

Appendix 2

## 28. Some reactions of alcohols – Student Sheet













In these experiments you will be introduced to some of the reactions of the alcohol functional group.

### Intended lesson outcomes

By the end of this practical you should be able to recall the:

- combustion reaction of alcohols;
- reaction of alcohols with sodium;
- oxidation of ethanol to ethanal and ethanoic acid;
- dehydration of alcohols to alkenes;
- reaction of alcohols with carboxylic acids to form esters.

### Safety

	You must wear eye protection throughout these experiments.
	Alcohols are <b>highly flammable</b> .
	Sodium is <b>corrosive</b> ,
	<b>highly flammable</b> , and undergoes a <b>violent reaction with water</b> .
	Fumes from burning sodium are <b>highly irritant</b> .
	Sodium dichromate(VI) is <b>highly toxic</b>
	<b>and irritant</b> .
	Dilute sulphuric acid ( $1 \text{ mol dm}^{-3}$ ) is <b>irritant</b> . Bromine water is <b>harmful</b> and <b>irritant</b> .
	Dilute, acidified aqueous potassium manganate(VII) is <b>harmful</b>
	and <b>oxidising</b>
	and <b>dangerous to the environment</b>
	Concentrated sulphuric acid and glacial ethanoic acid are <b>corrosive</b> .

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### **Experiment 1. Combustion**

Place about 1 cm<sup>3</sup> of ethanol on a watch glass and ignite with a lighted spill. Record your observations.

#### **Question**

- 1 Write an equation for this reaction.

### **Experiment 2. Reaction with sodium**

Put 1 cm<sup>3</sup> of ethanol in an evaporating basin. Add to this a very small piece of sodium, the size of a rice grain. Record what you observe. Take great care not to allow sodium to come into contact with any water. Ensure all the sodium has reacted before you wash out the evaporating basin.

#### **Questions**

- 2 (a) The gas that comes off from this reaction is hydrogen and the other product is sodium ethoxide (C<sub>2</sub>H<sub>5</sub>O<sup>-</sup>Na<sup>+</sup>). Write a balanced equation for the reaction of sodium with ethanol.  
(b) Write an equation for the reaction of sodium with water.

### **Experiment 3. Oxidation of ethanol**

Put 3 cm<sup>3</sup> of dilute sulphuric acid in a boiling tube and add a few drops of sodium dichromate(VI) solution. Add five drops of ethanol. Heat the mixture very gently until it just boils. Cautiously note the smell. Also record any colour change.

The experiment can be repeated with propan-2-ol and 2-methylpropan-2-ol.

#### **Questions**

- 3 (a) What does the colour of the solution suggest about what has happened to the dichromate(VI) ion?  
(b) The new organic compound produced by heating ethanol is ethanal. The ethanal can be oxidised further to ethanoic acid. In the experiment you have done, this did not happen because the ethanal boiled off as soon as it was produced. What apparatus could be used to ensure the ethanal stays in contact with the oxidising agent?

### **Experiment 4. Dehydration of ethanol**

1. Put ethanol in a test tube to a depth of 2 cm.
2. Use a stirring rod to push in some ceramic fibre, so as to soak up the ethanol.
3. Add aluminium oxide granules to the middle of the tube.
4. Heat the aluminium oxide strongly. Very occasionally, flick the flame onto the ceramic fibre, but only enough to ensure a steady stream of bubbles (figure 28.2).

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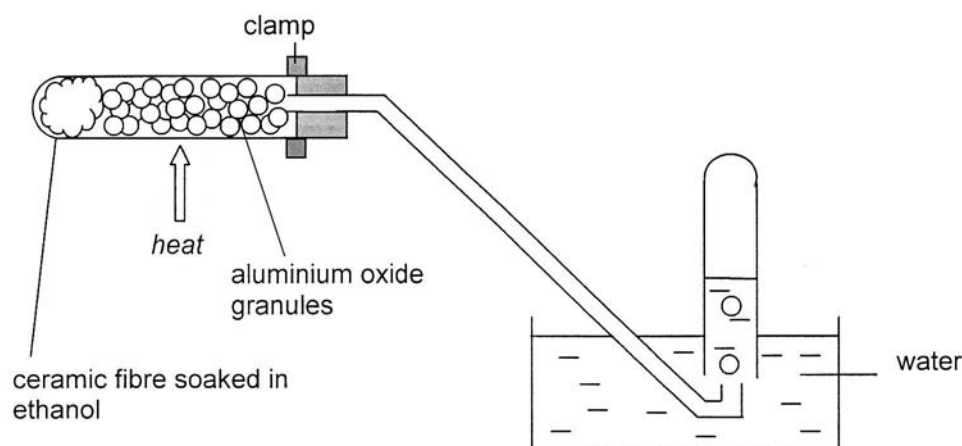


Figure 28.2

5. Discard the first test tube of gas collected and then collect three tubes of gas. Seal each with a bung.
6. Lift the whole apparatus out of the water to avoid suck-back as soon as you stop heating.
7. Light one tube of gas and record your observation.
8. Add two drops of dilute (pale yellow) bromine water to the second tube and shake gently. Record what you see.
9. Add two drops of very dilute (pale pink), acidified potassium manganate(VII). Note the change of colour.

**Questions**

- 4 (a) Why is the first test tube of gas discarded?
- (b) What is the identity of the gas tested?
- (c) Write an equation for the dehydration of ethanol.

**Experiment 5. Ester formation**

In a test tube, make a mixture of 10 drops of ethanol, 5 drops of glacial ethanoic acid and 3 drops of concentrated sulphuric acid. Put hot (recently boiled) water into a 250 cm<sup>3</sup> beaker and warm the mixture for 5 minutes. Pour the liquid into about 20 cm<sup>3</sup> of sodium carbonate solution. This will neutralise any remaining acid and allow you to smell the sweet aroma produced by the ester.

**Question**

- 5 The ester produced is ethyl ethanoate (CH<sub>3</sub>COOC<sub>2</sub>H<sub>5</sub>) and the formula for ethanoic acid is CH<sub>3</sub>COOH. Write a balanced equation for this esterification reaction.

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### 28. Some reactions of alcohols – Teachers' Notes

These experiments introduce students to some reactions of the alcohol functional group.

#### Learning outcomes

These are printed on the Student Sheet.

#### A suggested approach

Ensure at the outset that students understand that they are going to do five experiments that are potentially hazardous. Take them through the various hazards associated with each of the compounds they are going to use. The experiments are perfectly safe if instructions are followed carefully and if students stick to the volumes suggested.

The questions on the Student Sheet are designed to make students consider the reactions that they observe. The practical session could be followed by a theory lesson explaining what they have observed.

#### Technical information

Requirements per student/group:

Ethanol  
Sodium (the size of a rice grain)  
Sodium dichromate(VI)  $0.1 \text{ mol dm}^{-3}$   
Dilute sulphuric acid ( $1 \text{ mol dm}^{-3}$ )  
If desired, propan-2-ol and 2-methylpropan-2-ol  
Aluminium oxide granules – 10 g  
Ceramic fibre  
Bromine water ( $0.04 \text{ mol dm}^{-3}$ )\*  
Very dilute, acidified potassium manganate(VII) solution –  $\text{KMnO}_4(\text{aq})$   $0.001 \text{ mol dm}^{-3**}$   
**(harmful and oxidising)**  
Concentrated sulphuric acid  
Glacial ethanoic acid  
Sodium carbonate solution – a spatula measure in  $20 \text{ cm}^3$  water  
Supply of hot (recently boiled) water for water baths  
Evaporating basin  
Dropper pipettes  
 $250 \text{ cm}^3$  beaker  
 $100 \text{ cm}^3$  beaker  
 $10 \text{ cm}^3$  measuring cylinders  
Hard glass test tubes  
Hard glass boiling tubes  
Test-tube rack  
Delivery tube with bung, preferably fitted with a Bunsen valve (see below)

\*The concentration does not have to be accurate but the solution should be a pale yellow colour.

\*\* The concentration does not have to be accurate but the solution should be a pale pink colour.

#### Safety

The main points are included on the Student Sheet but it is the teacher's responsibility to ensure that a full risk assessment is carried out prior to the practical session. As for practical 25, using a Bunsen valve minimises the risk of suck-back. However, this can still occur, so always warn students to remove the delivery tube

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from the water if the rate of production of bubbles slows. Keep checking that melted bungs do not block the delivery tube as an explosion could occur. MSDS sheets should be consulted so that the correct action can be taken in event of a spillage and/or accident.

### Answers to questions on the Student Sheet

- 1  $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$
- 2 (a)  $2\text{C}_2\text{H}_5\text{OH} + 2\text{Na} \rightarrow \text{C}_2\text{H}_5\text{O}^-\text{Na}^+ + \text{H}_2(\text{g})$   
 (b)  $2\text{Na}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{H}_2(\text{g})$
- 3 (a) The dichromate(VI) ion has been reduced from  $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$  (orange) to  $\text{Cr}^{3+}(\text{aq})$  (green/blue).  
 (b) Reflux apparatus, i.e. a condenser fitted to a pear-shaped flask, could be used.
- 4 (a) The first test-tube of gas contains mostly air.  
 (b) Ethene.  
 (c)  $\text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
- 5  $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \rightarrow \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$