Conduct the test after the driver has thoroughly rinsed his mouth with water. A positive result probably indicates that the driver has drunk. [1]

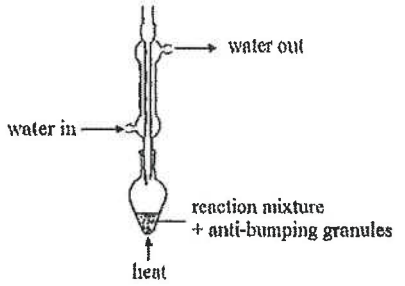
Ethanol is soluble in water. The concentration of ethanol in the breath will drop after the driver has rinsed his mouth. [1]

OR, Conduct the test after a few minutes. A positive result probably indicates that the driver has drunk.

The concentration of ethanol in the air breathed out will drop after a period of time as ethanol is a volatile liquid.

CE04_09b

(i) [2]

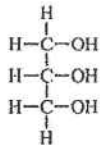


(1 mark for a correct diagram of the set-up; 1 mark for labelling the direction of water flow in the condenser.)

(ii) Heating under reflux can reduce loss of reactants / products by evaporation. [1]

CE05_11

(a) (i)



[1]

(ii) X has a larger molecular size / mass. [1]
Its side-chains can entangle together and relative motion between molecules will be hindered / larger intermolecular force. [1]

(iii) chemical to change the rate of reaction (hydrolysis) but itself remains chemically unchanged after reaction [1]

(iv) use a separating funnel [1]

(b) Any TWO of the following: [2]

- vegetable oils are renewable energy source
- the reserve of petroleum (a source of diesel) is limited
- biodiesel is more biodegradable
- biodiesel does not contain S which causes the formation of acid rain
- the exhaust produced does not contribute much to global warming because the CO_2 in the exhaust is already a part of the natural carbon cycle
- biodiesel burns with a less sooty flame

CE06_02

(a) $CH_3CH_2COOCH_3$ [1]

(b) alkanoic acid / carboxylic acid / fatty acid [1]

(c) propan-1-ol / propanal [1]

(d) The colour of the mixture changes from orange to green. [1]

(e) catalyst [1]

CE07_12

(a)

	C	H	O
Mole	$\frac{0.401}{12}$	$\frac{0.068}{1}$	$\frac{0.531}{16}$
Mole ratio	0.033	0.068	0.033
Simplest mole ratio	1	2	1

Empirical formula of Z: CH_2O [2]

(b) Let the molecular formula of Z be $(CH_2O)_n$.

Formula mass of $Z = \frac{1}{400 \times 10^{-3}} \times 24 = 60$

$(12 + 2 + 16)n = 60, \quad n = 2$

Molecular formula of Z is $C_2H_4O_2$. [2]

(c) (i) $HCOOCH_3$ [1]

Explanations:

from (III): Z is not an acid. [1]

from (IV): No carbon-carbon double bond in Z. [1]

(ii) methyl methanoate [1]

CE11_10b

(i) Anode. It is because the conversion of ethanol to ethanoic acid is an oxidation. [1]

(ii) $CH_3CH_2OH + H_2O \longrightarrow CH_3COOH + 4H^+ + 4e^-$ [1]

(iii) Higher concentration of ethanol produces larger current. [1]

CE11_12

Chemical knowledge [6]

Reaction with oxygen in air

Method:

Burn hexane and hex-1-ene separately on watch glasses.

Observation:

Hexane gives a less sooty flame. / Hex-1-ene gives a more sooty flame.

Explanation:

Carbon percentage by mass of hexane is lower than that of hex-1-ene.

Reaction with bromine

Method:

Add bromine solution to hexane and hex-1-ene separately in test tubes.

Observation:

Bromine solution decolourises in hexane less readily than in hex-1-ene.

Explanation:

Hex-1-ene is unsaturated while hexane is saturated.

OR, Hex-1-ene undergoes addition reaction with bromine while hexane does not undergo addition reaction.

OR, Hexane undergoes substitution reaction with bromine under light.

Effective communication [3]

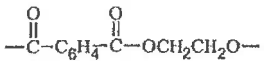
Part 2: Plastic

CE94_03

(b) polyethene / polypropene / polyvinyl chloride / nylon [1]

(d) (i) condensation polymerization [1]

(ii) [1]



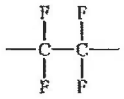
CE07_08

(a) (i)

[1]

OR, $-CF_2-CF_2-CF_2-CF_2-CF_2-CF_2-CF_2-CF_2-CF_2-CF_2-$

(ii) Repeating unit:



[1]

OR, $-CF_2-CF_2-$

Monomer: $CF_2=CF_2$ / tetrafluroethene [1]

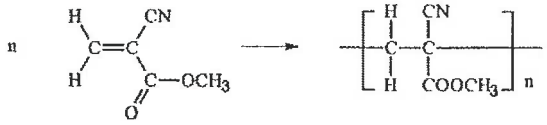
(b) (ii) Carpets may be made of a variety of materials. Separating nylon from carpets may be difficult. [1]

(iii) Poisonous gas / NO_2 / NO / CO / HCN / soot may evolve. [1]

CE08_08

(a) addition polymerization [1]

(b)

 [1]

(c) $CH_2=C(CN)COOH$ [1]

CH_3OH [1]

(d) To keep the superglue in an air-tight container / a dry place. [1]

CE08_09

Chemical knowledge [6]

(a) Add a few drops of concentrated sulphuric acid into the potassium dichromate solution to prepare acidified $K_2Cr_2O_7$ solution. Add excess acidified potassium dichromate solution into ethanol.

(b) Heat the mixture under reflux until no further reaction.

(c) Collect ethanoic acid produced by fractional distillation.

(d) Mix ethanoic acid, ethanol and a few drops of concentrated sulphuric acid.

(e) Heat the mixture under reflux.

(f) Collect ethyl ethanoate by fractional distillation.

Effective communication [3]

CE09_05

(a) cracking [1]

Large molecules break into small molecules. [1]

(b) addition / hydration [1]

(c) fractional distillation [1]

(d) **(i)** Gasohol is less flammable. / More energy can be obtained from gasohol. [1]

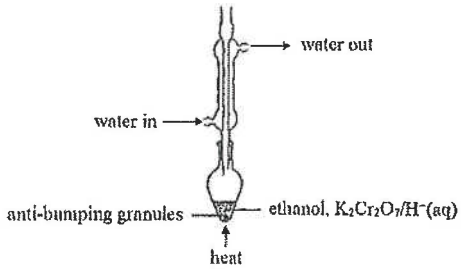
(ii) Gasohol undergoes complete combustion more readily. / Gasohol gives less carbon monoxide / particulates / soot / smoke. [1]

CE09_08

(a) Acidified potassium dichromate / potassium permanganate solution. [1]

(b) Prevent the ethanol from catching fire. / Ethanol is flammable. [1]

(c) (i) [3]

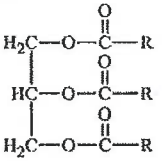


(ii) The new set-up prevents ethanol from escape. / helps the reaction occur for longer time. [1]

<u>Part 3: Soaps and Soapless detergents</u>

CE91_01b

(i)

 [1]

(ii) H_2SO_4 is a catalyst. [1]

(iii) Saponification (making soap) [1]

(iv) $R-COO^-Na^+$ [1]

(vi) • The hydrocarbon tail of Y dissolve in oil. [1]

• And the ionic head of Y dissolve in water. [1]

• After shaking, the oil turns to oil droplets due to the repulsion of the negatively charged ionic heads. [1]

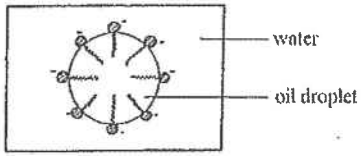
• Oil droplets cannot stick together. [1]

(vii) Emulsification / emulsifying action. [1]

Soap cleaning / detergent cleaning / to remove oil. [1]

CE93_01e

(i) (1)



[2]

(2) The hydrophilic ionic heads of detergent dissolve in water and the hydrophobic hydrocarbon tails dissolve in oil. Water molecules attract the hydrophilic ionic heads and bring the oil into water. [1]

After shaking, the oil becomes oil droplets. Oil droplets so not stick together because of the repulsion between negatively charged oil droplets. [1]

(ii) No, they will stick together and this will weaken or lose their cleaning action. [2]

CE94_05a

(v) Rainbow (conc. H_2SO_4) causes hydrolysis of the fats and greases in drain to form more soluble products (glycerol and carboxylic acid). [2]

CE95_02c

Vinegar [1]

It is acidic / the others are alkaline. [1]

CE95_09a

(i) Step 1: Heat / boil vegetable oil with sodium hydroxide solution. [2]

Step 2: Add concentrated NaCl solution to salt out the soap. [1]

Step 3: Separate (filter) the soap from the solution. [1]

(ii) Formula mass of the soap = $12(n + 1) + (2n + 1) + 2 \times 16 + 23 = 14n + 68$ [1]

$300 < 14n + 68 < 310$

$16.6 < n < 17.3$

$n = 17$ [1]

(iii) (1) petroleum (fraction) [1]

concentrated sulphuric acid [1]

(2) Advantage:

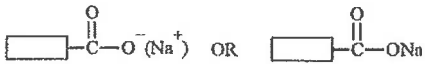
- the soapless detergent can be used in the hard water / acidic solution. [1]

Disadvantage: (any one) [1]

- some soapless detergent is non-biodegradable / may cause water pollution which can kill marine lives.
- may cause skin allergies

CE97_07b(iii)

(1) Compound I [1]

(2)  [1]

(3) The hydrocarbon tail of detergent is hydrophobic and readily soluble in the greasy dirt. [1]

The COO^- (ionic) end is hydrophilic and readily soluble in water. [1]

Water molecules attract the hydrophilic ionic heads and bring the oil into water.

Stirring (shaking) will cause the grease to break down into droplets. [1]

The negative charge on the droplets repels each other and hence oily droplets will become suspended in the aqueous solution and wash away by running water. [1]

CE00_06c

(ii) Detergents have a hydrocarbon tail which is hydrophobic (oil attraction) and an ionic head which is hydrophilic (water attracting), which can make oil into oil droplets for collection. [2]

CE01_06a

(i) Soap react with Ca^{2+} and Mg^{2+} ions in hard water to form scum / precipitate. Thus reduces the effectiveness of soap. [1]

(ii) Soda (sodium carbonate) removes Ca^{2+} and Mg^{2+} by forming insoluble calcium carbonate / magnesium carbonate [1]

$Ca^{2+} + CO_3^{2-} \longrightarrow CaCO_3$ [1]

OR, $Mg^{2+} + CO_3^{2-} \longrightarrow MgCO_3$

CE02_09a

(i) (1) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ [1]

(2) Oils react with alkalis (undergoes hydrolysis) to give soaps / water soluble substances. [1]

(ii) The glass cleaner should be used in a well-ventilated environment because ammonia has a pungent smell / is toxic. [2]

OR, wear gloves because alkaline solutions can attack skin.

OR, wear safety spectacles because ammonia solutions attacks eyes.

CE04_07b

(i) The structure of the detergent consists of a hydrocarbon tail and an anionic head / the carboxylate ion ($-COO^-$). [1]

When mixed with paraffin oil, the hydrocarbon tail dissolves in the oil / is hydrophobic, while the ionic head dissolves in water / is hydrophobic. [1]

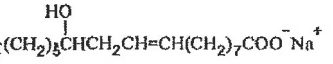
Upon shaking, oil drops, which carry negative charges, are formed. Repulsion of the negatively charged oil drops prevents them from joining together. So, an emulsion is formed. [1]

(ii) Not suitable.
Sea water contains a lot of metal ions, such as Ca^{2+} and Mg^{2+}. [1]
This anionic detergent will react with the metal ions to form scum and hence reduce the effectiveness of the detergent. [1]

CE07_13
Chemical knowledge [6]
- Both soapy and soapless detergents have ionic group / head and long hydrocarbon chain tail.
- Both soapy and soapless detergents have hydrophilic property and hydrophobic property.
- Soapy detergents made from fats / oils, while soapless detergents made from petroleum.
- Soapy detergents have $-COO^-$ group, while soapless detergents have $-SO_3^-$ / $-OSO_3^-$ group.
- Both soapy and soapless detergents act as wetting agents.
- Both soapy and soapless detergents act as emulsifying agents.
- Soapy detergents are usually biodegradable, while soapless detergents usually are not.
- Soapless detergents can be tailor-made, while soapy detergents cannot.

Effective communication [3]

CE09_12
(a) saponification / alkaline hydrolysis [1]
(b) concentrated sodium chloride solution / conc. NaCl(aq) / brine [1]
(c) [1]

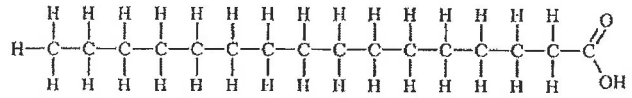


(d) The hydrocarbon tail of white solid is hydrophobic and readily soluble in the greasy dirt. The ionic head of white solid end is hydrophilic and readily soluble in water. [1]
Water molecules attract the hydrophilic ionic heads and bring the oil into water. [1]
Stirring (shaking) will cause the grease to break down into droplets. The negative charge on the droplets repels each other and hence oily droplets will become suspended in the aqueous solution and wash away by running water. [1]
(e) Preparation of soap / detergent *OR* Hyddrolysis of caster oil [1]
AND
Testing the emulsifying property of the product / cleaning action [1]
(f) White precipitate would be observed. [1]

CE11_11
(a) (i) Citrate ions can react with Mg^{2+} or Ca^{2+} ions in hard water to form insoluble substances. [1]
Prevent Mg^{2+} or Ca^{2+} ions from reacting with the soapy detergents to form scum. [1]
(ii) Phosphate ions can cause growth of algae / red tide. [1]

(b) (i) $CH_3(CH_2)_{14}COOH$ [1]

OR,



(ii) Sodium carbonate can reduce the acidity in the acidic environment. [1]
$2H^+ + CO_3^{2-} \longrightarrow CO_2 + H_2O$ [1]

(c) Any 3 points, 1 mark for each point [3]
- This detergent is biodegradable.
- This detergent works well in acidic medium.
- This detergent works well in hard water. / This detergent does not form scum with Mg^{2+} or Ca^{2+} ions in hard water.
- This detergent can save food in the production process.

AL96(II)_07b
(i) $\text{Moles of } (CH_3)_3COH = \frac{25}{74} = 0.338$ [½]

$\text{Moles of HCl} = \frac{36}{36.5} = 0.986$ [½]

$(CH_3)_3COH + HCl \longrightarrow (CH_3)_3CCl + H_2O$

HCl is in excess ∴ $(CH_3)_3COH$ is the limiting reactant. [½]

(ii) $\text{Moles of } (CH_3)_3CCl = \frac{28}{92.5} = 0.303$ [½]

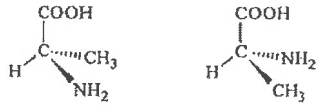
$\%\text{ yield} = \frac{0.303}{0.338} \times 100\% = 89.6\%$ [1]

(iii) Substitution [1]

AL96(II)_07c
(i) Warm the compound with Tollen's reagent / ammoniacal silver(I) oxide / ammoniacal silver nitriate. [1]
Cyclopentanecarbaldehyde gives a silver mirror, while cyclohexanone cannot. [1]
OR, Fehling reagent, only cyclopentanecarbaldehyde gives red precipitate.
OR, $K_2Cr_2O_7/H^+$, only cyclopentanecarbaldehyde changes the color of solution from orange to green.
(ii) Warm the compound with $AgNO_3(aq)$. [1]
$C_6H_5CH_2Cl$ gives a white precipitate, while $C_6H_5CH_2I$ give a yellow precipitate. [1]

AL96(II)_08b
(i) Geometrical isomerism / cis-trans isomerism [1]

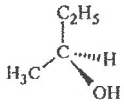
[1]
(ii) Enantiomerism / optical isomerism [1]



[1]

AL98(I)_04

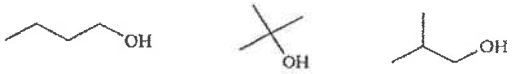
(a) (i)



[1]

(ii) Optical isomerism / enantiomerism [1]

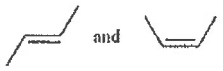
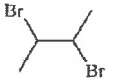
(b) (i)



[½]
[½]
[½]

(ii) Upon reaction with Zn/conc. HCl, **E** gives turbidity slower than $(CH_3)_3COH$, but faster than $CH_3(CH_2)_3OH$ and $(CH_3)_2CHCH_2OH$. [1] [½]

(c) (i)

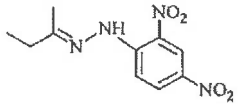
F and **G**  and **H** 

[3]

(ii) Geometrical isomerism / cis-trans isomerism [1]

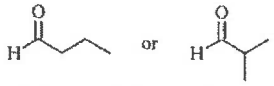
AL98(I)_05

(a)



[1]

(b) (i)



[1]

(ii) Melting point determination: compare the melting point of the red precipitates with those from tables. [1]

AL98(I)_08a

(i) Use a polarimeter: if no rotation then (±); if rotation to the right / there is rotation of plane-polarized light, then (+). [½] [½]

(ii) Add $AgNO_3(aq)$: RCOCl gives white precipitate, AgCl(s); RCOBr gives yellow precipitate, AgBr(s). [½] [½]

ASL99(I)_05

(a) W [1]

Acidified $K_2Cr_2O_7$, heating [1]

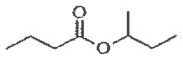
(b) Shake samples with 2,4-dinitrophenylhydrazine solution respectively. [1]

Only Y give a red/orange/yellow precipitate. [1]

OR, Mix samples with Tollen's reagent respectively.

Only Y give a silver mirrow.

(c) Heating reflux, with concentrated H_2SO_4 [1]



[1]

ASL99(II)_11 (modified)

(a) 4-methylpent-2-ene [1]

(b) (i)

[1]

(ii) *Cis-trans* isomerism / geometrical isomerism [1]

(c) (i) Mole ratio of C : H = $\frac{92.3}{12} : \frac{7.7}{1} = 7.69 : 7.7 = 1 : 1$ [1]

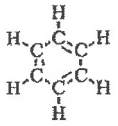
Empirical formula of S is CH

Assume that the molecular formula of S be $(CH)_n$

$(12 + 1)n = 78.1 \rightarrow n = 6$

molecular formula of S is C_6H_6 [1]

(ii)

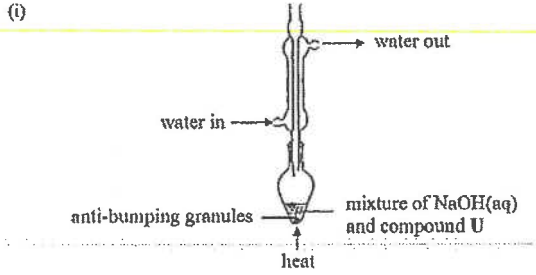


[1]

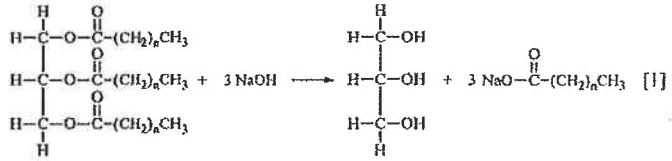
ASL99(II)_13 (modified)

(a) Ester linkage [1]

(b) (i)



[2]

(ii)  [1]

(iii) Mole of NaOH remained after alkaline hydrolysis

$= \frac{100}{10} \times 0.53 \times 27.5 \times 10^{-3} = 0.146$

Mole of NaOH used for alkaline hydrolysis

$= 2 \times 100 \times 10^{-3} - 0.146 = 0.05425$

Mole of compound $\mathbf{U} = \frac{0.05425}{3} = 0.01808$ [1]

Molecular mass of compound $\mathbf{U} = \frac{8.51}{0.01808} = 470.6$ [1]

$12 \times 9 + 16 \times 6 + 1 \times 14 + 3n \times (12 + 1 \times 2) = 470.6$

$n = 6.01$

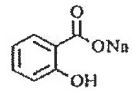
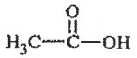
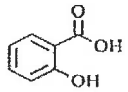
$\therefore$ value of n = 6 [1]

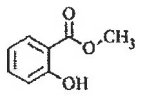
(iv) (I) A white solid float on the top of the saturated sodium chloride solution. [1]

(II) Saturated sodium chloride solution provides a highly polar environment (solvent with high ionic strength) for slightly polar sodium carboxylate to salting out. Nonpolar alkyl group in sodium carboxylate is unlikely miscible in polar solvent. [1]

ASL00(I)_06

(a) Carboxylic acid (carboxyl group), esher, aromatic ring (benzene). [2]

(b) X  Y  Z  [3]

(c)  [1]

AL01(I)_08

(a) Propyl propanoate / $CH_3CH_2CO_2CH_2CH_2CH_3$ [1]

Some propan-1-ol was oxidized to propanoic acid which reacts with excess propan-1-ol to give the ester. [1]

(b) Fractional distillation / chromatography [1]

(c) Any TWO of the following: [2]

- Boiling point determination
- Treat propanal with 2,4-dinitrophenylhydrazine, then determine the m.p. of the crystals formed.
- Compare IR spectrum (finger print region) of the propanal with that of an authentic sample.
- Compare mass spectrum (finger print) of the propanal with that of an authentic sample.

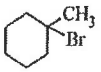
ASL01(II)_10

(a) (i) Reagent: $H_2(g)$, Pt [1]

Condition: high temperature and high pressure [1]

(ii) Shake the samples with acidified potassium permanganate solution respectively. [1]

Only 1-methylcyclohexene can decolorize the purple color of $KMnO_4(aq)$. [1]

(b)  [1]

ASL01(II)_12

(a) The detergent has an ionic head ($SO_3^-Na^+$) and a hydrocarbon tail. [1]

The hydrocarbon tail dissolves in grease droplets / is hydrophobic while the ionic head dissolves in water / is hydrophilic. [1]

The ionic heads of the grease droplets repel from each other and the dirts inside these droplets are then removed. [1]

(b) The detergent with branched hydrocarbon chain is non-biodegradable. [1]

Concentrated suphuric acid and sodium hydroxide solution are used in preparing detergent. [1]

ASL02(I)_03

(a) Mole ratio of C :H :O $= \frac{55.8}{12} : \frac{7.0}{1} : \frac{37.2}{16} = 4.65 : 7 : 2.325 = 2 : 3 : 1$ [1]

Empirial formula of X = C_2H_3O [1]

(b) Let the molecular formula of X be $(C_2H_3O)n$

$82 < (12 \times 2 + 1 \times 3 + 16)n < 90$

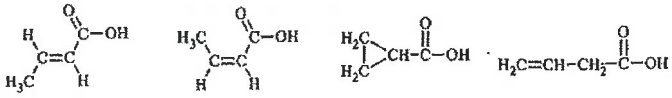
$1.91 < n < 2.09$ [1]

molecular formula of X = C_4H_6O [1]

(c) X reacts with sodium carbonate solution to give carbon dioxide. X possesses COOH.

Double bond equivalence of X is 2,

X possesses C=O and C=C, or X is a cyclic alkanoic acid. [3]



ASL02(II)_11

(a) Heat the samples with acidified $KMnO_4(aq)$ respectively, only $CH_3(CH_2)_3OH$ can decolorize purple $KMnO_4(aq)$. [1]
[1]

OR, Heat the sampes with acidified $K_2Cr_2O_7(aq)$ respectively, only $CH_3(CH_2)_3OH$ can turn orange $K_2Cr_2O_7(aq)$ to green.

(b) Warm the samples with NaOH(aq), followed by acidifying with $HNO_3(aq)$. [1]
Add silver nitrate solution into the resultant mixture. [1]
Chloroalkane will give white precipitate, [1]
while iodoalkane will give yellow precipitate. [1]

ASL03(I)_02

Boiling point increases in the order:
$CH_3(CH_2)_2CH_3 < CH_3(CH_2)_3CH_3 < CH_3(CH_2)_3Cl < CH_3(CH_2)_3OH$ [1]
Both $CH_3(CH_2)_2CH_3$ and $CH_3(CH_2)_3CH_3$ are non-polar. Their intermolecular attraction is weak van der Waals' force. [1]
The strength of van der Waals' forces increases with relative molecular size. [1]
∴ The boiling point of $CH_3(CH_2)_3CH_3$ is higher than the boiling point of $CH_3(CH_2)_2CH_3$.
$CH_3(CH_2)_3Cl$ has a net dipole moment. Its intermolecular attraction is stronger than that in alkanes but weaker than the intermolecular attraction between the alcohol molecules. [1]
Hydrogen bonds exist between the alcohol molecules. ∴ $CH_3(CH_2)_3OH$ has the highest boiling point. [1]

ASL03(II)_09

(a) $CH_3CH_2CH_2Cl \xrightarrow[1]{NaOH(aq),\ \Delta} CH_3CH_2CH_2OH \xrightarrow[3]{K_2Cr_2O_7/H^+(aq)} CH_3CH_2CH_2-C(=O)-OH$ [3]

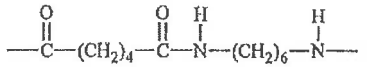
(b) $CH_3CH{=}CH_2 \xrightarrow{HCl(aq)} CH_3-CH(OH)-CH_3 \xrightarrow[1]{K_2Cr_2O_7/H^+(aq)} CH_3-C(=O)-CH_3$ [3]

ASL03(II)_12

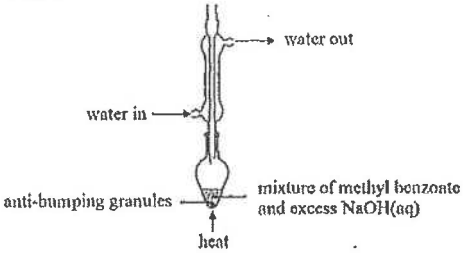
(a)  [1]

(b) Method (I): The waste contains $Cr_2O_7^{2-}$ which is toxic. [1]
Removal of $Cr^{3+}(aq)$ from the product is costly.
Method (II): HNO_3 is a strong acid. Discharge of the waste into waterways leads to environmental pollution. [1]

(c) Excess H_2O_2 in to reaction mixture can easily be removed as it can be decomposed by heating. [1]
Other products of the reactions, namely $H_2O(l)$ and $O_2(g)$, will not cause threat to the environment. [1]

(d)  [1]

ASL04(II)_10

(a) 

[2]

(b) Add $H_2SO_4(aq)$ and filter [1]

(c) Dissolve crude sample in minimum amount of hot water. [½]
Filter mixture while hot. [½]
Allow filtrate to cool and collect crystals by filtration [1]

(d) mole of methyl benzoate $= \frac{3.0}{136.0} = 0.022$ [½]

mole of benzoic acid $= \frac{1.9}{122.0} = 0.0156$ [½]

% yield $= \frac{0.0156}{10.022} \times 100\% = 70.8\%$ [1]

ASL05(I)_03

(a) $CH_3CO_2H + CH_3OH \longrightarrow CH_3CO_2CH_3 + H_2O$ [1]

(b) The reaction of CH_3CO_2H with CH_3OH involves breaking of the O–H in the alcohol and the C–O bond in the acid. [1]
∴ The ^{18}O always resides in the ester, [1]

OR, The mechanism is likely to be:

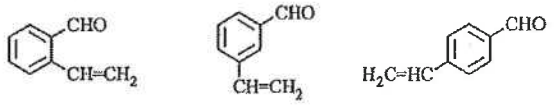
$$CH_3-C(=O)-O-H + H-{}^{18}O-CH_3 \rightleftharpoons CH_3-C(=O)-{}^{18}O-CH_3 + H_2O$$
mass = 76 amu

ASL05(I)_06

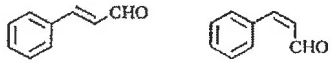
(a) mole ratio of C : H : O $= \frac{81.8}{12} : \frac{6.1}{1} : \frac{12.1}{16} = 6.82 : 6.10 : 0.756 = 9 : 8 : 1$ [1]
Empirical formula is C_9H_8O [1]
Molecular formula is $(C_9H_8O)n$
$130 < n(9 \times 12 + 8 + 16) < 140, \quad n = 1$
Molecular formula is C_9H_8O [1]

(b) A reacts with Tollens' reagent. ∴ A possess an aldehyde functionality / the CHO group. [1]
A is an aromatic compound with molecular formula C_9H_8O. It has a double-bond equivalent (DBE) of 6. [1]
A is likelu to possess a C=C bond or an alicyclic structure. [1]

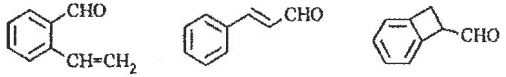
(c) Possible types of isomerism:
Position ismerism: [1]
Structure (Any TWO of the following) [1]



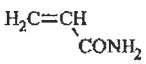
Geometrical isomerism:

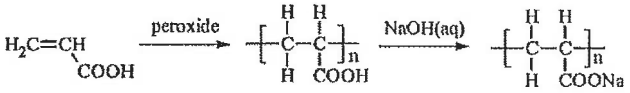


Sructural isomerism



ASL05(I)_07

(a)  [1]

(b)  [2]

(c) (i) Polyacrylamide contains a large number of amide groups ($CONH_2$). These amide groups can form hydrogen bonds with water, [1] [1]
(ii) In sodium polyacrylate, the Na^+ ions have a high affinity for water, and cause the water in the urine to flow towards the diaper. [1]

(d) Any ONE of the following: [1]
- leak-proof tape for undersea cables
- Water absorbent meat packaging
- In gasoline filters for removal of water
- In farming (to retain moisture)

ASL05(II)_09

Boiling point: **B < D < C** [1]
The boiling point of a compound depends on its intermolecular attraction.
The intermolecular attraction of B is van der Waals' force. The attraction force is weakest among the three. [1]
The attraction between molecules of C is hydrogen-bond which is the strongest among the three. ∴ C has the highest boiling point. [1]

ASL05(II)_09

Add water to the liquids. [1]
Both CH_3COCH_3 and $CH_3(CH_2)_4NH_2$ can mix with water in all proportions. [1]
Add a piece of pH paper to the aqueous solutions. [1]
$CH_3(CH_2)_4NH_2$ is alkaline, but CH_3COCH_3 is not. [1]
OR, $CH_3(CH_2)_4NH_2$ has a strong fishly odor while CH_3COCH_3 doe not.

Add Br_2 solution to the two compounds which are not miscible with water. [1]
Only cyclohexene can decolorize Br_2 solution. [1]
OR, Add $AgNO_3(aq)$ to the two compounds which are not miscible with water.
$CH_3CH_2CH_2Br$ gives a pale yellow precipitate slowly.

ASL05(II)_10

(c) When heated under reflux, the CH_3CHO formed will be oxidized by $Cr_2O_7^{2-}/H^+$ to CH_3COOH. [1]
Appropriate method: warm a mixture of excess CH_3CH_2OH and $Cr_2O_7^{2-}/H^+$, and collect the product by simple distillation. [1] [1]

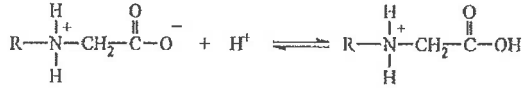
ASL06(I)_01

(a) Structural isomers [1]
(b) Structural isomers [1]
(c) Identical molecule [1]
(d) Identical molecule [1]

ASL06(I)_08 (modified)

(a) $CH_3(CH_2)_4CH_2$– is a non-polar group which can dissolve in dirt; [1]
$-^+NH_2CH_2COO^-$ is a polar group which can dissolve in water. [1]
The Ionic heads of the grease droplets repel from each other and the dirts inside these droplets are then removed. [1]

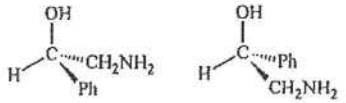
(b) No matter it is used in acidic or alkaline medium, ionic heat still exist to demonstrate cleaning property of a detergent. [1]


[1]


[1]

$R = CH_3(CH_2)_{14}CH_2-$

AL06(II)_05b

(i) (I)  [2]

(II) They rotate the plane of polarization of a beam of plane polarized light to opposite directions. [1]

(ii) The neuroreceptor is likely to be chiral. The reaction between compound B and the neuroreceptor is stereospecific. [1]

(iii) Conduct a chromatographic study. [1]

Compare the R_f value of the suspected stimulant with that of an authentic sample of B. [1]

ASL06(II)_09

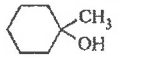
(a) Warm the samples with $K_2Cr_2O_7/H^+(aq)$. [1]

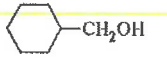
$(CH_3)_3COH$: solution remains orange color

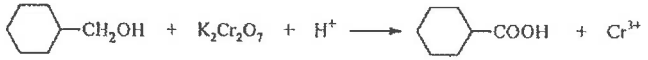
$(CH_3)_2CHCHO$: solution turns from orange ($Cr_2O_7^{2-}$) to green (Cr^{3+}). [1]

$(CH_3)_2CHCHO + K_2Cr_2O_7 + H^+ \longrightarrow (CH_3)_2CHCOOH + Cr^{3+}$ [1]

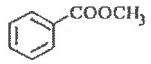
(b) Warm the samples with $K_2Cr_2O_7/H^+(aq)$. [1]

 solution remains orange [½]

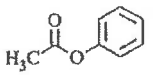
 solution turns from orange to green [½]

 [1]

ASL06(II)_10

(a)  [1]

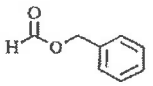
$C_6H_5COOCH_3 + NaOH \longrightarrow C_6H_5COONa + CH_3OH$ [1]

(b)  [1]

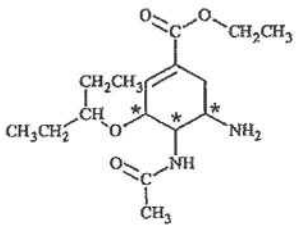
$CH_3COOC_6H_5 + NaOH \longrightarrow CH_3COONa + C_6H_5OH$ [1]

$2CH_3COONa + H_2SO_4 \longrightarrow 2CH_3COOH + Na_2SO_4$ [1]

The smell of vinegar comes from CH_3COOH [1]

(c)  [1]

ASL07(I)_07

(a)  [1]

(b) 4 [1]

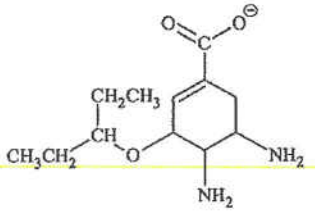
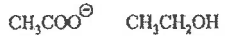
Any TWO of the following [1]

Amide

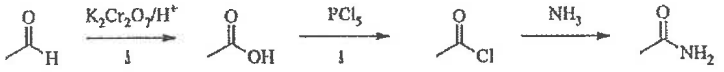
C=C bond

Amine/ NH_2

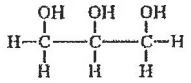
ester

(c)   [2]

ASL07(II)_02

 [2]

ASL08(I)_06

(a)  and $C_{17}H_{35}COONa$ [2]

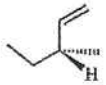
(b)  [1]

ASL08(II)_01

A is an alkaene (it undergoes hydrogenation over Pt.) [½]

Structure of A: Structure of the enantiomers of A:

[½]

   [½] [½]

Hydrogentation of A gives 3-methylpentane which is achiral [1]

B is also an alkene. (It undergoes addition.) [½]

B reacts with Br_2 to give a single compound and with HBr to give a single achiral compound.

Each carbon atom in the double bond of B should have the same substitutents.

G can only be $(CH_3)_2C{=}C(CH_3)_2$ [1]

$(CH_3)_2C{=}C(CH_3)_2 + Br_2 \longrightarrow (CH_3)_2CBrC(CH_3)_2Br$ (single compound) [½]

$(CH_3)_2C{=}C(CH_3)_2 + HBr \longrightarrow (CH_3)_2CHC(CH_3)_2Br$ (single achiral compound) [1]

ASL08(II)_02 (modified)

(a)  [1]

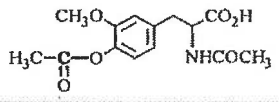
(b) (i) Total no. of mole of products $= \dfrac{(0.2 + 0.167 + 0.117)}{134.5} = 3.60 \times 10^{-3}$ [½]

Moles of 2,4 – dimethylpentane $= \dfrac{0.45}{100} = 4.50 \times 10^{-3}$ [½]

Overall % yield $= \dfrac{3.60 \times 10^{-3}}{4.50 \times 10^{-3}} \times 100\% = 80\%$ [1]

(ii) Mole ratio of 1°, 2° and 3° monochlorinated products formed
= 1.71 : 1 : 1.43 [1]

AL09(II)_05b (modified)

(i) (I)  [1]

(II) Enantiomerism [1]

(III) Both M and N show optical rotation. One of them turns the plane of polarization of a beam of plane polarized light to the left, while the other to the right. [1]

(ii) (I) The double bond is planar. When hydrogenation takes place over Pt, the two H atoms can add to the double bond from either side of the double bond. [1]
There is an equal likelihood of obtaining the enantiomers. [1]
The product is a racemic mixture.

(II) Use an asymmetric catalyst / asymmetric reagent for the hydrogenation. [1]

ASL10(I)_06

(a) Geometrical isomerism / *cis-trans* isomerism [1]

(b) The melting point of a substance depends intermolecular attraction as well as molecular symmetry. [1]
In both dimethyl fumarate and A, the intermolecular attraction is van der Waals' forces and they are of comparable strength.
Dimethyl fumarate, being more symmetrical, can better fit into a solid lattice. ∴ It has a higher melting point. [1]

ASL10(II)_04 (modified)

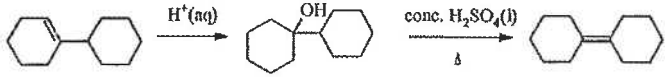
(a) Mole ratio of C : H : O $= \dfrac{62.1}{12} : \dfrac{10.3}{1} : \dfrac{27.6}{16} = 5.18 : 10.3 : 1.73$ [1]
Simlpest ratio of C : H : O =3 : 6 : 1
Empiricial formula of D is C_3H_6O [1]
Let molecular formula of D be $(C_3H_6O)n$
$(12\times3+1\times6+16)n=58$, $n = 1$
Molecular formula of D is C_3H_6O [1]

(b) D does not react with $Cr_2O_7^{2-}/H^+$. It is not aldehyde or alcohol [1]
DBE of D is 1, D possesses C=O or C=C

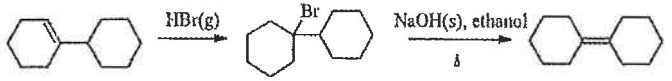
 or  [1]

ASL11(I)_06

(a) 1-cyclohexylcyclohexene [1]

(b)  [2]

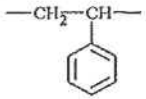
OR



ASL11(II)_07

(a) Br_2; light / UV / peroxide; (excess ethylbenzene) [1]

(b) Elimination / dehydrogenbromination / dehydrogenhalogenation [1]

(c) (i)  [1]

(ii) Peroxide; heat [1]

ASL12(I)_06

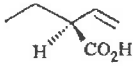
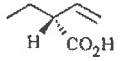
(a) Double bond equivalence of B $= \frac{6 \times 18 + 2 - (6 \times 4 + 10 \times 7 + 2 \times 6)}{2} = 2$

B has two double bonds. [½]

B can undergo catalytic hydrogenation. B contains C=C bond(s). [½]

1 mol of D reacts with excess $NaHCO_3(aq)$ to give 1 mol of $CO_2(g)$. D is a monocarboxylic acid. [1]

Possible structure of B:

 and  [1½]

Possible structure of D:

 [1]

D does not have a chiral centre. It is optically inactive. [½]

ASL12(I)_10

(a) Phenolphthalein / phenol red [1]

(b) No. of moles of excess $OH^-(aq) = 2.50 \times 23.1 \times 10^{-3}$ [½]

No. of moles of NaOH(aq) used $= 3.05 \times 25 \times 10^{-3}$ [½]

No. of moles of $OH^-(aq)$ reacted with aspirin

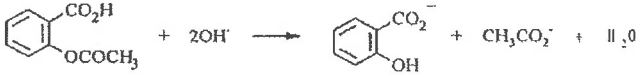
$= 3.05 \times 25 \times 10^{-3} - 2.50 \times 23.1 \times 10^{-3}$

$= 0.0185$ [½]

Mass of aspirin $= 0.0185 \times 180.0 = 3.33$ [½]

% by mass $= \frac{3.33}{2.25} = 148$ [1]

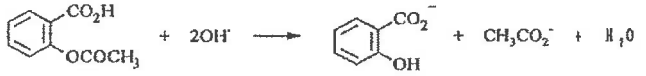
Reason: The ester group in aspirin undergoes alkaline hydrolysis. [½]



The amount of $OH^-(aq)$ consumed is greater than the expected value. [½]

(c) Any ONE of the following: [1]

- Use a smaller amount of aspirin so that a less concentrated NaOH(aq) can be used.
- Heat the reaction mixture to ensure complete hydrolysis of the ester so that the calculation can be based on the reaction:



ASL12(II)_07 (modified)

(a) Peroxide; heat; high pressure [1]

(b) The intermolecular attraction between PE polymers is van der Waals' force (dispersive force). [½]

C–Cl bond is polar. The intermolecular attraction between PVC polymers is predominately dipole-dipole attraction which is a stronger than dispersive force / a stronger van der Waals' force. [1] [½]

(c) (i) Most parts of DEHP (the benzene ring and the aliphatic carbon chain) are hydrophobic. [½]

Emulsifier has a hydrophilic head and a hydrophobic tail. [½]

When DEHP, water and emulsifier are shaken vigorously, the hydrophobic tail of the emulsifier dissolves in DEHP while the hydrophilic head dissolves in water. A cloudy mixture is formed. [½]

The repulsion of the hydrophilic heads prevents the recombination of the droplets and keeps the cloudy mixture stable.

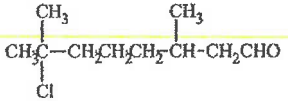
(ii) Chromatography + mass spectrometry [1]

Chromatography + (comparing the R_f value of the peak due to DEHP with that of an authentic sample)

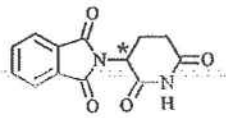
ASL12(II)_08

(a)  [1]

(b) 3,7-dimethyloct-6-enal [1]

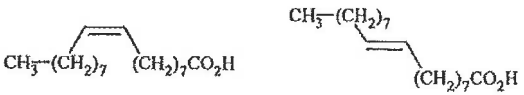
(c)  [1]

ASL13(I)_06 (modified)

(a)  [1]

(b) Receptor molecules in the body are chiral. [½]
The action of chiral drug on receptor molecules is stereo-specific. [1]
The key-and-lock hypothesis applies to the effect of chiral drugs on human bodies.
Mismatching of drug molecules with the targeted receptors may cause undersirable side effect such as requirement of higher dosage ad increasing toxicity. [½]

ASL13(II)_06

(a) 
 [2]

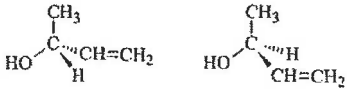
(b) Measure the m.p. of the two compounds. [1]
The trans-isomer has a higher melting point. [1]
OR, Compare the melting points of the compounds with data in chemical literature.
(Accept other appropriate physical methods for differentiating the two compounds.)

ASL13(II)_08

(1) Mole ratio of C : H : O $= \frac{66.7}{12} : \frac{11.1}{1} : \frac{22.2}{16} = 5.56 : 11.1 : 1.39 = 4 : 8 : 1$ [1]
Empirical formula of D = C_4H_8O [1]
∵ the relative molecular mass of D is 72, ∴ molecular formula of D = C_4H_8O [1]
∵ D.B.E. of D is 1, ∴ D possess 1 C=C or 1 C=O bond.

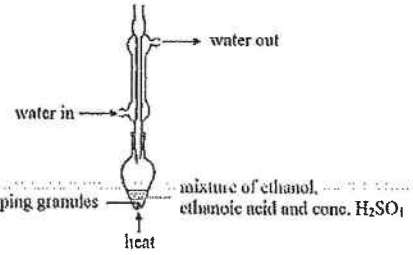
(2) ∵ D exhibits optical isomerism, ∴ D possess a chiral carbon, attached with 4 different groups. [1]

(3) ∵ D can turn acidified $K_2Cr_2O_7$(aq) from orange to green, ∴ D is either a secondary alcohol or an aldehyde. [1]
[1]

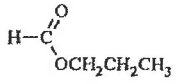
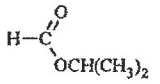
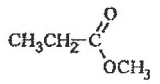
structure of D 

DSE11SP_12

(a) Concentrated sulphuric acid / conc. H_2SO_4 [1]

(b) [2]


(c) Iodine has a simple molecular structure and attraction between I_2 molecules is due to the weak van der Waals' forces. [1]
Sodium iodide has an ionic structure and attraction between Na^+ and I^- ions is due to strong ionic bond. [1]
The strength of inter-particle attraction in ethyl ethanoate is comparable to that in iodine. (Indication of an understanding of the idea of 'like-dissolve-like" in terms of the strength of attraction between particles.) [1]

(d) Any ONE of the following:

propyl methanoate

methylethyl methanoate

methyl propanoate [2]
(1 mark for structure, 1 mark for name.)

DSE11SP_13

(a) For (a) and (b), accept other correct reaction sequences.

$CH_3CH_2CH_2Cl \xrightarrow{a} b \xrightarrow{c} CH_3CH_2CO_2H$

a: NaOH(aq) [3]
b: $CH_3CH_2CH_2OH$
c: $Cr_2O_7^{2-}/H^+$ or MnO_4^-/H^+

(b)
$CH_3CH{=}CH_2 \xrightarrow{d} e \xrightarrow{f} CH_3COCH_3$

d: (1) conc. H_2SO_4; (2) H_2O [3]
e: $CH_3CH(OH)CH_3$
f: $Cr_2O_7^{2-}/H^+$

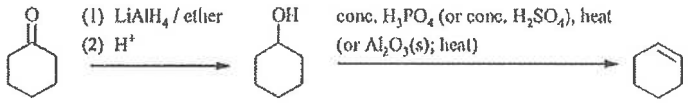
DSE12PP_02

(a) Some components of wine (substances with a pleasant odour) can be oxidized by oxygen in air to give products that have a flat taste. [1]
OR, Ethanol in wine can be oxidized by oxygen in air to give ethanol / ethanoic acid.

(b) (i) The outermost shell of an argon atom is a stable octet structure. ∴ Ar does not readily form bonds with other atoms. [1]
(ii) Ar is denser than air. It displaces air from the bottle, and thus prevents the wine from contact with air. [1]
(iii) He is less dense that air. It will not displace air / it will easily diffuse from the bottle. [1]

(c) The substances with a pleasant odour are volatile organic compounds. Pumping air out from the bottle may also remove these substances. [1]

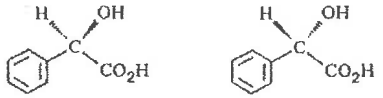
DSE12PP_11



[3]

DSE12PP_12

(a) (i)



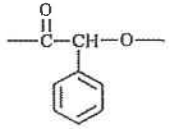
[2]

(ii) They turn the plane of polarization of a beam / plan polarized light in opposite directions. [1]

OR, One of the compounds is laevorotary while the other is dextrorotatory.

OR, Crystals of the two compounds have different appearance.

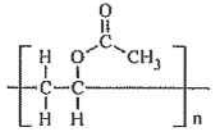
(b) Repeating unit:



[1]

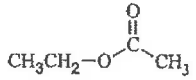
DSE12_02

(b)



[1]

(c) (i)



[1]

(ii) Bromine test – ethenyl ethanoate can decolorize orange / brown / yellow bromine / Br_2 solution immediately while ethyl ethanoate cannot. [1]

(NOT Accept Br).

(Require to mention the reaction of Br_2 with ethenyl ethanoate is much faster than ethyl ethanoate) [1]

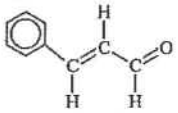
OR

Treating with acidified potassium permanganate solution - ethenyl ethanoate can decolorize purple acidified potassium permanganate solution while ethyl ethanoate cannot.

(Also accept treating with potassium permanganage solution (without acidification) with the correct descriptions of observations – change from purple to brown (ppt)).

DSE12_12

(a)



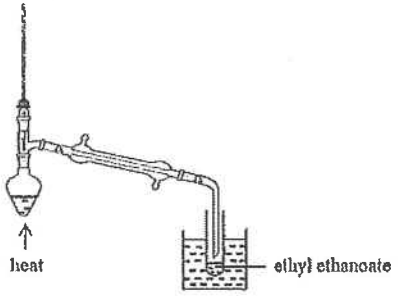
[1]

The bond angles of the alkene should be about 120°. The bonds drawn in 90° are not accepted.

(b) Cinnamaldehyde is a non-polar compound which can dissolve in a relatively non-polar organic solvent like ethyl ethanoate. However, water is a polar solvent. [1]

Both cinnamaldehyde and ethyl ethanoate are relatively non-polar compounds. Their molecules are attracted by weak intermolecular forces / van der Waals' forces.

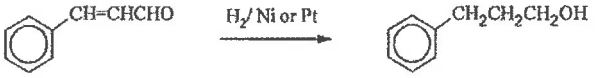
(c)



[2]

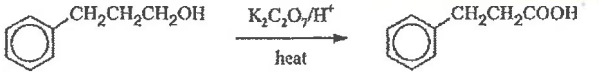
- ✓ 1 mark is given to the drawing of the correct setup
- ✓ No mark will be given to the drawing if:
  - The thermometer or the condenser is missing
  - The setup is a closed system
  - The top of the distillation head is open to air
  - A fractional column is included in the drawing
- ✓ 1 mark is given to the correct labeling and spelling of the distillate (ethyl ethanoate)

(d)



[1]

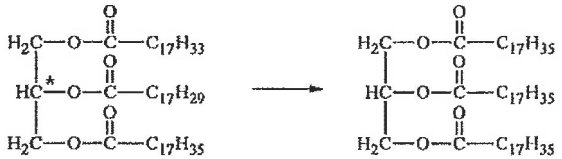
(Accept the aldehyde group (CHO) is NOT reduced by H_2/catalyst to give CH_2OH)



[1]

DSE12_14

(a) (i)



[1]

(ii) Yes. X has one chiral carbon and hence optically active, while Y does not has chiral carbons and hence optically inactive. Thus, there is a change in optical activity for the conversion. [1]

(b) The $C_{17}H_{35}COO^-$ ion has an ionic head (COO^-) and a hydrocarbon tail ($C_{17}H_{35}$). [1]

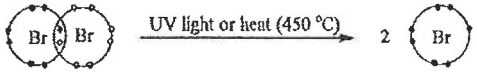
The hydrocarbon tail dissolves in grease droplets / is hydrophobic while the ionic head dissolves in water / is hydrophilic. [1]

The ionic heads of the grease droplets repel from each other and the dirts inside these droplets are then removed. [1]

Effective communication [1]

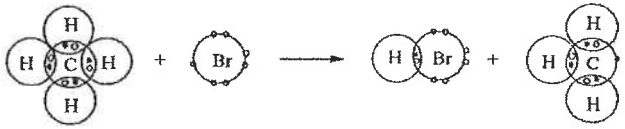
DSE12_15

Chain initiation



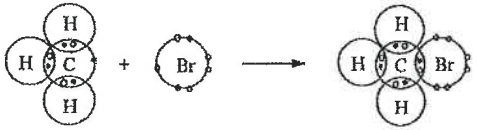
[1]

Chain propagation



[1]

Chain termination



[1]

DSE13_03

(a) Mole ratio of C : H : O $= \frac{2.64}{44} : 2 \times \frac{1.08}{18} : \frac{0.48}{16} = 2 : 4 : 1$ [1]

Empirical formula is C_2H_4O

Molecular formula is $(C_2H_4O)_n$ [1]

$n \times (12 \times 2 + 1 \times 4 + 16 \times 1) = 88.0$

$n = 2$

molecular formula of W is $C_4H_8O_2$ [1]

Alternative method:

No. of C atoms in W $= \frac{2.64}{44} \times \frac{88}{1.32} = 4$ (1)

No. of H atoms in W $= 2 \times \frac{1.08}{18} \times \frac{88}{1.32} = 8$

No. of O atoms in W $= \frac{88 - 12 \times 4 - 8 \times 1}{16} = 2$ (1)

molecular formula of W is $C_4H_8O_2$ (1)

(b)

[2]

Also accept other possible structure, e.g. ester.

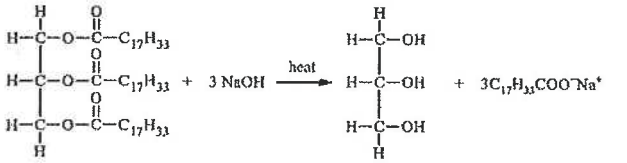
DSE13_04

(a) Ethanedioic acid [1]

DSE13_14

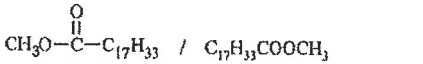
(a) H_2, Ni / Pd / Pt [1]

(b) (i)



[1]

(ii)



[1]

(c) G has a smaller relative molecular mass than F, so G can be vaporized more easily than F. [1]

G burns more completely / more easily than F. [1]

OR, G has a smaller relative molecular mass than F, so G has a lower boiling point than F. ∴ G burns more completely / more easily than F.

OR, G has a smaller relative molecular mass than F, so the molecular size of G is smaller than that of F. The intermolecular attraction / van der Waals' forces between G are weaker than that between F, G can be vaporized more easily than F. ∴ G burns more completely / more easily than F.

DSE13_15

(a) Correct chemical reagent [1]

Correct observations with comparison between the tests on X and Y. [1]

Possible tests and the corresponding observations:

$Cr_2O_7^{2-}/H^+$	Observations: X – no change; Y – from orange to green
MnO_4^-/H^+	Observations: X – no change; Y – from purple to colorless
MnO_4^-/OH^-	Observations: X – no change; Y – formation of brown ppt.
2,4-DNP	Observations: X – formation of orange ppt; Y – no change
CH_3COOH / H^+ / heat	Observations: X – no change; Y – fruity smell substance formed.

2,4-DNP = 2,4-dinitrophenylhydrazine

(b) $LiAlH_4$ / $NaBH_4$ [1]

(c)  and [1]

Geometrical (isomerism) / cis/trans-(isomerism) [1]

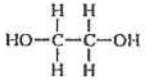
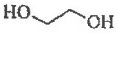
(d) $CH_3\underset{\displaystyle Cl}{\underset{|}{C}}HCH_2CH_2CH_3$ / $CH_3CHClCH_2CH_2CH_3$ [1]

DSE13(II)_02a

(ii) Molecules of cellulose may contain various number of glucose molecules joined together. [1]

OR, Molecules of cellulose is composed of polymer chain of glucose with different length.

DSE14_02

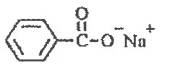
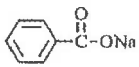
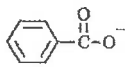
  $HOCH_2CH_2OH$ [1]

It has a smaller molecular size. / It is a small molecule. / It has a short carbon chain. [1]

The hydroxyl groups in it can form hydrogen bonds with water. [1]

DSE14_12

(a) (i) (alkaline) hydrolysis [1]

(ii)  or  or  [1]

(iii) HCl(aq) / H_2SO_4(aq) (accept other reasonable strong acids; not accept H^+) [1]

(iv) X (sodium benzoate) is an ionic compound which has strong(er) interactions with water. [1]

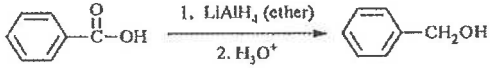
OR, Benzoic acid exists as molecules which has weak(er) intermolecular interactions with water.

OR, X is an ionic compound while benzoic acid exist as molecules.

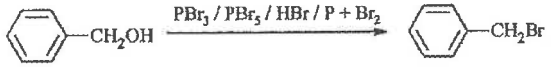
(v) Filter the mixture to obtain the solid benzoic acid. Wash it with deionized water and then dry in oven. [1]

(not accept mixing with drying agents)

(not accept evaporation or crystallization before filtration)

(b) 

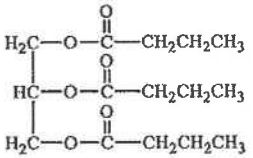
(not accept using $LiAlH_4$ in acidic medium; not accept using $NaBH_4$ and catalytic hydrogenation)



Correct reagent for each step in the conversion. [2]

Intermediate ($C_6H_5CH_2OH$) [1]

DSE14_14

(a) 

Accept represent $-CH_2CH_2CH_3$ as $-C_3H_7$

Accept the answer has 1 to 2 $-CH_2CH_2CH_3$ carbon chains, while the other carbon chains have different chain lengths and structurally correct. [1]

(b) Methylpropanoic acid (2-methylpropanoic acid) [1]

(c) (i)  [1]

(ii) Correct chemical reagent [1]

Correct observations with comparison between the tests on Q and Z [1]

	Q	Z
$Cr_2O_7^{2-}/H^+$	no change	from orange to green
MnO_4^-/H^+	no change	from purple to colorless
MnO_4^-/OH^-	no change	formation of brown ppt.
2,4-DNP	no change	formation of orange ppt.
CH_3CH_2OH/H^+/heat	fruity smell detected	no change
CH_3COOH/H^+/heat	no change	fruity smell detected
CO_3^{2-}	formation of gas (CO_2)	no change
HCO_3^-	formation of gas (CO_2)	no change
Mg / Zn	formation of gas (H_2)	no change

2,4-DNP = 2,4-dinitrophenylhydrazine

(d) (Catalytic) hydrogenation / addition of hydrogen [1]

DSE15_06

(a) Substitution [1]

(b) Light / ultra-violet / UV / heat / radical initiator (e.g. benzoyl peroxide) [1]

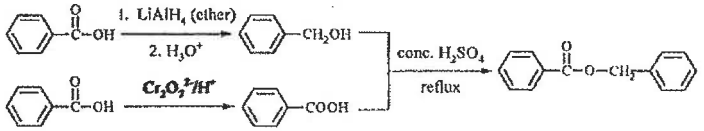
(c) Orange / brown color of bromine fades away [1]
Orange / brown color of bromine changes to colorless (slowly)
(bromine color: NOT accept 'yellow')

(d) Br atom does not have the stable noble gas electronic configuration. [1]
OR Br atom does not have the stable octet electronic configuration.
OR The electronic configuration of Br atom does not fulfill the octet rule.

(e) (i) CH_2Br_2 / $CHBr_3$ / CBr_4 [1]

(ii) Use (large) excess amount of CH_4 [1]
OR, Br_2 is the limiting reactant.

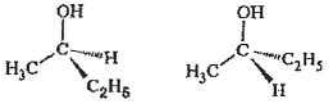
DSE15_12



[3]

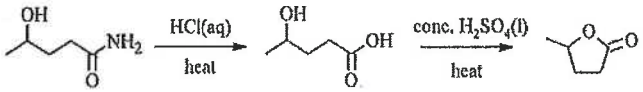
(1 mark for each pair of reactants and product)

DSE15_13



- Suitable diagrams [1]
- Chiral centre / chiral carbon / a carbon atom bonded to four different groups [1]
- Non-superimposable on its mirror image / the two mirror images are two different molecules [1]
- Optically active / can rotate plane-polarized light to different directions [1]
- Effective communication [1]

DSE16_12



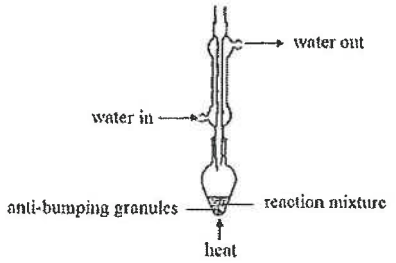
1st step: appropriate reagent and heat [1]

Appropriate intermediate [1]

2nd step: conc. H_2SO_4 and heat [1]

DSE16_13

(a)



[2]

1 mark for correct diagram, 1 mark for correct labels
Not accept "Δ" for 'heat'

(b) $LiAlH_4$ / H_2 (catalyst - Pt) (with appropriate example of catalyst such as Pd, Pt, Ni) [1]
(Not accept $LiAlH_4$ in $H^+(aq)$)

(c) Enantiomers / optical isomers / They are isomers that exhibit enantiomerism. [1]

(d) Optical activity. P and Q rotate plane-polarized light to opposite directions to the same degree / extent. [1]

(e) Correct chemical reagent [1]

Correct observations with comparison between the tests on acetophenone and P [1]

Possible tests and the corresponding observations:

$Cr_2O_7^{2-}/H^+$	acetophenone – no change; P – from orange to green
MnO_4^-/H^+	acetophenone – no change; P – from purple to colorless
MnO_4^-	acetophenone – no change; P – formation of brown ppt.
MnO_4^-/OH^-	acetophenone – no change; P – formation of brown ppt.
2,4-DNP	acetophenone – formation of orange ppt.; P – no change
CH_3COOH / H^+ / heat	acetophenone – no change; P – pleasant odur substance formed.

2,4-DNP = 2,4-dinitrophenylhydrazine

(Accept other chemical tests that can distinguish a ketone from an alkanol, e.g. Na / PCl_5)

DSE17_03

(a) A propene molecule has C=C bond whereas propane molecule has not. [1]
(Not accept: Propene is unsaturated while propane is saturated. / Propene is an alkene while propane is an alkane.)

(b) $HO_2C(CH_2)_4CO_2H$ is a di-functional molecule / has two $-CO_2H$ groups / has two function groups (to react with $-NH_2$ group). [1]
On the other hand, $CH_3(CH_2)_4CO_2H$ is a mono-functional molecule / has only one $-CO_2H$ group / has only one function group (to react with $-NH_2$ group).
Each $HO_2C(CH_2)_4CO_2H$ molecule can react with two $H_2N(CH_2)_6NH_2$ molecules to form a chain, while $CH_3(CH_2)_4CO_2H$ can only react with one $H_2N(CH_2)_6NH_2$ and cannot form a chain.

DSE17_09

FOR Alkanol,

Acidified $K_2Cr_2O_7$(aq) test: only $HOCH_2CH_2CH_2OH$ will produce a orange to green color change. [1]

OR, Acidified / neutral $KMnO_4$(aq) test: only $HOCH_2CH_2CH_2OH$ or $CH_2=CHCO_2H$ will produce a purple to colorless / brown color change.

FOR Alkene,

Br_2(in organic solvent) test: only $CH_2=CHCO_2H$ will produce a brown/orange/yellow to colorless color change. [1]

OR, Br_2(aq) test: only $CH_2=CHCO_2H$ will produce a brown/orange/yellow to colorless color change.

Acidified / neutral $KMnO_4$(aq) test: only $HOCH_2CH_2CH_2OH$ or $CH_2=CHCO_2H$ will produce a purple to colorless / brown color change.

FOR carboxylic acid

Add each liquid into water, [1]

Mg / Zn test: only $CH_3CH_2CO_2H$ or $CH_2=CHCO_2H$ reacts to give a colorless gas (bubbles) / hydrogen gas / H_2(g). [1]

OR, using CO_3^{2-} / HCO_3^-(aq) test: only $CH_3CH_2CO_2H$ or $CH_2=CHCO_2H$ reacts to give a colorless gas (bubbles) / carbon dioxide gas / CO_2(g).

Esterification: with conc. H_2SO_4 and heat / warm, only $CH_3CH_2CO_2H$ or $CH_2=CHCO_2H$ reacts with an alkanol (e.g. ethanol) to give a pleasant smell.

Neutralization: only $CH_3CH_2CO_2H$ or $CH_2=CHCO_2H$ reacts with an alkali (e.g. NaOH(aq)) / a base and water to give out heat.

$CH_3CO_2CH_3$ gives a negative result in the above three chemical tests.

(Do not accept tests like smell, pH/litmus paper, indicator, solubility in water, etc.)

Communication mark [1]

Chemical knowledge = 0 to 2, mark = 0,

Chemical knowledge = 3 to 4, mark = 0 or 1,

Incomplete answer / difficult to understand / no distinguishing intention, mark = 0)

DSE17_12

(a) $CH_3CH_2CH(Br)CH_2CH_3$ / $CH_3CH_2CHBrCH_2CH_3$ [1]

(b) (i) **The OH group in B will change to Br group in C by HBr, and there is no chiral carbon due to no optical activity.** [1]

(Accept: B is an alcohol as B reacts with HBr to have Br group in C.)

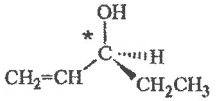
Thus the structure of B is $CH_3CH_2CH(OH)CH_2CH_3$ / $CH_3CH_2CHOHCH_2CH_3$

(ii) Substitution [1]

(c) (i) A has a C=C (or a C=O) double bond as there are 2 hydrogen atoms less in A as compared with B. [1]

A is optically active, so it has a chiral carbon.

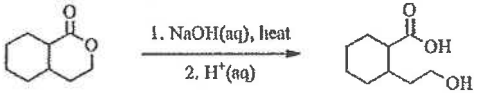
A has the structure



[1]

(ii) H_2 / Pd (heat), or H_2 / Pt (heat), or H_2 / Ni (heat) [1]

DSE17_13



[3]

(intermediate: 1 mark; reagent for each step: 1 mark)

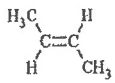
(For 1st step:

1. Reagent accept: OH^-, NaOH or NaOH(aq); Not accept NaOH(s) or solid NaOH.
2. Reagent accept: H^+/ H_2SO_4 / H_2SO_4(aq), or HCl / HCl (aq)
3. For acid hydrolysis / base hydrolysis, "heat" is required.
4. Accept COO^-Na^+ as the intermediate.
5. Not accept O–Na for the intermediate

For 2nd step:

1. Accept COO^-Na^+ as the intermediate for $LiAlH_4$ reduction if the 1st step is alkaline hydrolysis without acidification.
2. Not accept $LiAlH_4$ in acidic medium.
3. Acidification is required after reduction with $LiAlH_4$. $LiAlH_4$ and acidification should be expressed clearly as two steps.

DSE18_04

(b) (i)  [1]

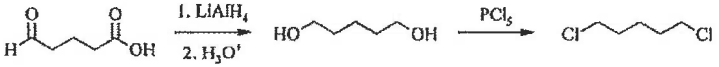
(ii) But-1-ene or methypropene [1]

(c) (i) Pass excess H_2 to ethene in the pressure of Pt / Pd / Ni [1]

OR Catalytic hydrogenation

(ii) Ethene turns Br_2(In CH_3CCl_3) [1]
from brown / orange to colorless, while ethane does not. [1]
(Not accept yellow)
(Accept $KMnO_4/H^+$ - purple to colorless
$KMnO_4$ - purple to brown (precipitate)
$KMnO_4/OH^-$ - purple to brown (precipitate))
(Accept: combustion test; ethene gives more sooty flame, while ethane gives less sooty flame)

DSE18_10



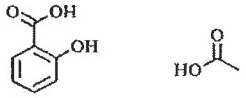
(1) $LiAlH_4$ (2) H_3O^+ [1]
$HOCH_2CH_2CH_2CH_2CH_2OH$ [1]
PCl_3 / PCl_5 / HCl / $SOCl_2$ [1]
(intermediate: 1 mark; reagent for each step: 1 mark)

For 1st step
1. Not accept $LiAlH_4$ in acidic / aqueous medium. Not accept $NaBH_4$ for reducing –COOH
2. Acidification is required after reducing with $LiAlH_4$. $LiAlH_4$ and acidification should be expressed clearly as two steps.
3. Accept "dry ether" is omitted in the $LiAlH_4$ step.

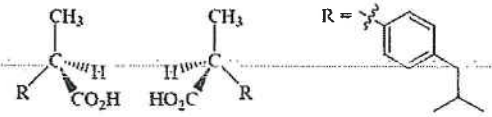
DSE18_12

(a) Reduce fever / inflammation / risk of heart attack / Rheumatoid arthritis [1]
(Not accept hypertension)

(b) –COOH group of aspirin reacts with hydrogencarbonate ions in water. [1]
to give a soluble sodium salt / soluble ions / soluble $–COO^-$. [1]
(Not accept soluble substance / soluble compound)

(c) (i)  [2]

(ii) Hydrolysis of ester in acidic medium is a reversible reaction [1]
And if the reaction mixture is heated under reflux for a long time, it attains equilibrium position and reactants and products co-exist in the system.

(d)  [2]

Note:
1 mark for the correct spatial arrangements of the chiral centers of the two enantiomers.
1 mark for the correct structures of the four substituents connected to the chiral center.

DSE19_03a

(i) bromine (in organic solvent) [1]
(Not accept aqueous bromine solution)

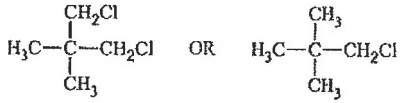
(ii) $CH_3–CH=CH–CH_3 + Br_2 \longrightarrow CH_3–(CHBr)_2–CH_3$ [1]
But-2-ene / an alkene reacts with Br_2, and Br_2 is decolourised / all Br_2 is consumed [1]
/ a colourless product is formed.

DSE19_05

(a) chlorine / Cl_2 [1]
(Not accept Cl_2(aq))

(b) Light / hυ / ultra-violet / UV / radical initiator [1]

(c) Substitution (reaction) [1]

(d) (i)  [1]

1,3-dichloro-2,2-dimethylpropane or 1,1-dichloro-2,2-dimethylpropane
OR 1,3-dichlorodimethylpropane or 1,1-dichlorodimethylpropane
(The structure and the systematic name must be matched.)

(ii) The structure other to the answer in (i) [1]

(iii) Structural isomer / position isomer [1]

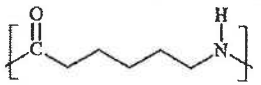
DSE19_13

(a) (i) ethanal / acetaldehyde / CH_3CHO [1]

(ii) Because ethanal has a low boiling point / is volatile, so was easily distilled off [1]
/ vaporised out and cannot be further oxidised to give ethanoic acid.

(b) (i) † Ethanamide [1]

(ii) Method 1: 1. PCl_3 2. NH_3 [1]
(Correct sequence in Method 1 is required)
OR Method 2 : NH_3 with heating (Ignore the states of the reagents used)

(c) (i)  [1]
(Accept answer without the square bracket; Not accept answer with "n" next to the square bracket.)

(ii) As there is no losing of small molecules during the polymerization, it can be regarded no condensation is involved.
OR Accept "No H_2O/HCl is formed."
NOT accept no other product / no side product

DSE19_15

Any FOUR of the following FIVE items (1 mark for each) : [4]

- **It reduces the water surface tension so that water can spread and wet the surfaces. / It is a wetting agent so water can spread and wet the surfaces.**
- **The hydrocarbon tails of the detergent particles dissolve in the oil (hydrophobic),**
- **while the ionic heads of detergent particles dissolves in water (hydrophilic).**
- **Water molecules attract the hydrophilic ionic heads and bring the oil into water.**
- **By stirring, the oil breaks up into tiny droplets and these droplets cannot come together again due to the repulsion between ionic heads/negative charges.**

Communication mark [1]

Chemical knowledge = 0 to 3, communication mark = 0

Chemical knowledge = 4 to 5, communication mark = 0 or 1)

Incomplete answer or difficult to understand, communication mark = 0)

Notes:

- Candidates may answer this question by using sketches with clear and easily understand annotations.
- For item 2 and 3, also accept:
  - The detergent particles has an ionic head and a hydrocarbon tail. (1 mark)
  - The tail dissolves in grease droplets / is hydrophobic, while the head dissolves in water / is hydrophilic. (1 mark)

DSE20_05

5. (a) Carboxyl (group) / $-CO_2H$ (group) / $-COOH$ (group) / $-CO_2H$ / $-COOH$ / CO_2H / $COOH$ 1
(Not accept: acid / alkanoic acid / organic acid / $COOH^-$ / CHO_2 / $HO_2CCH_2CH_2CO_2H$ / carboxylic acid group)

(b) (i) $HO_2CCH_2CH_2CO_2H$ / $HOOCCH_2CH_2COOH$ / $(CH_2COOH)_2$ 1
(Not accept: $HOOCC_2H_4COOH$)
$HO_2CCH(CH_3)CO_2H$ / $HOOCCH(CH_3)COOH$ 1
$HO_2CCH_2COOCH_3$ / $HO_2CCOOCH_2CH_3$ (1)

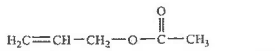
(ii) • The enthalpy change when solutions of an acid and an alkali / a base react together / neutralise under standard conditions to produce 1 mole of water. 1
(Accept: 25°C (298K) and one atmospheric pressure (760 mmHg, 103 kPa)
• As indicated in the equation, the reaction produces 2 moles of water, hence y / 2 represents the standard enthalpy change of neutralisation. 1
(Accept: No unit)

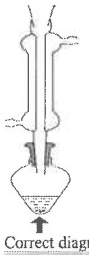
(iii) • Less negative than -57.3 kJ mol^{-1} 1
• **W** is a weak acid when compared with HCl(aq), energy / heat energy / heat is needed to ionise the hydrogen in the carboxyl / $-CO_2H$ group. 1
/ **W** is a weak(er) acid, energy / heat energy / heat is needed to ionise the hydrogen in the carboxyl / $-CO_2H$ group.
(Accept: absorb energy to break the O–H bond in carboxyl group.)
(Not accept: dissociate)

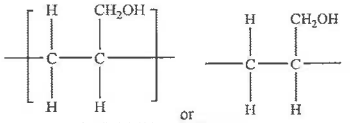
DSE20_10

10. (a) (i) $H_2C{=}CH{-}CH_2{-}Cl + NaOH \rightarrow H_2C{=}CH{-}CH_2{-}OH + NaCl$ / $H_2C{=}CH{-}CH_2{-}Cl + OH^- \rightarrow H_2C{=}CH{-}CH_2{-}OH + Cl^-$ 1
(State symbols not required) (Ignore incorrect state symbols)

(ii) † substitution (reaction) 1

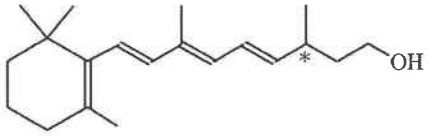
(b) (i)  1
(Accept $H_2C{=}CHCH_2OOCCH_3$ / $H_2C{=}CHCH_2OCOCH_3$ / $CH_2{=}CHCH_2OOCCH_3$)

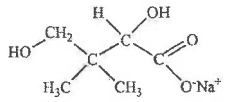
(ii)  2
Correct diagram (1 mark);
(The diagram should show the flask and the condenser are two pieces of glassware.)
(Not accept closed system apparatus. E.g. condenser fitted with a stopper)
Correct labels for water in, water out and heat (1 mark)
(Not accept labelling heat with a triangle or an arrow only)

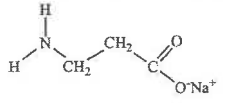
(c)  1
(Accept condensed representation)

DSE20_11

11. (a) **Z** 1

(b)  1

(c) **U** : $HOCH_2C(CH_3)_2CH(OH)CO_2^-Na^+$ / $HOCH_2C(CH_3)_2CH(OH)CO_2Na$ 1


V : $H_2NCH_2CH_2CO_2^-Na^+$ / $H_2NCH_2CH_2CO_2Na$ 1


(d) (i) $Na_2CO_3(aq)$ 1

(ii) • Colourless gas evolves when $Na_2CO_3(aq)$ is put into **X**, but not **W**, **Y** nor **Z**. 1
• Only **X** has a carboxyl group but **W**, **Y** and **Z** have not. 1
(Accept **X** has COOH group / **X** is an acid / **X** is acidic)