Organic Chemistry

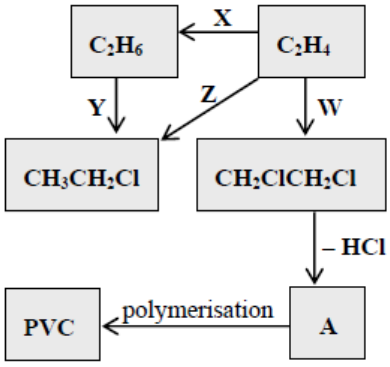
Chemistry Past Exam Questions

Higher Level

2013

Section B - Question 8

8. Study the reaction scheme and answer the questions that follow.



(*a*) Ethane and ethene belong to the homologous series of alkanes and alkenes, respectively.

Explain the underlined term.

What type of reaction was involved in conversion **X**?

How does the geometry around the carbon atoms change as a result of conversion **X**? (15)

(*b*) Identify the reagent required to bring about (*i*) conversion **Y**, (*ii*) conversion **Z**, (*iii*) conversion **W**. (9)

(*c*) Describe the mechanism of reaction **W**. (12)

(*d*) Draw the structure of **A** and give its name. (9)

(*e*) Draw the structure of two repeating units of PVC. (5)

2012

Section B - Question 8

2. Ethene gas can be prepared from ethanol in a school laboratory.

(*a*) Draw a labelled diagram showing the arrangement of apparatus and the reagents used in the preparation and collection of the ethene. (11)

(*b*) It is important to be aware of the possibility of a 'suck-back' occurring when carrying out this procedure.

(*i*) At what stage in the procedure is a 'suck-back' most likely to occur?

(*ii*) Give one possible consequence of a 'suck-back' occurring.

(*iii*) How could a 'suck-back' be avoided? (9)

(*c*) Describe how you could test the gas produced for unsaturation. (9)

(*d*) Write a balanced equation for the preparation of ethene from ethanol. (6)

(*e*) When ethanol is converted to ethene by this method, a 60% yield can be expected.

Assuming this percentage yield, what is the maximum number of 75 cm^3 test tubes of ethene gas that could be collected at room temperature and pressure when 2.4 cm^3 of ethanol, density 0.8 g cm^{-3}, react? (15)

2011

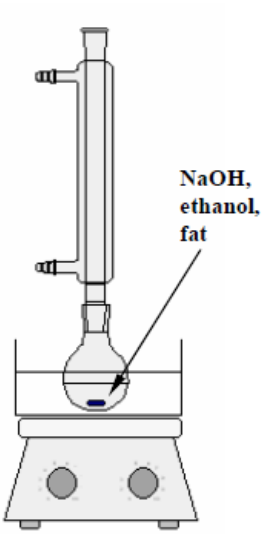
Section B - Question 4 (i)

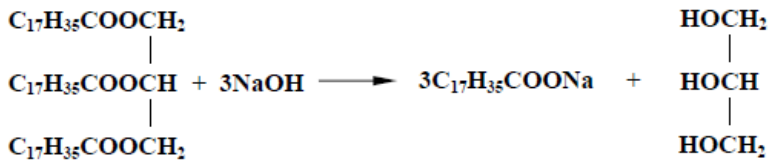
(*i*) What is a *homologous series* of organic compounds?

2010

Section A - Question 2

2. To prepare soap, a student refluxed 8.9 g of glyceryl tristearate (obtained from animal fat), 2 g of sodium hydroxide pellets and 30 cm^3 of ethanol, together with a few anti-bumping granules, using the apparatus shown on the right. At the end of the experiment 7.0 g of pure, dry soap were isolated. The balanced equation for the reaction is as follows:





glyceryl tristearate sodium stearate glycerol

(*a*) Write the systematic (IUPAC) name for glycerol. (5)

(*b*) Why was the reaction mixture heated under reflux?
Name the type of reaction that occurred during the reflux.
What was the purpose of the ethanol? (12)

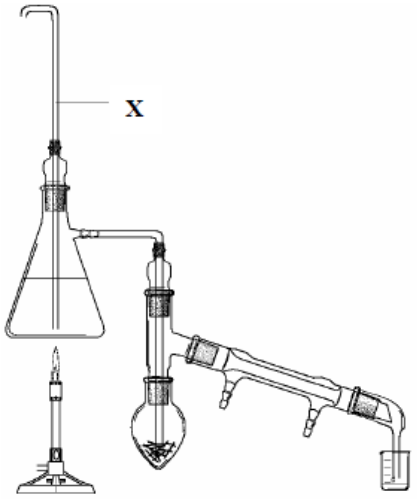
(*c*) (*i*) Describe, with the aid of labelled diagrams, how the ethanol was removed after the reflux stage.
(*ii*) How was the soap isolated from the other substances left in the reaction mixture?
(*iii*) After isolating the soap, how was it purified and dried? (21)

(*d*) Given that the sodium hydroxide was in excess, calculate the percentage yield of soap (sodium stearate). (12)

2008

Section A - Question 2

Steam distillation, using an apparatus like that shown, is a technique used to isolate an organic substance from plant material. The principle of this technique is that the boiling point of a mixture of two *immiscible liquids* is below the boiling points of both pure liquids. This allows the organic substance to be isolated at temperatures below 100 °C and avoids the delicate organic molecules being damaged at high temperatures.



(*c*) What is meant by the term *immiscible liquids*? (3)

(*d*) Name a substance you isolated by steam distillation in the school laboratory and the plant material from which it was extracted. (6)

(*e*) Explain the function of the tube labelled **X**. (6)

(*f*) Describe the appearance of the distillate collected.
Name or describe briefly a technique that could be used to separate the organic substance from the water. (9)

(*g*) In a steam distillation experiment 20.0 g of plant material were heated in the presence of steam. Only 0.250 g of pure organic liquid was obtained. Calculate the percentage yield. (5)

Section A – Question 9

9. The alkenes are a homologous series of *unsaturated* hydrocarbons. Ethene (C_2H_4) is the first member of the series. Alkenes undergo addition reactions and polymerisation reactions.

(*a*) Draw a labelled diagram of an apparatus used to prepare ethene gas in the school laboratory. (8)

(*b*) Draw the structure of any one of the isomers of the third member of the alkene series. Indicate clearly which carbon atoms have planar bonding and which are bonded tetrahedrally. (12)

(*c*) Explain the term *unsaturated*. (6)

(*d*) The ionic addition mechanism for the reaction of ethene with bromine water involves the formation of an intermediate ionic species. Draw the structure of this species.

Give the names or structural formulas of the three products that would be formed if the bromine water used in the reaction contained sodium chloride.

How does the formation of these three products support the mechanism of ionic addition? (18)

(*e*) Name the polymer formed when ethene undergoes addition polymerisation.
Draw two repeating units of this polymer. (6)

Section - Question 11 A

(*a*) Alcohols can be obtained by the reduction of aldehydes and ketones using hydrogen and a suitable catalyst.

(*i*) Name a suitable catalyst for these reduction reactions. (4)

(*ii*) Name the alcohol produced when propanal ($\mathbf{C_2H_5CHO}$) is reduced. (3)

(*iii*) Draw the structure of the alcohol produced when propanone ($\mathbf{CH_3COCH_3}$) is reduced. To which class (primary, secondary or tertiary) of alcohols does it belong? (6)

(*iv*) Which of the two compounds, propanal or propanone, would be oxidised by warm Fehling's solution? Give the name *and* structure of the organic product of the oxidation reaction. (9)

(*v*) Give **one** common use for propanone. (3)

2007

Section A - Question 2

2. A sample of ethanoic acid (CH_3COOH) was prepared by the oxidation of ethanol using the apparatus shown. The reaction is exothermic and is represented by the following equation:

$$3C_2H_5OH + 2Cr_2O_7^{2-} + 16H^+ \rightarrow 3CH_3COOH + 4Cr^{3+} + 11H_2O$$

(*a*) Before heating the reaction flask, the ethanol and water were added from the tap funnel. State **two** precautions which should be taken when carrying out this addition in order to avoid excessive heat production. (8)

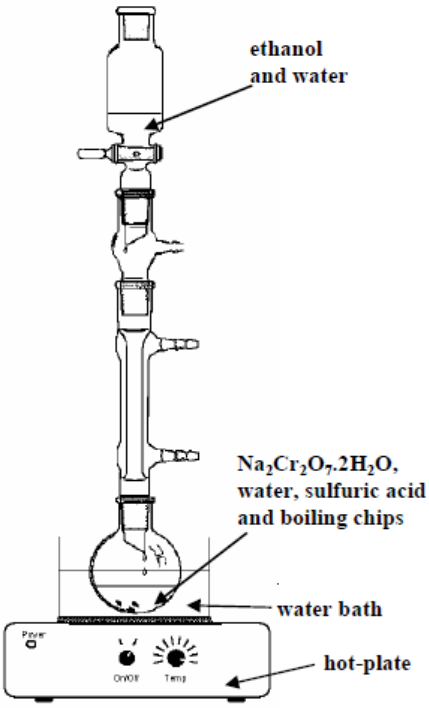
(*b*) Describe and explain the colour change observed in the reaction flask as the ethanol was oxidised. (9)

(*c*) What was the purpose of heating the reaction mixture under reflux after the addition from the tap funnel was complete? (6)

(*d*) Show clearly that the ethanol was the limiting reagent when 8.0 cm^3 of ethanol (density 0.80 g cm^{-3}) was added to 29.8 g of sodium dichromate, $Na_2Cr_2O_7.2H_2O$. There was excess sulfuric acid present. (12)

(*e*) Describe how the ethanoic acid product was isolated from the reaction mixture. (6)

(*f*) Describe your observations when a small quantity of solid sodium carbonate was added to a sample of the ethanoic acid produced. Write a balanced chemical equation for the reaction which occurred. (9)



Section B - Question 8

8. Study the reaction scheme and answer the questions which follow.

$$\underset{\textbf{A}}{C_2H_4} \rightleftharpoons \underset{\textbf{B}}{C_2H_5OH} \rightleftharpoons \underset{\textbf{C}}{CH_3CHO}$$

(*a*) Name the homologous series (*i*) to which **A** belongs, (*ii*) to which **C** belongs. (8)

(*b*) The conversion of **B** to **A** is an elimination reaction. What two features of elimination reactions are illustrated by this conversion? (6)

(*c*) Name the reagent and the catalyst required to convert **C** to **B**. (6)

(*d*) Draw full structural formulas for **B** and **C**. Indicate any carbon atom in either structure that has planar geometry. List the bonds broken in **B** and the bond made in **C** in the synthesis of **C** from **B**. (18)

(*e*) After carrying out a laboratory conversion of **B** to **C**, how could you test the product to confirm the formation of **C**? (9)

(*f*) Compound **C** is formed as a metabolite of compound **B** in the human body. How does compound **B** come to be present in the body? (3)

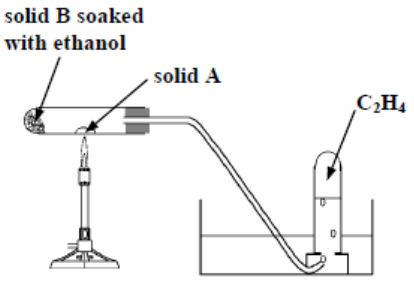
2006

Section B - Question 9

9. The alkenes are a homologous series. Ethene (C_2H_4) is the first member of the series.

(*a*) What is meant by a *homologous series*? (5)

(*b*) Ethene may be made in a school laboratory using the arrangement of apparatus drawn on the right.



(*i*) Give the name and formula of the solid **A** which is heated using the Bunsen burner. (6)

(*ii*) Identify the solid **B** which is used to keep the ethanol at the end of the test tube. (3)

(*iii*) What precaution should be observed when heating is stopped? Why is this necessary? (6)

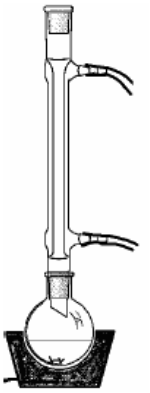
(*iv*) Give **one** major use of ethene gas. (3)

(*c*) Describe the mechanism for the bromination of ethene. (9)
State and explain **one** piece of experimental evidence to support this mechanism. (6)

(*d*) Draw the structures and give the systematic (IUPAC) names for **two** alkene isomers of molecular formula C_4H_8. (12)

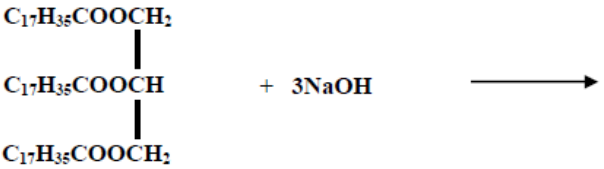
Section A - Question 2

2. A sample of soap was prepared in the laboratory by refluxing a mixture of approximately 5 g of animal fat, 2 g of sodium hydroxide pellets (an excess) and 25 cm^3 of ethanol in an apparatus like that drawn on the right.



(*a*) Why was the reaction mixture refluxed? Name the *type* of reaction which occurs during the reflux stage of the preparation. (8)

(*b*) Complete and balance the equation below for the reaction between glyceryl tristearate, an animal fat, and sodium hydroxide. (9)



glyceryl tristearate

(*c*) What is the purpose of the ethanol? Why is it desirable to remove the ethanol after reflux? Describe with the aid of a labelled diagram how you would remove the ethanol after the reflux stage of the experiment. (12)

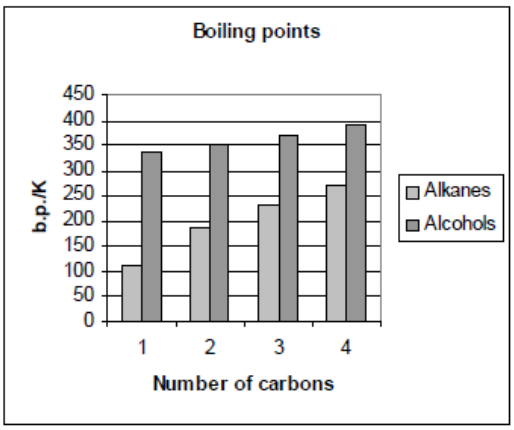
(*d*) Describe how a pure sample of soap was obtained from the reaction mixture. (9)

(*e*) At the end of the experiment, what is the location
(*i*) of the second product of the reaction,
(*ii*) of the excess sodium hydroxide? (6)

(*f*) What would you observe, upon shaking, if a little of the soap prepared in this experiment is added to (*i*) a test tube containing deionised water,
(*ii*) a test tube containing mineral water from a limestone region? (6)

Section B - Question 10 C

(*c*) The chart compares the boiling points of alkanes and primary alcohols containing from one to four carbon atoms.



(*i*) Give **two** reasons why each of these alcohols has a higher boiling point than the corresponding alkane. (7)

(*ii*) Explain why the difference in boiling points between methane and methanol is 226.5 K while the difference in boiling points between butane and butanol is only 119 K. (6)

(*iii*) Describe, in general terms, the solubilities of methane, methanol, butane and butanol in water. (12)

2005

Section A - Question 2

2. A group of students prepared ethanal (CH_3CHO) by slowly adding an aqueous solution of ethanol (C_2H_5OH) and sodium dichromate(VI) ($Na_2Cr_2O_7.2H_2O$) to a hot aqueous solution of sulfuric acid (H_2SO_4). The apparatus drawn below was used. The reaction is described by the following equation.

$$3C_2H_5OH + Cr_2O_7^{2-} + 8H^+ \rightarrow 3CH_3CHO + 2Cr^{3+} + 7H_2O$$

(*a*) Why was the receiving vessel cooled in ice-water? (5)

(*b*) State **two** features of the preparation that are necessary to maximise the yield of ethanal and, for each feature stated, explain why it is necessary. (12)

(*c*) Describe and account for the colour change which is observed during the addition of the ethanol and sodium dichromate(VI) solution to the hot acid. (9)

(*d*) Describe how you would carry out Fehling's test on a sample of ethanal. What observation would you expect to make in this test? (12)

(*e*) Assuming that all of the features needed to maximise the yield of ethanal were present, what mass of ethanal would be produced in the preparation if the students used 8.94 g of sodium dichromate(VI) ($Na_2Cr_2O_7.2H_2O$), and a 75% yield was obtained? (12)