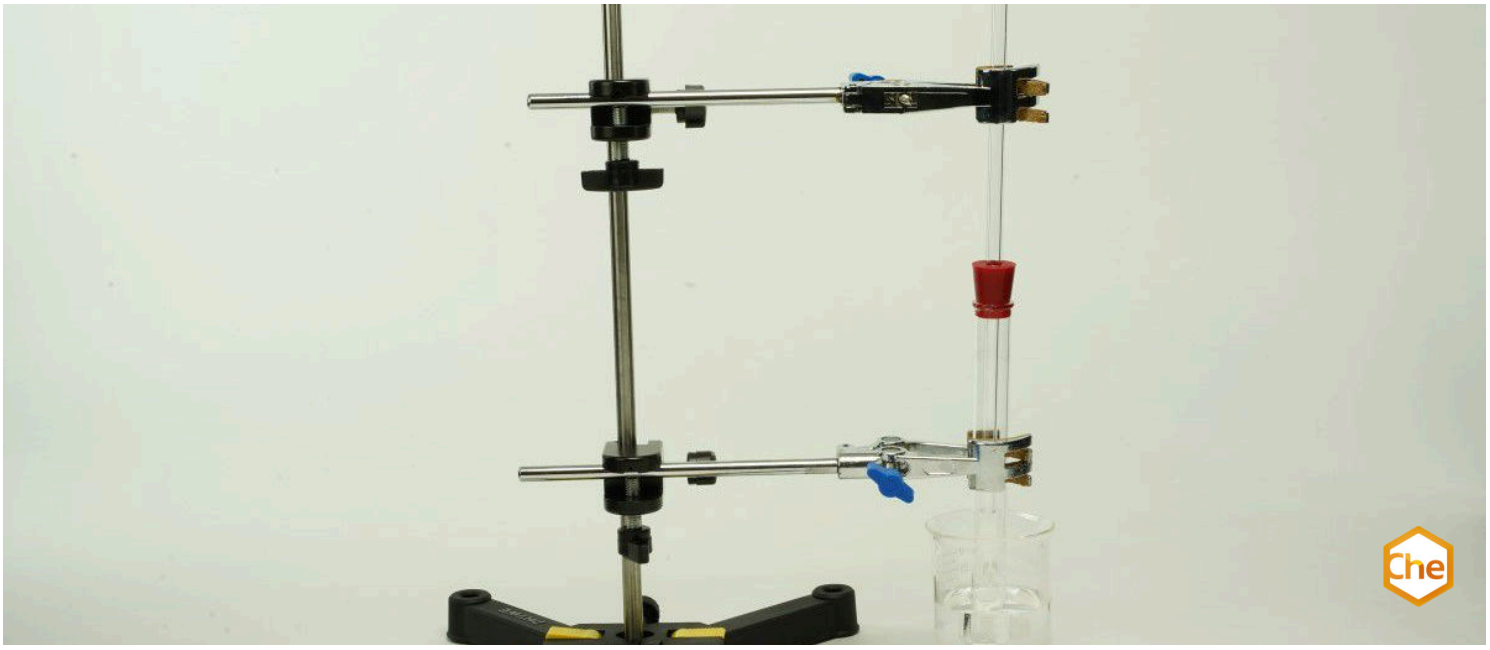
Esters of various alkane acids



Chemistry > Organic chemistry > Organic compounds containing oxygen

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/6388db94a0ce13000322a3d5

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Teacher information

Application

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The experimental setup

In chemistry, esters are a group of chemical compounds that formally or de facto result from the reaction of an acid and an alcohol or phenol with the elimination of water (a condensation reaction).

Building on the previous experiment "Esters of acetic acid (P7173100)", this experiment deals with the ester formation of alkanoic acids. In this experiment, the students observe the change of esters with variation of alkanoic acids and alcohols.

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Other teacher information (1/6)

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Prior knowledge

The students should already have a basic knowledge of alkanes, acids and bases, as well as carboxylic acids and their salts. Furthermore, the students should already be familiar with the safe handling of chemicals, as well as butane or Bunsen burners.

Principle

Alkanoic acids react with alcohols in a proton-catalysed manner to form esters, which are characterised by an intensive fruit-like odour. By varying the reactants, different odour components can be produced, which can be used as nature-identical flavouring substances.

Other teacher information (2/6)

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Learning objective

The students learn that alkanoic acids react proton-catalysed with alcohols to form esters. Different odour components can be produced by varying the reactants.

Tasks

React different alkanols with different alkanoic acids. Write down your observations.

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Other teacher information (3/6)

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Notes on the experiment (1/2)

During the reaction of alkanoic acids and alcohols, slightly volatile, intensely fruit-like smelling substances are formed that dissolve little in water (alkanoic acid esters). The sulphuric acid added to the reaction has only a catalytic function, which may need to be discussed with the class. The following reaction equations can be set up and discussed:

$$C_2H_5COOH + C_2H_5OH \rightarrow C_2H_5COOC_2H_5 + H_2O$$

$$C_3H_7COOH + CH_3OH \rightarrow C_3H_7COOCH_3 + H_2O$$

$$C_3H_7COOH + C_2H_5OH \rightarrow C_3H_7COOC_2H_5 + H_2O$$

Other teacher information (4/6)

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Notes on the experiment (2/2)

The esterification of short-chain alkanols with equally short-chain alkanoic acids produces aromatic substances with a fruity (fruit-like) smell. When esterified with aromatic acids, aromatic substances with a plant-like (flower-like) character are produced.

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Other teacher information (5/6)

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Notes on set-up and procedure

Preparations
Provide hot water (boiler) with a temperature of approx. 90 °C.
Have an eyewash bottle ready.

Notes on the student experiments
If there are not enough fume hoods available, the odour nuisance can be minimised by filling the butyric acid beforehand. The alcohol-acid mixture should boil weakly during most of the test time. Since propionic acid/butyric acid have a correspondingly higher boiling point than acetic acid, boiling water may have to be added during the course of the experiment.
The esters produced must not be subjected to taste testing. The resulting esters must under no circumstances be subjected to a taste test.

Other teacher information (6/6)

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Methodological remarks

This experiment is particularly suitable for group work. It can be carried out together with the previous one.

Disposal

Neutralise the contents of the beakers by adding NaOH pellets and put them into the collection container for flammable organic substances.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

For H- and P-phrases please consult the safety data sheet of the respective chemical.

Dangers

- The alcohols used are highly flammable! Extinguish all open flames.
- Sulphuric acid is highly corrosive, acetic acid is corrosive. Put on protective goggles! Wash off splashes on the skin with plenty of water.
- Make rubber-glass compounds slippery with glycerine!

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Student information

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Motivation

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Characteristic aroma of fruit is also created by fruit esters

Esters, derived from acetic ether, are a group of chemical compounds that are formed by the reaction of an acid and a phenol or alcohol with the elimination of water. Esters of organic acids (e.g. carboxylic acids including the alkanoic acids) are esters with the functional group $-COOR$ and form a frequently encountered group of substances in organic chemistry and in nature (fruit esters, fats and oils). Fruit aromas also have a high proportion of esters, which give fruits their characteristic smell and taste.

In this experiment, different esters are produced from alkanoic acids and it is investigated how the different reaction products differ from each other.

Tasks

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The experimental setup

React different alkanols with different alkanoic acids.

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Equipment

Position	Material	Item No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
3	Boss head	02043-00	2
4	Wash bottle, 250 ml, plastic	33930-00	1
5	Glass tubes,straight, 400 mm, 10	MAU-16074545	1
6	Beaker, 150ml, low-form	46060-00	2
7	Beaker, Borosilicate, low form, 250 ml	46054-00	1
8	Graduated cylinder, 10 ml, plastic	36636-00	1
9	Test tube, 180x18 mm,100pcs	37658-10	1
10	Test tube brush w. wool tip,d20mm	38762-00	1
11	Test tube rack for 12 tubes, holes d= 22 mm, wood	37686-10	1
12	Universal clamp	37715-01	2
13	Rubber stopper, d = 22/17 mm, 1 hole	39255-01	1
14	Protecting glasses, clear glass	39316-00	1
15	Rubber gloves, size M (8), one pair	39323-00	1
16	Pipette with rubber bulb	64701-00	1
17	Ethanol extra pure ab.95% 1000 ml	30008-70	1
18	N-butyric acid 100 ml	30047-10	1
19	Glycerol, 250 ml	30084-25	1
20	Sulphuric acid, 95-97%, 500 ml	30219-50	1
21	Water, distilled 5 l	31246-81	1
22	Propionic acid, 500 ml	31753-50	1
23	Boiling beads, 200 g	36937-20	1

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Set-up (1/3)

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Figure 1

1. Set up the stand as shown in Fig. 1 with two sleeves and universal clamps. Clamp the test tube in the lower universal clamp about halfway up the stand.

Set-up (2/3)

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Figure 2

2. Add about 3 ml acetic acid and 3 ml 1-pentanol to the test tube (Fig. 2).

3. Add 3 boiling stones and pipette 10 drops of concentrated sulphuric acid exactly into the centre of the test tube opening (Fig. 3). This must not touch the edge of the test tube.

Figure 3

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Set-up (3/3)

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Figure 4

4. Carefully twist one end of the glass tube into the stopper (make it slippery with glycerine) (Fig. 4). Let the other end of the glass tube rest on the exerperimentation table as much as possible when turning it in.

5. Close the test tube with the rubber stopper and loosely secure the glass tube attached to it in the universal clamp attached to the upper part of the stand (Fig. 5).

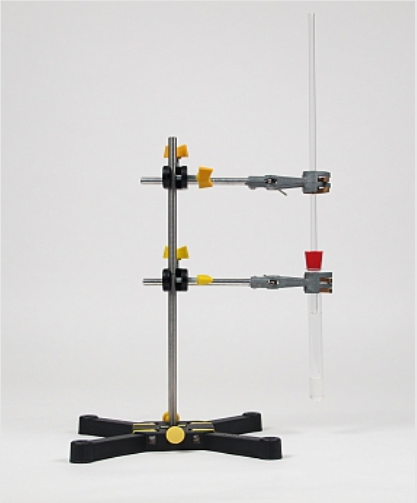

Figure 5

Procedure (1/2)

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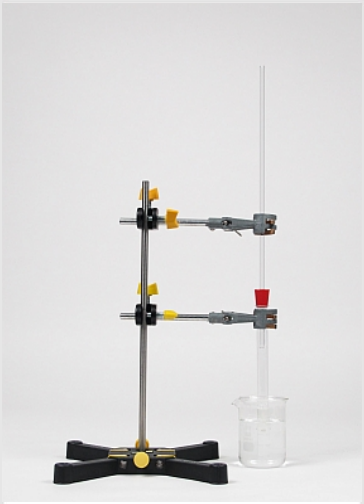

Figure 6

1. Fill the large beaker halfway with water that is as hot as possible.

2. Carefully lower the test tube into the hot water (Fig. 6).

3. Let the mixture boil for about 5 minutes, add boiling water if the boiling stops.

4. Move the test tube upwards and let it cool down.

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Procedure (2/2)

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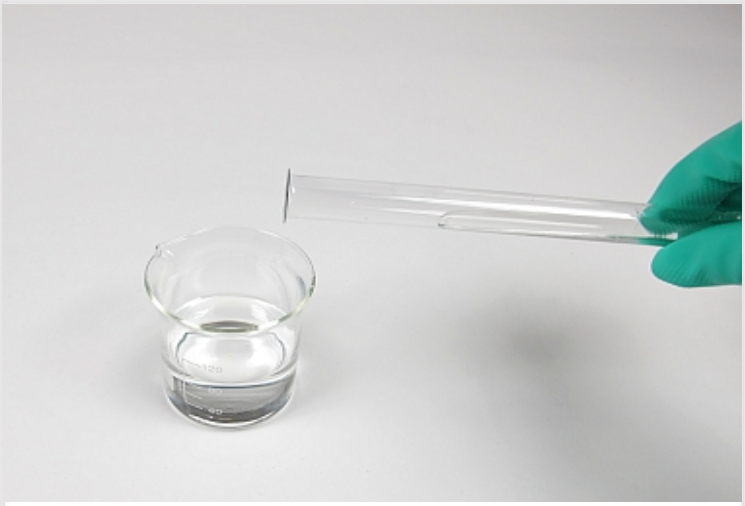

Figure 7

5. Fill a small beaker halfway with distilled water and pour the cooled mixture into it (Fig. 7).

6. Fill the second test tube with 3 ml butyric acid and 3 ml ethanol, then carry out the experiment with this mixture as before.

Disposal

Neutralise the contents of the beakers by adding NaOH pellets and place in the flammable organic substances collection container.

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Report

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Task 1

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Write down your observations.

Task 2

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Enter the results in the table.

RG	Content	Name of the ester	Formula	Smell
1	Ethanol + propionic acid			
2				

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Task 3

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How can the smell of the resulting products be described?

- spicy
- fruity
- rotten
- pungent

Task 4

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What role does sulphuric acid play in the reaction?

- ○ The sulphuric acid has a catalytic function.
- ○ The sulphuric acid is responsible for the formation of odours.
- ○ The sulphuric acid prevents the mixture from burning.

Check

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Task 5

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Reaction equation

Formulate the two reaction equations.

Test tube 1

____ + Propionic acid -> ____ + ____

Test tube 2

Ethanol + ____ -> ____ + ____

Butyric acid ethyl ester
Propionic acid ethyl ester
Sulphuric acid
Ethanoic acid
Butyric acid
Ethanol
Water

Check

Slide	Score / Total
Slide 22: Smell	0/1
Slide 23: Function of sulphuric acid	0/1
Slide 24: Reaction equation	0/6

Total 0 / 8

Solutions Repeat Export text

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