Lavender

Contents: A demonstration of the steam distillation of lavender with reading, questions, data analysis and an outline of the history of a commercial enterprise.

Time: 1 double period and homework.

Intended use: GCSE Chemistry, Biology and Science courses. Links with work on distillation, emulsions, industrial processes, molecular structure and plant breeding.

Aims:

- To revise and complement work on distillation and separation techniques
- To describe an application of selective plant breeding and plant propagation
- To develop an awareness of the scale of industrial processes compared to laboratory operations
- To develop an awareness of the timescale involved in setting up a new business
- To provide opportunities to practise skills of reading, comprehension, and the interpretation of data and chemical symbols.

Requirements: Students' worksheets No.1004 including copies of the diagram sheet which may be cut up. The requirements for the teacher demonstration are given below. It may also be useful to have a set of molecular models available.

Author: Malcolm Walker

Suggested use

This is an interdisciplinary unit which can be adapted for use with the whole GCSE ability range. Pages 1 and 2 have more links with chemistry. Page 3 relates to the study of plant reproduction in biology while page 4 describes the historical background to the development of the commerical enterprise. The diagram sheet is for use with the teacher demonstration and with questions 6 to 10.

Teacher demonstration of the steam distillation of lavender

Requirements

steam generator with safety tube and delivery tube
250 cm^3 round-bottomed flask, fitted with bung and delivery tubes
condenser with bung and delivery tube
2 short lengths of connecting tubing
measuring cylinder, 25 cm^3
burner, tripod and mat
3 stands with bosses and clamps
microscope and slide
scissors
lavender (see step A)
access to a sink

Procedure

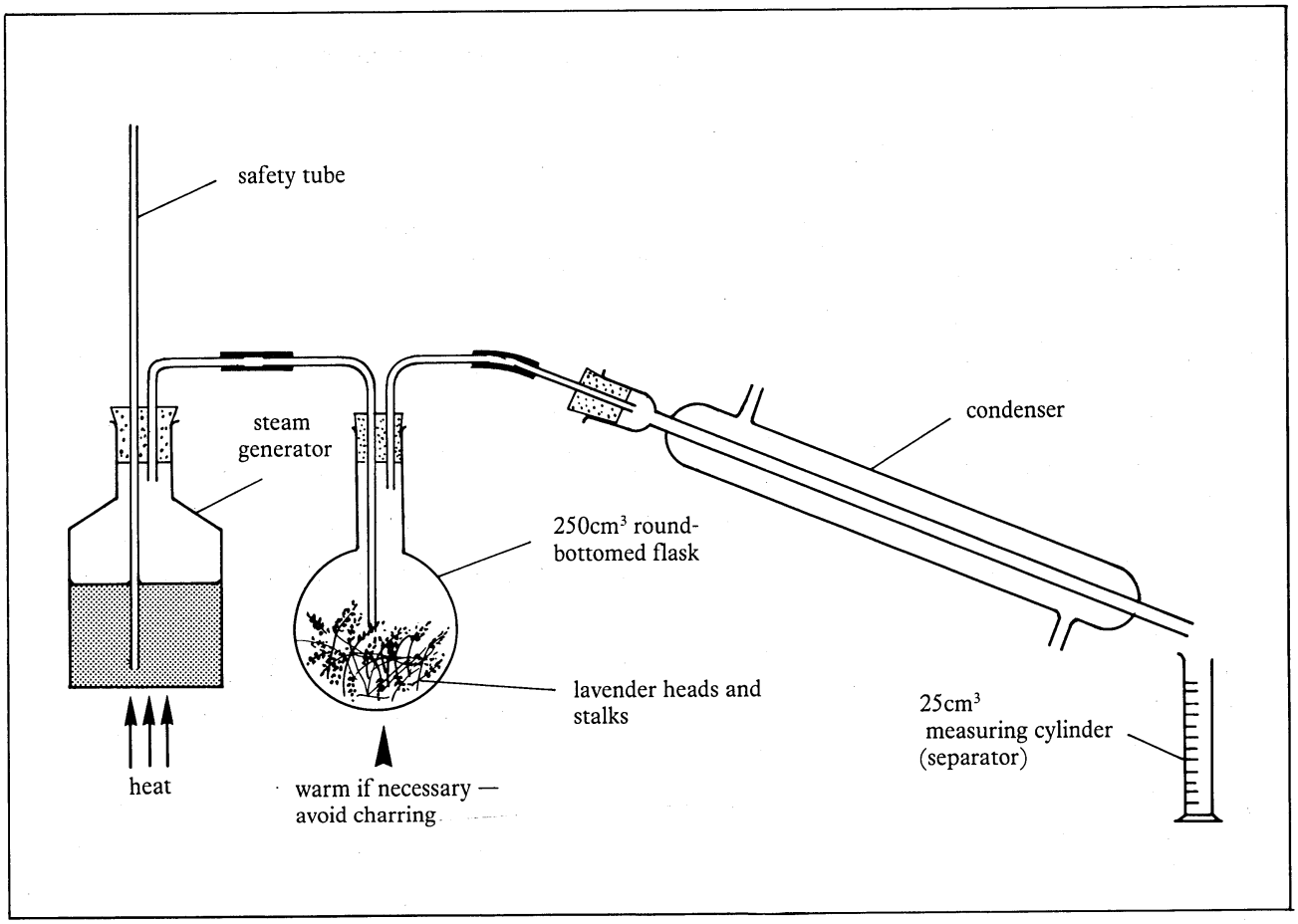


Figure 1 Apparatus for steam distillation

Step A Harvest the blooms and stalks of lavendar in July. Immediately hang the bunches to dry for 2 to 3 days (for example, in the prep. room). The dry blooms will keep well. In industry the lavender is **not** dried before steam distillation.

Step B Chop 5 to 10 of the heads into a 250 cm^3 round-bottomed flask.

Step C Set up the apparatus shown in Figure 1. Steam distil. It may be necessary to warm the flask containing the blooms if too much water begins to condense. This has to be done carefully to avoid charring. Discuss this with the students to help them with question 1.

Distillation will produce a cloudy distillate in the measuring cylinder which acts as the separator. The watery emulsion has a very distinctive odour. There will not be enough oil to form a separate layer. The commercial process uses 0.25 tonnes of blooms at a time.

Step D Examine a drop of the distillate with a microscope. Droplets of lavender oil will be visible. Allow time for the students to smell the oil and examine it.

Notes on some of the questions

Q.1 The steam carries the perfume molecules with it. Distillation on its own would cause charring and decomposition of the perfume molecules.

Q.2 This is a safety tube. It prevents a build-up of pressure if the apparatus becomes blocked.

Q.3 Newquay

Q.4 Norwich and Sheffield

Q.5 The Norwich area is the best of those in the table with high average hours of sunshine, low rainfall, and high average temperatures. The soil is alkaline. Lavender will also grow elsewhere.

Q.6 – 10 These questions are for students studying the theory of chemistry to a relatively high level. The questions show that the rules for bonding in more complex carbon compounds are similar to those in simpler substances. It may help to show students molecular models of the compounds.

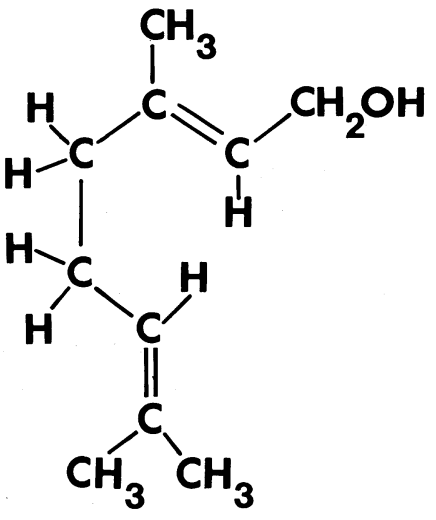
Q.6 Carbon, hydrogen and oxygen

Q.7 Linalool, $C_8H_{14}O$; linalyl acetate, $C_{12}H_{20}O_2$

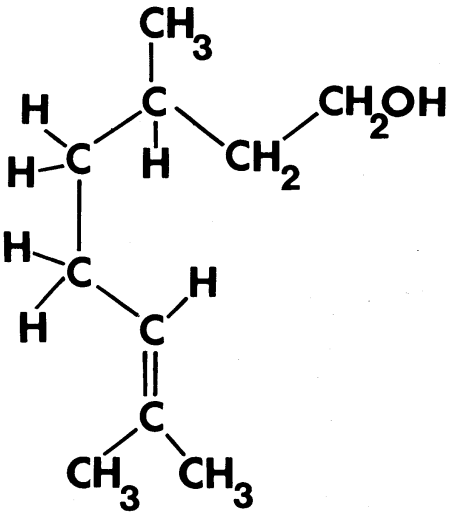
Q.8 C — 4 bonds, H — 1 bond, O — 2 bonds in both the perfume molecules and the simple molecules.

Q.10 The orange colour disappears as bromine adds to the double bond.

The compounds in lavender oil can be compared with some of the compounds which give rose oil its odour (see Figure 2).



geraniol



citronellol

Figure 2 Molecules in rose oil

Q.11 Sexual reproduction allows variation and the production of hybrids. Vegetative reproduction produces identical plants.

Q.12 Five thousand bushes are needed to plant an acre of lavender. The information in the unit suggests that it might take as little as ten years to get a new oil to market once a suitable bush has been identified. In fact it would be unusual to get a large field full-bearing in less than twenty years.

Q.13 In France there were people with experience of distilling perfumes. Other French people had expertise in the use of copper stills for making brandy.

Q.14 Cross-channel trade was cut off during the Second World War. English perfumers continued to export to the USA.

Q.15 Twenty-one years

Norfolk Lavender supply their oil exclusively to Yardley.

Possible extension work

1 The use of steam distillation to extract perfumes from plant materials makes an excellent open-ended investigation. Possible ideas:
   Try other plant materials such as lemon peel, orange peel and apples.
   Carry out 'market research' on student/staff preference for perfumes.
   Study the stability of the perfumes with time. (**Care!** Watch for bacterial growth.)

2 Study topics based on library reading including subjects such as the development of synthetic perfumes (see the article in *Chemistry in Britain* listed under Further Resources).

3 A short play to enact the setting up of the lavender business. This might take the form of an argument between Linn Chilvers, 'Ginger' Dusgate and two other local farmers as they discuss the merits of using farm land to grow lavender commercially. This can be based on page 4 of the unit.

Further resources

Norfolk Lavender Ltd, Caley Mill, Heacham, King's Lynn, Norfolk, PE31 7JE will provide further information about the lavender industry.

Ingasetter Ltd, Fragrance of Scotland, Royal Deeside, Banchory, Scotland, AB3 3YR. This company will loan a 10-minute film of the process.

Andrews, B. 'The chemistry and art of perfumery', *Chemistry in Britain*, Dec.1982, page 864.

Festing, Sally. *The Story of Lavender*, London Borough of Sutton Libraries and Arts Services, 1982.

Acknowledgements Students' worksheets Figure 1 based on photo by Malcolm Walker; Figures 2 and 3 reproduced by permission of *The Daily Telegraph.*

LAVENDER

Our noses are insensitive compared to the noses of other animals such as dogs. Yet we can distinguish as many as 10 000 different odours. One of the most memorable is the smell of lavender.

Lavender grows well on the coast of the Mediterranean and was chosen by the Romans to scent their baths. Today, lavender is used in perfumes, soaps, talcs, bath cubes, bubble baths, hand lotions, after-shaves and midge repellants.

In this unit you will be shown how to get the perfume from the flowers and stalks of lavender. You will also read about the growth of the only successful lavender business in England.

How is a perfume extracted from lavender flowers?

You may be shown a demonstration of the method used to extract the perfume from the flowers. The technique used is called **steam distillation.** The diagram sheet shows the pieces of apparatus used for the distillation.

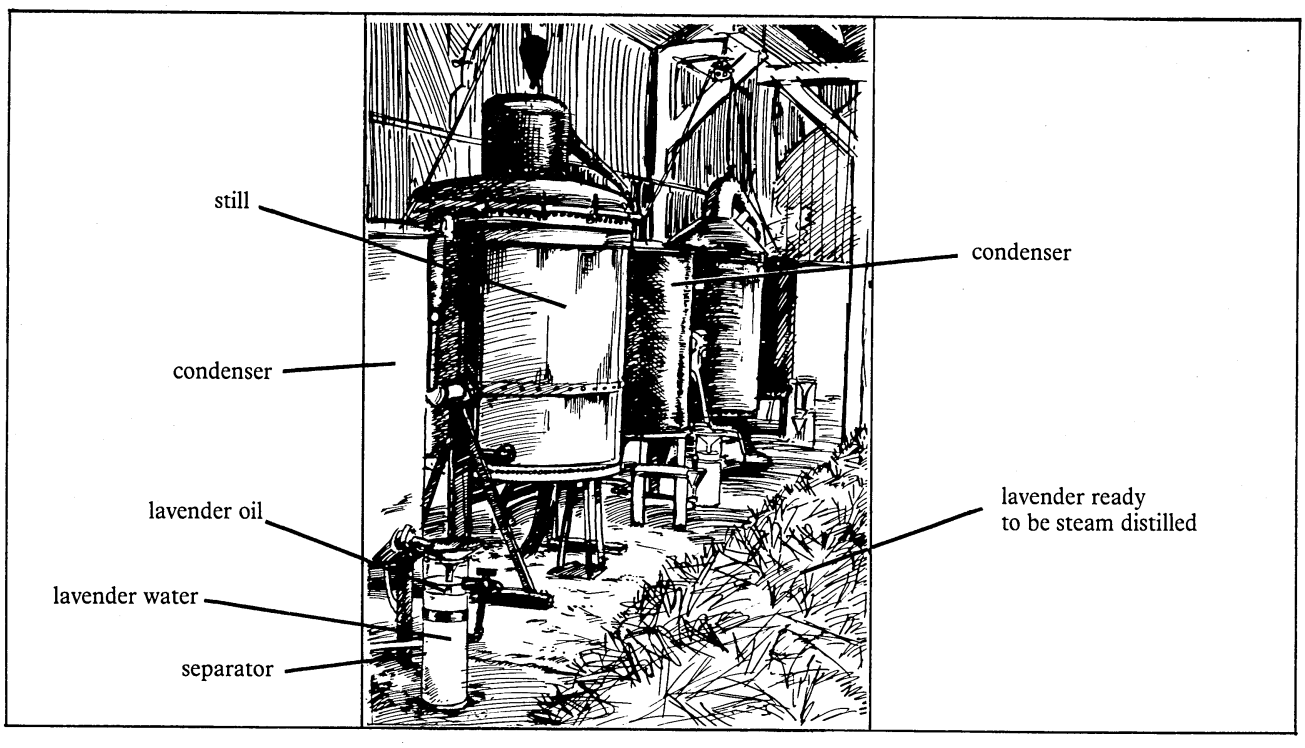


Figure 1 Commercial equipment for steam distillation

Produce a diagram of the steam distillation apparatus. You can do this by cutting up the diagram sheet and sticking the parts together as in the demonstration. Or you can use the diagram sheet to help you prepare your own diagram.

Label your diagram using the captions on the diagram sheet. You can cut out the captions and stick them in place, or you can copy them.

You may be shown what the lavender water looks like when seen through a microscope. If so draw a diagram of what you see.

Now answer questions 1 and 2.

Questions

(Your observations during the steam distillation may help you with your answers)

1 *Why is steam distillation used to extract the perfume from lavender? What would happen if the lavender was simply distilled on its own?*

2 *What is the purpose of the straight glass tube in the bung of the steam generator?*

Where will lavender grow well?

Lavender grows well in sunny positions on light, well drained soils which are alkaline.

Look at the table below, then answer questions 3 to 5.

Town	*Average daily sunshine/ hours*	*Annual rainfall/ inches*	*Average monthly temperature/ °C*	*Soil type*
Blackpool	4.1	35	9.6	wet, pH 6
Durham	3.6	26	8.7	dry, pH 7 - 7.5
Newquay	4.5	34	10.7	wet, pH 5.5
Norwich	4.3	26	9.9	dry, pH 8
Sheffield	3.4	32	9.6	wet, pH 7.5 - 8

Questions

3 *Which town has the most sunshine on average?*

4 *Which town has the most alkaline soil?*

5 *Which town seems to have the best conditions for growing lavender?*

Which molecules give the perfume its smell?

The diagram sheet shows you the structures of two of the chemicals which give lavender its smell. **Cut out the diagrams and stick them in your notes.** Then answer questions 6 to 10.

Questions

6 *Which three chemical elements are combined in linalool and linalyl acetate?*

7 *Write the molecular formulas of the two compounds in the form $C_xH_yO_z$. Replace the x, y and z by the correct numbers.*

8 *(a) How many bonds are formed by a carbon atom, a hydrogen atom and an oxygen atom in the molecules?*
(b) How do your answers to part (a) compare with the numbers of bonds formed by the same atoms in simpler molecules such as water and methane?

9 *Draw one diagram to show the parts of the linalool and linalyl acetate molecules which are the same in both molecules.*

10 *What would you expect to see happen if you shook some linalool with a solution of bromine?*

How is a good variety of lavender found?

There are two main types of lavender. Cross-breeding can produce many hybrids. The cultivated varieties are hybrids of Lavendula angustifolia. Lavendula angustifolia is resistant to diseases. It grows wild in France.

Once a suitable variety has been developed it can still take a long time before it can be used to produce perfumes on a large scale. These are the stages:

1 Select a bush for tests.
2 Steam distil the flowers from that bush alone.
3 Measure the amount of oil produced, analyse it and test the quality of the perfume.
4 If the test results are favourable, take *cuttings* from the plant in October. Plant out the cuttings to produce new bushes.
5 Five years later, if the bushes have grown to a suitable size, take samples of flowers from the bushes. Distil the samples and test the perfume.
6 If the results are still good, take a large number of cuttings from the bushes and plant a field.
7 Five years later the field may be full-bearing.

Answer questions 11 and 12.

Questions

11 Plant breeders use two different methods to produce lavender bushes.
(a) Hybrid plants are developed by using the pollen from one type of lavender to fertilize a different variety.
(b) Bushes of a chosen hybrid are reproduced by taking cuttings.
Why are two methods of producing new plants used?

12 How long does it take to get to large-scale production once a good new hybrid has been found?

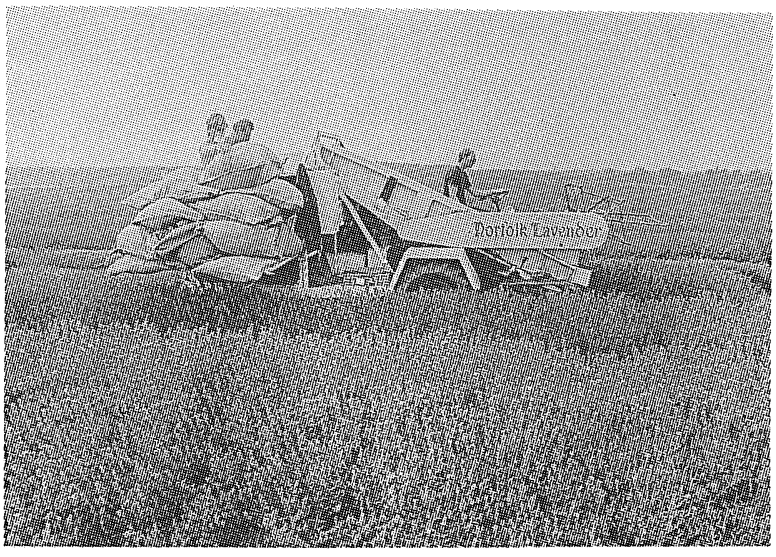


Figure 2 Harvesting the lavender

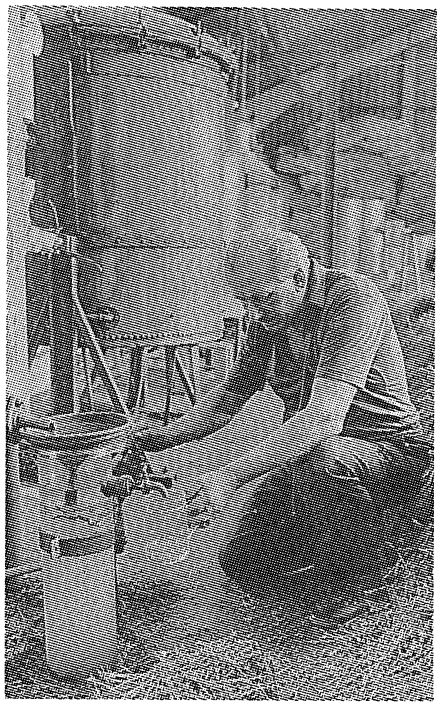


Figure 3 Drawing off the distilled lavender oil

How did a lavender business start in England?

1932
On April 26th, 'Francis Edwin Dusgate of Fring Hall near Docking in the County of Norfolk, Esquire, and Linnaeus Chilvers of Hunstanton in the same county, Nurseryman' agreed to form a partnership. They decided to produce lavender oil for commerical purposes. 'Ginger' Dusgate provided 6 acres of land and Linn Chilvers provided 33 000 rooted lavender cuttings at £10 per 1000.

At that time Linn Chilvers owned a small market garden nursery. He had started to grow lavender successfully and realised its great commercial possibilities. He needed a large acreage to make a business out of growing lavender. Some local farmers were reluctant to grow lavender. They believed (wrongly) that lavender reduces the fertility of the soil. However, Linn Chilvers was able to persuade 'Ginger' Dusgate, a local sportsman and landowner, to join him.

1936
The directors of a famous perfume company gave encouragement to the new business. Traditional copper stills were bought from France,to distil the lavender oil.

Mr Horace Avery, a Leicester chemist, was visiting the Norfolk coast. He bought a bunch of lavender and then took an interest in the business. He knew about perfumery and was able to give Linn Chilvers a secret, eighteenth-century formula for lavender perfume.

1939 - 1945
The production of lavender oil increased to supply an English perfumer whose supplies from France were cut off.

1941
The partnership was named 'Norfolk Lavender Ltd'.

1953
Linn Chilvers died followed shortly by 'Ginger' Dusgate. The company was continued by the Head family.

1984
Henry Head, the company's Managing Director, told *The King's Lynn Trader:* 'We hope to expand the market for the product especially to the United States.'

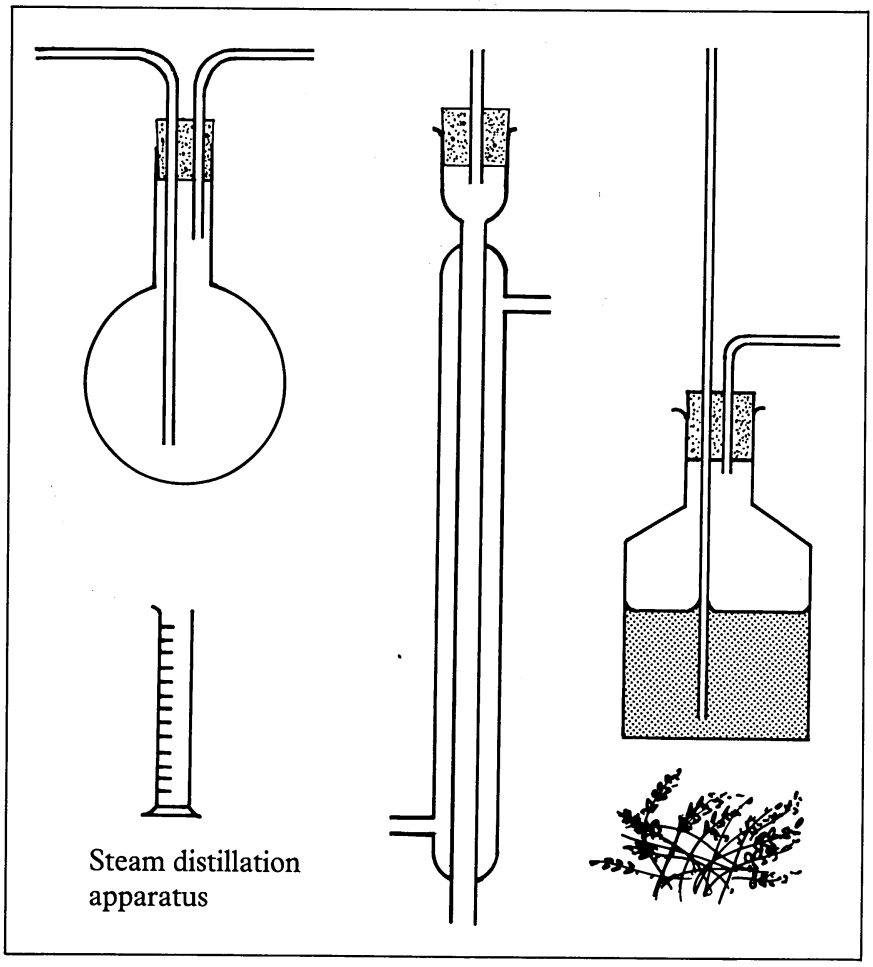
Answer questions 13 to 15.

Questions

13 Why do you think that the copper stills were imported from France?

14 Why were English perfumers cut off from French supplies in the years 1939-45?

15 For how long did the partnership between Linn Chilvers and 'Ginger' Dusgate last?



Steam distillation apparatus

Labels for diagram

still
condenser
heat

steam generator

water to make steam

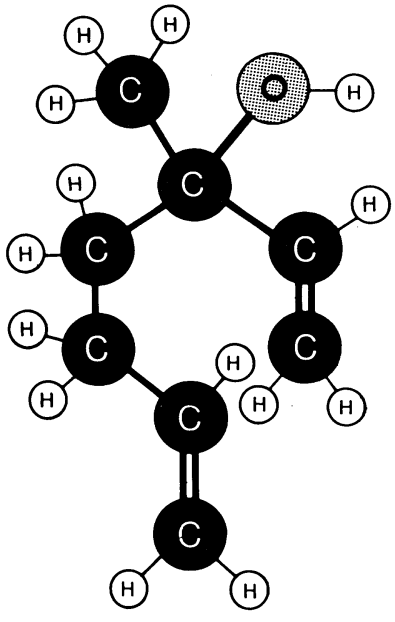
lavender heads

water in

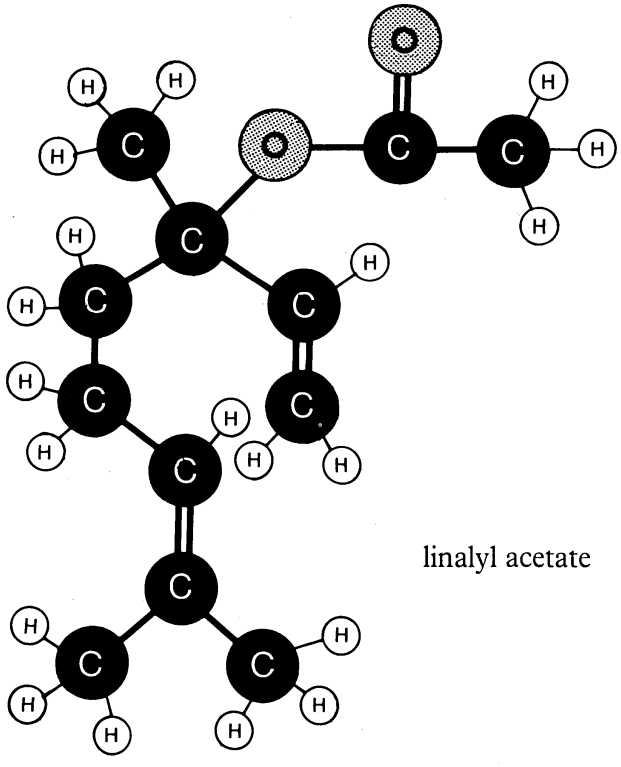
water out

lavender water

collector and separator



linalool



linalyl acetate