Appendix 2

# 25. Cracking hydrocarbons – Student Sheet

This experiment introduces you to the industrially important cracking reactions. Without them we would not be able to produce many of the organic chemicals on which we rely. We would also not be able to use most of the larger hydrocarbon molecules in crude oil.

### Intended lesson outcomes

By the end of this practical you should:

- understand the importance of cracking large hydrocarbon molecules to produce more useful alkanes and alkenes of smaller $M_r$;
- have continued to develop manipulative and observational skills.

### Background information

The demand for petrol is greater than the amount produced by distilling crude oil. Large hydrocarbon molecules do not have much commercial use and these can be cracked to produce smaller molecules that can be converted into petrol. The other molecules that are produced in this reaction are hydrocarbon molecules called alkenes. These are very important in the synthesis of thousands of organic chemicals on which the world relies. The smallest alkene molecule is ethene and this is likely to be one of the alkenes present following a cracking reaction.

The cracking reaction you are going to perform uses a catalyst. The catalyst is able to hold hydrocarbon molecules on its surface until they are literally shaken apart as the C-C bonds break.

### Safety

| | |
|---|---|
| | You must wear eye protection throughout this experiment. |
| | Bromine water is **harmful and irritant**. |
| | Dilute, acidified aqueous potassium manganate(VII) is **harmful**<br>and **oxidising**<br>and **dangerous to the environment.** |

Do not allow the water to suck back or the hot test tube will shatter. Using a Bunsen valve makes suck-back less likely.

### Procedure

1. Add a depth of 2 cm of liquid alkane to a test tube and gently push down some mineral fibre using a stirring rod, allowing the complete absorption of the alkane.
2. Set up the apparatus as shown in Fig. 25.1.

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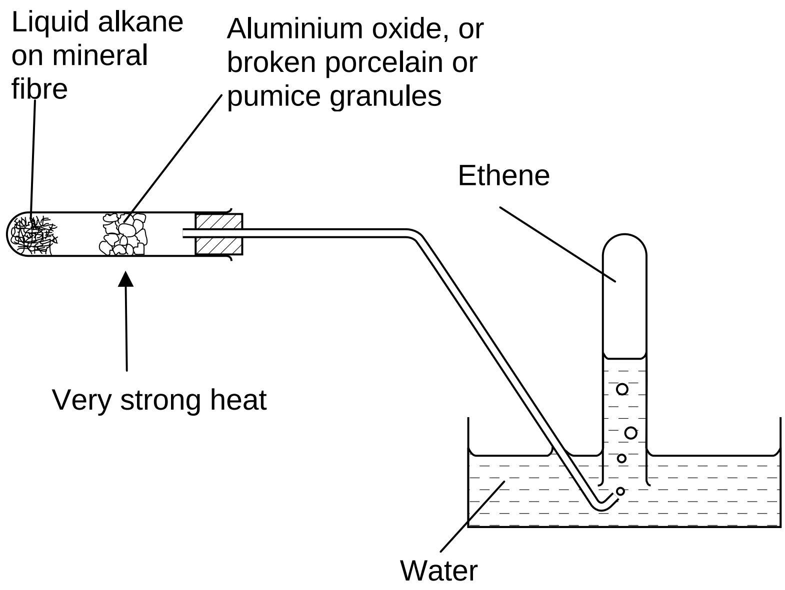


**Figure 25.1**

3. Heat the aluminium oxide (or broken porcelain/pumice granules) strongly for a few minutes, but be careful not to melt the rubber bung. Just flick the Bunsen flame onto the mineral fibre to ensure you collect a steady stream of bubbles.
4. Discard the first test tube of gas collected, then fill three test tubes with the gas coming off and stopper them.
5. As soon as the number of bubbles slows down, remove the apparatus from the water to avoid water being sucked up the delivery tube and cracking the hot test tube.
6. Carry out the following tests and record your results:
   (a) What does the gas look like?
   (b) What does the gas smell like?
   (c) Use a lighted spill to see if the gas burns.
   (d) Add two or three drops of dilute, aqueous bromine (the colour should be pale yellow) and shake. What do you observe?
   (e) Add two drops of very dilute (pale pink), acidified potassium manganate(VII). Note the change of colour.

**Questions**

**1** Why do you need to discard the first test tube of gas collected?

**2** Does the gaseous alkene product have the same properties as alkanes?

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# 25. Cracking hydrocarbons – Teachers' Notes

This experiment introduces students to the industrially important cracking of hydrocarbons to produce smaller alkanes and alkenes.

### Learning outcomes

These are printed on the Student Sheet.

### A suggested approach

Explain that crude oil is a mixture of many hydrocarbons. The gasoline fraction is used for petrol but the gasoline fraction on its own is not enough. Typically about 40% of the output of a distillation column may be required as petrol and this is why heavier fractions containing larger hydrocarbon molecules are cracked.

Students do not require foreknowledge of the properties of alkenes and this is a good linking experiment to the properties of alkanes.

### Technical information

Requirements per student/group:

Liquid paraffin or decane
Bromine water (0.04 mol $dm^{-3}$)* **(harmful and irritant)**
Very dilute, acidified potassium manganate(VII) solution – $KMnO_4$(aq) 0.001 mol $dm^{-3}$** **(harmful and oxidising)**
Aluminium oxide granules, or broken porcelain chips or pumice granules
Hard glass test tube or hard glass boiling tube
Delivery tube with bung, preferably fitted with a Bunsen valve (see below)
Three test tubes to collect the gas
Trough or bowl

*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. MSDS sheets should be consulted so that the correct action can be taken in event of a spillage and/or accident.

A Bunsen valve can be fitted onto the end of the delivery tube (Fig. 25.2).

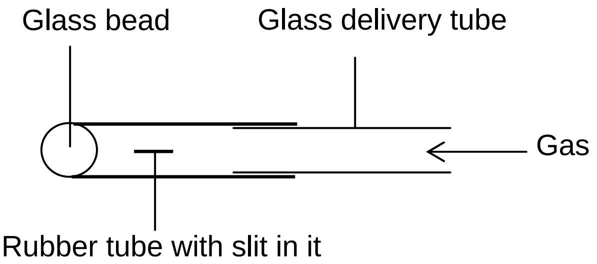


**Figure 25.2** A Bunsen valve

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Gas passes through the slit from the inside into the collection tube, but if the pressure drops inside the delivery tube, the sides of the slit are pushed together so water cannot enter. However, even with a Bunsen valve fitted, suck-back can still occur so always warn students to remove the delivery tube 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.

**Answers to questions on the Student Sheet**

**1** The first test tube will contain mostly air.

**2** The appearance is a colourless gas but the reaction with bromine water is an instant decolourisation due to the presence of the double bond.