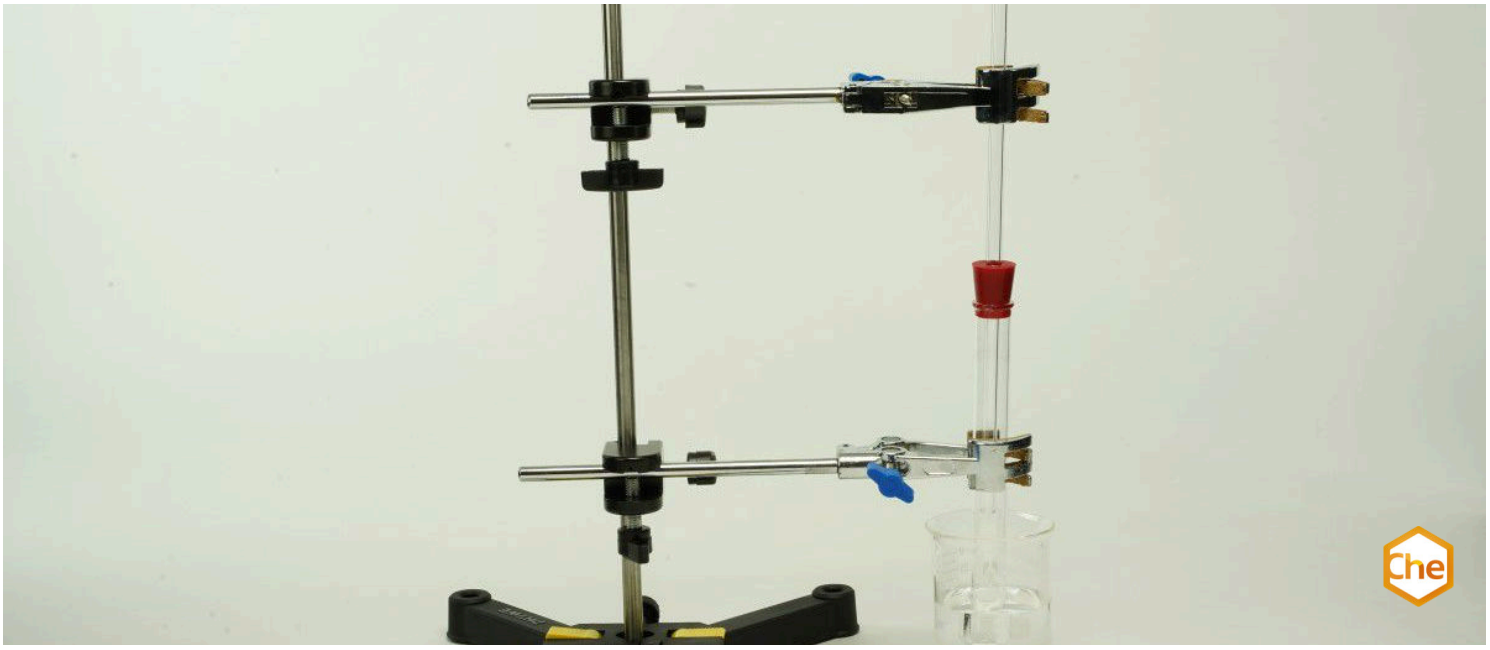
Esters of acetic acid



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/638a5545abe2e70003a7e2c7

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Teacher information

Application

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The experimental setup

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

In this experiment, students investigate the proton catalytic reaction of acetic acid with alcohols to form esters.

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Other teacher information (1/6)

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Prior knowledge

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 intense fruit-like odour.

Other teacher information (2/6)

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Learning objective

The students learn that alkanoic acids react with alcohols in a proton-catalysed way to form esters. Esters are characterised by an intense fruit-like smell.

Tasks

React different alkanols with acetic acid.

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Other teacher information (3/6)

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Notes on the experiment (1/2)

The (formerly so-called) ester condensation proceeds according to the type of proton-catalysed nucleophilic substitution. This is an equilibrium reaction in which the acetic acid is about 60 % under experimental conditions.

In advanced classes (upper secondary school), this experiment can be used as part of the treatment of nucleophilic substitutions. If a suitable photometer is available, the equilibrium setting can also be demonstrated.

Other teacher information (4/6)

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Notes on the experiment (2/2)

During the reaction of acetic acid and alcohols, slightly volatile, intensely fruit-like smelling substances are formed that dissolve little in water (acetic 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:

$$CH_3COOH + C_5H_{11}OH \rightarrow CH_3COOC_5H_{11} + H_2O$$

$$CH_3COOH + CH_3C_3H_7OH \rightarrow CH_3COOC_3H17 + H_2O$$

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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

The alcohol-acid mixture should boil weakly for most of the experimental time. It may be necessary to regulate the temperature of the water bath by adding appropriately tempered water. Under no circumstances should the resulting esters be subjected to a taste test.

Other teacher information (6/6)

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Methodological remarks

The experiment is particularly suitable for working in groups. The next experiment "Esters of various alkanoic acids (P7173100)" can also be included here; four esters can then be produced in parallel. It is also possible to produce further esters under the same experimental conditions.

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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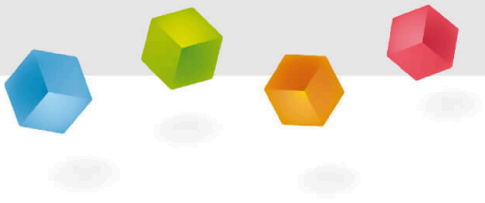

Student information

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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. It is therefore a so-called condensation reaction.

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.

This experiment investigates how the ester of acetic acid can be produced.

Tasks

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The experimental setup

React different alkanols with acetic acid.

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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	Glycerol, 250 ml	30084-25	1
18	Sulphuric acid, 95-97%, 500 ml	30219-50	1
19	N-amyl alcohol 500 ml	31051-50	1
20	Water, distilled 5 l	31246-81	1
21	Acetic acid 99...100%, pure 1 l	31301-70	1
22	Isobutyl alcohol 250 ml	31393-25	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 secure the attached glass tube loosely in the universal clamp attached to the upper part of the stand (Fig. 5).

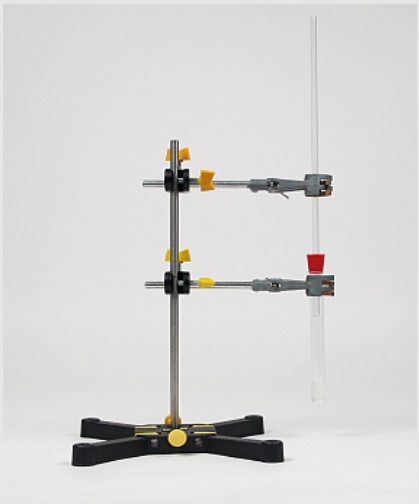

Figure 5

Procedure (1/2)

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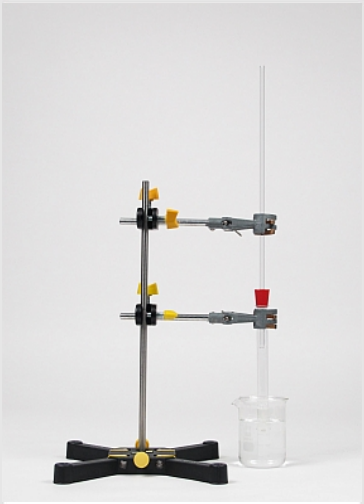

Figure 6

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 acetic acid and 3 ml 2-methylpropanol-(1), 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	1-pentanol + acetic acid			
2				

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Task 3

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How can the smell of the resulting products be described?

- pungent
- fruity
- rotten
- spicy

Task 4

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What role does sulphuric acid play in the reaction?

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

Check

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Task 5

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Reaction equation

Formulate the two reaction equations.

Acetic acid-2-methyl-propyl-1-ester
Acetic acid pentyl ester
Sulphuric acid
Ethanoic acid
1-Pentanol
Oxygen
Water

Test tube 1

____ + Acetic acid -> ____ + ____

Test tube 2

2-Methylpropanol-(1) + ____ -> ____ + ____

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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