Esters of various alkane acids (Item No.: P7173100)

Curricular Relevance

Area of Expertise: Chemie
Education Level: Klasse 7-10
Topic: Organische Chemie
Subtopic: Sauerstoffhaltige organische Verbindungen
Experiment: Ester verschiedener Alkansäuren

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

alkane acids, reaction behaviour of alkane acids, esters

Task and equipment

Information for teachers

Learning objectives

- Carboxylic acids undergo acid-catalyzed reactions with alcohols under the formation of esters.
- Variations of the reactants allow the production of various olfactory components, which can be used as identical-to-natural aromas.

Notes on setup and procedure

Preparation:
Make sure that hot water of about 90 °C is available.
Have an eyewash bottle ready.

Remarks on the students experiments:
When insufficient working room in the fume hood is available, the nuisance caused by the smell can be minimized by previously portioning the butyric acid. The alcohol-acid mixture should weakly boil during most of the length of the experiment. As propionic acid and butyric acid have correspondingly higher boiling points than acetic acid, boiling water must possibly be added during the experiment.
The esters which are formed must on no account be subjected to a taste test!

Hazard and precautionary statements

Butyric acid:	
H314:	Causes severe skin burns and eye damage.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P309 + P310:	IF exposed or you feel unwell: Immediately call a POISON CENTER or doctor/physician.
Ethanol:	
H225:	Highly flammable liquid and vapour.
P210:	Keep away from heat/sparks/open flames/hot surfaces – No smoking.
Propionic acid:	
H226:	Flammable liquid and vapour.
H314:	Causes severe skin burns and eye damage.
P210:	Keep away from heat/sparks/open flames/hot surfaces – No smoking.
P241:	Use explosion-proof electrical/ventilating/light/…/equipment.
P303 + P361 + P353:	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P405:	Store locked up.
P501:	Dispose of contents/ containers to be collected by a licensed contractor in accordance with national and local regulations.
Sulphuric acid:	
H314:	Causes severe skin burns and eye damage.
H290:	May be corrosive to metals.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301 + P330 + P331:	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P309 + P310:	IF exposed or you feel unwell: Immediately call a POISON CENTER or doctor/physician.

Hazards

- The used alcohols are highly inflammable. Extinguish all open flames!
- Sulphuric acid is highly corrosive! Propionic acid and butyric acid are corrosive! Wear protective glasses! Wash splashes off the skin with copious water!
- Propionic acid and butyric acid have an unpleasant smell. Carry out the experiment in the fume hood!
- To make glass/rubber connections, wet the glass with glycerol so that it can be easily inserted!

Notes

When short-chain alcohols are esterified with short-chain carboxylic acids, flavouring materials are obtained with fruit-like smells. When they are esterified with aromatic acids, flavouring materials are obtained with a plant or flower-like character.

Remarks on the method

The experiment is particularly suitable for work in groups. It can be carried out together with the previous one (P7173100).

Waste disposal

- Neutralize the contents of the beakers with NaOH pellets and pour them into the container for combustible organic substances.

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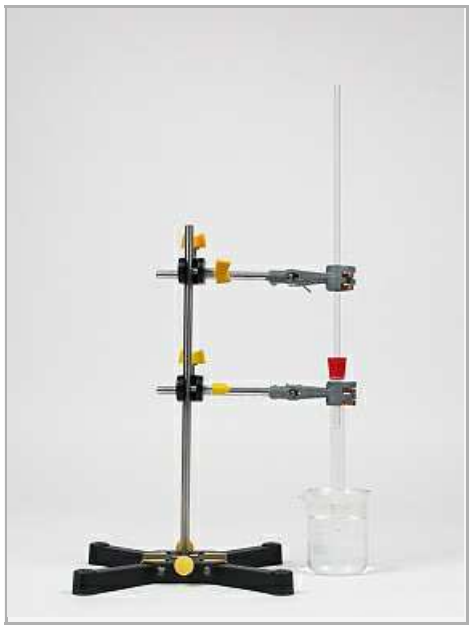
Task and equipment

Task

How do esters change with variation of the carboxylic acid and the alcohol?

Cause various alcohols to react with various carboxylic acids.



Equipment

Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
3	Glass beaker DURAN®, short, 150 ml	36012-00	2
4	Protecting glasses, clear glass	39316-00	1
5	Boss head	02043-00	2
6	Universal clamp	37715-00	2
7	Test tube brush w. wool tip,d25mm	38762-00	1
8	Glass tube,straight,400 mm,8 mm	64132-00	1
9	Test tube, 180x18 mm,100pcs	37658-10	(2)
10	Wash bottle, 250 ml, plastic	33930-00	1
11	Pipette with rubber bulb	64701-00	1
12	Test tube rack for 12 tubes, holes d= 22 mm, wood	37686-10	1
13	Rubber stopper, d = 22/17 mm, 1 hole	39255-01	1
14	Graduated cylinder, 10 ml, plastic	36636-00	1
15	Glass beaker DURAN®, short, 250 ml	36013-00	1
16	Rubber gloves, size S (7)	39325-00	1
	Ethanol extra pure ab.95% 1000 ml	30008-70	1
	N-butyric acid 100 ml	30047-10	1
	Glycerol, 250 ml	30084-25	1
	Sulphuric acid, 95-98% 500 ml	30219-50	1
	Water, distilled 5 l	31246-81	1
	Propionic acid, 500 ml	31753-50	1
	Boiling beads, 200 g	36937-20	1

Set-up and procedure

Set-up

Hazards

- The used alcohols are highly inflammable. Extinguish all open flames!
- Sulphuric acid is highly corrosive! Propionic acid and butyric acid are corrosive! Wear protective glasses! Wash splashes off the skin with copious water!
- Propionic acid and butyric acid have an unpleasant smell. Carry out the experiment in the fume hood!
- To make glass/rubber connections, wet the glass with glycerol so that it can be easily inserted!




Setup

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

Fig. 1

Put about 3 ml of propionic acid and 3 ml of ethanol (Fig. 2) in the test tube and add 3 boiling stones. Pipette in 10 drops of concentrated sulphuric acid (Fig. 3) at the center of the mouth of the test tube so that they do not contact the walls of the test tube.

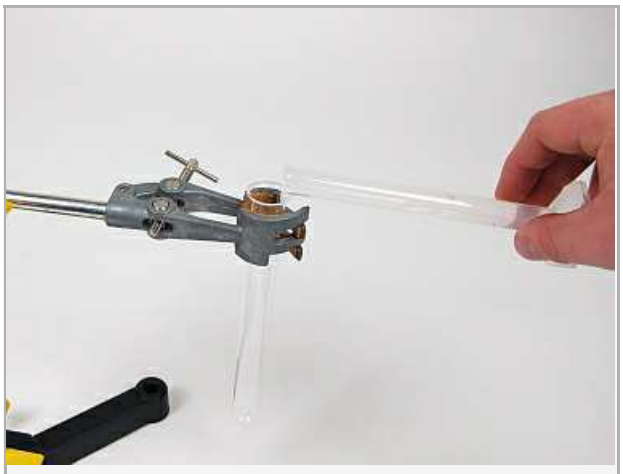


Fig. 2

Fig. 3

Carefully ease one end of the glass tube under turning through the stopper (wet with glycerol). Let the other end of the glass tube rest on the bench as much as possible while doing this (Fig. 4). Close the test tube with the stopper and secure the glass tube with a loose hold in the upper universal clamp (Fig. 5).

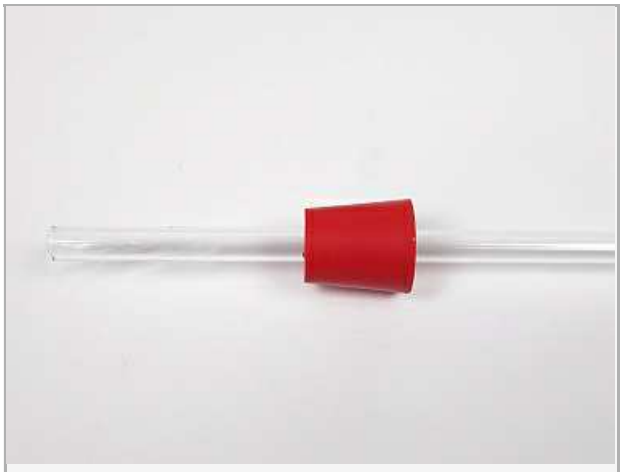


Fig. 4

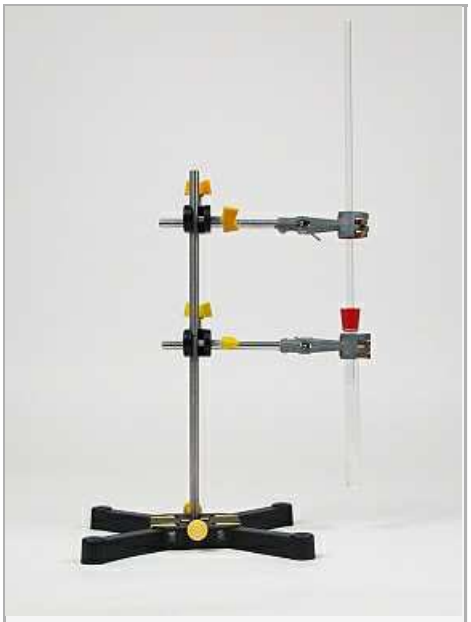


Fig. 5

Procedure

Half-fill the large beaker with water as hot as possible. Lower the test tube carefully into the hot water (Fig. 6).

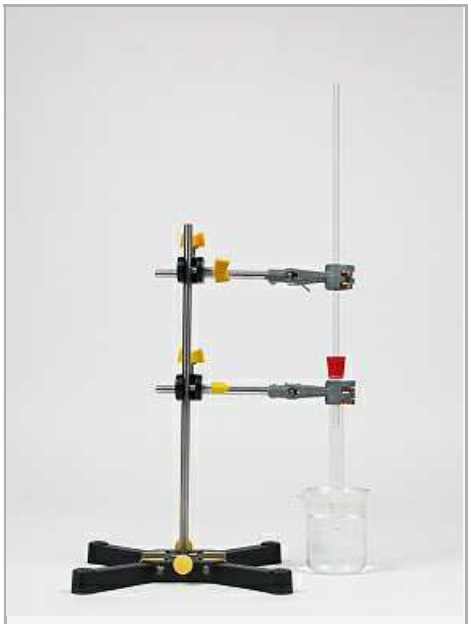


Fig. 6

Allow the mixture to boil for about 5 minutes, refilling the hot water if the boiling stops. Move the test tube up and allow it to cool.

Half-fill the small beaker with distilled water and pour the cooled mixture into it (Fig. 7).

Fig. 7

Fill 3 ml of butyric acid and 3 ml of ethanol into the second test tube and repeat the procedure above with this mixture.

Waste disposal

- Neutralize the contents of the beaker, then pour them into the container for combustible organic substances.

Report: Esters of various carboxylic acids

Result - Observations 1

Note the observations you make in general form.

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Result - Observations 2

Carefully test the smell of the formed products.

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Evaluation - Question 1

Draw conclusions from your observations.

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Evaluation - Question 2

Formulate the equations for both reactions, taking into consideration, that the added sulphuric acid only had a catalytic function.

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Evaluation - Question 3

Enter the results in the table.

Test tube	Content	Name of the ester	Formula	Smell
1	Ethanol + propionic acid	propionic acid ethyl ester [1]	$C_2H_5C\text{-}OO\text{-}C_2H_5$ [1]	peach
2	Ethanol + butyric acid	butyric acid ethyl ester [1]	$C_3H_7C\text{-}OO\text{-}C_2H_5$ [1]	apple

Evaluation - Question 4

Name uses of esters.

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