Drinking Alcohol

Contents: Practical work, reading and questions on alcohol and its effects on the body.

Time: 2 periods or more, depending on amount of discussion.

Intended use: GCSE Chemistry, Biology and Integrated Science. Links with work on ethanol and other alcohols in Chemistry, and work on nerves, absorption and the liver in Biology.

Aims:

- To complement prior work on ethanol, nerves, absorption and the liver (though it is not necessary to have covered all of these)
- To develop awareness of the effects of alcohol on the body
- To develop awareness of the dangers of alcohol abuse, and guidelines for safe drinking
- To provide opportunities to practise skills in reading, comprehension and application of knowledge, and certain practical skills.

Requirements: Students' worksheets No. 203. For practical work requirements in Part 1, see below.

Students may be introduced to the problems of alcohol abuse in other parts of the school curriculum, but it is also helpful to consider them in a scientific context.

The unit is in three parts:

Part 1 How much alcohol is in a drink?
Part 2 What does alcohol do to your body?
Part 3 Safe drinking.

Part 1

In this part, students make measurements which give them a clear idea of the quantities of alcohol present in a typical drink. In each case, the volume of pure alcohol present is approximately 10cm^3, or a little more. Later, in Part 3, this will be identified as a 'unit' of alcohol.

Requirements

Each group of students will require:

measuring cylinder (100cm^3 or 250cm^3)
evaporating basin or other heatproof dish of at least 100cm^3 capacity
heatproof mat

access to:

half-pint beer glass
wine glass
small sherry glass
spirits measure, or glass marked off with the correct measure (a single measure of spirit is about 25cm^3)
laboratory alcohol

Burning one 'unit' of alcohol gives a striking demonstration of the energy stored in this chemical. When alcohol is metabolized in the liver, this energy is either used in exercise, or stored as fat.

For the teacher's information, ethanol is metabolized in the liver by oxidative enzymes, first to ethanol, then to ethanoic acid. Ethanoic acid is then oxidized to carbon dioxide and water by normal biochemical routes. Methanol is also oxidized in the liver, but the methanoic acid so formed is toxic and cannot be removed by further oxidation.

Caution:
The teacher may prefer to demonstrate the burning of alcohol. A heatproof dish *must* be used, standing on a heatproof mat. Alcohol burns with a non-luminous flame, and care must be taken to avoid contact with the flame. Care must also be taken to avoid spills of alcohol, which might ignite on the bench.

If time permits, the concentrations of alcohol in the different drinks could actually be measured, using a relative density method.

A hydrometer can be used if available, or a home-made hydrometer can be contrived using a glass tube of about 1cm diameter and about 25cm in length, closed with a rubber bung at one end.

The hydrometer is first calibrated by floating in alcohol solutions of different concentrations and marking the liquid level on the hydrometer with a waterproof and alcohol-proof pen. Suggested concentrations of alcohol solution are: 8%, 16%, 32%, 48%, 96% by volume.

The calibrated hydrometer can then be used to estimate the alcoholic concentration of different drinks. The results are, of course, only approximate because sugar and other substances are dissolved in the drink as well as alcohol.

Part 2

This part gives a very simple physiological background to the effects of alcohol. The mechanism of the effect of alcohol on the nervous system is highly complex, and far from being well understood. Nevertheless, the idea to get across is that alcohol interferes with the transmission of nervous impulses. It is thought that alcohol has a particular effect on inhibitory nerve cells. These control the excitation of impulses which, unchecked, would lead to unrestrained behaviour and abnormal muscle stimulation. Hence the observed effect of alcohol in making people less inhibited.

Part 3

Here the idea of counting alcohol units is introduced. It is very difficult to quantify the effects of alcohol, since they vary so much according to weight, sex and tolerance. However, the figures in the table below may be useful to the teacher.

Blood alcohol level /mg per 100cm^3	Corresponding number of alcohol units for an average male	Effect
30	2	Increased sociability; feeling of well being; loss of inhibition
60	4	Some loss of muscular control; loss of reasoning
90—100	6—7	Marked loss of muscular control
200—300	14—20	Semi-consciousness or unconsciousness
500	33	Probably death

Other resources

1 A useful booklet, *That's the Limit — a Guide to Sensible Drinking* is produced by the Health Education Council (78 New Oxford Street, London WC1H 1AH). Available free.

2 The Teachers Advisory Council on Alcohol and Drugs Education have a range of resources, including alcohol education syllabuses for 11- to 16- and 16- to 19-year-olds. Details from TACADE, 2 Mount Street, Manchester M2 5NG.

3 The Schools Council/Health Education Council Project, 'Health Education', published by Forbes Publications, includes a useful treatment of alcohol.

4 A number of 'trigger' films on alcohol are available on free loan from The Central Film Library, Chalfont Grove, Gerrards Cross, Bucks.

Acknowledgements Figure 2 supplied by Whitbread; Figure 5 by the Metropolitan Police.

DRINKING ALCOHOL

The substance chemists call ethanol is a member of a family of compounds called the alcohols. All alcohols have the O-H group of atoms in their molecules. The structure of a molecule of ethanol is shown in Figure 1. In common, everyday language, ethanol is just called 'alcohol'.

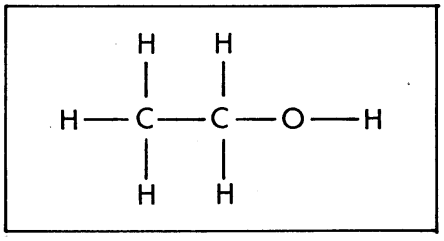

Figure 1 A molecule of ethanol

People have been drinking alcoholic drinks for thousands of years. Alcohol can give people a lot of pleasure, but it also causes a lot of sadness, illness and even death. In this unit you will find out more about alcohol, what it does to your body and how to use it safely.

This unit is in three parts:

Part 1 How much alcohol is in a drink?
Part 2 What does alcohol do to your body?
Part 3 Safe drinking.

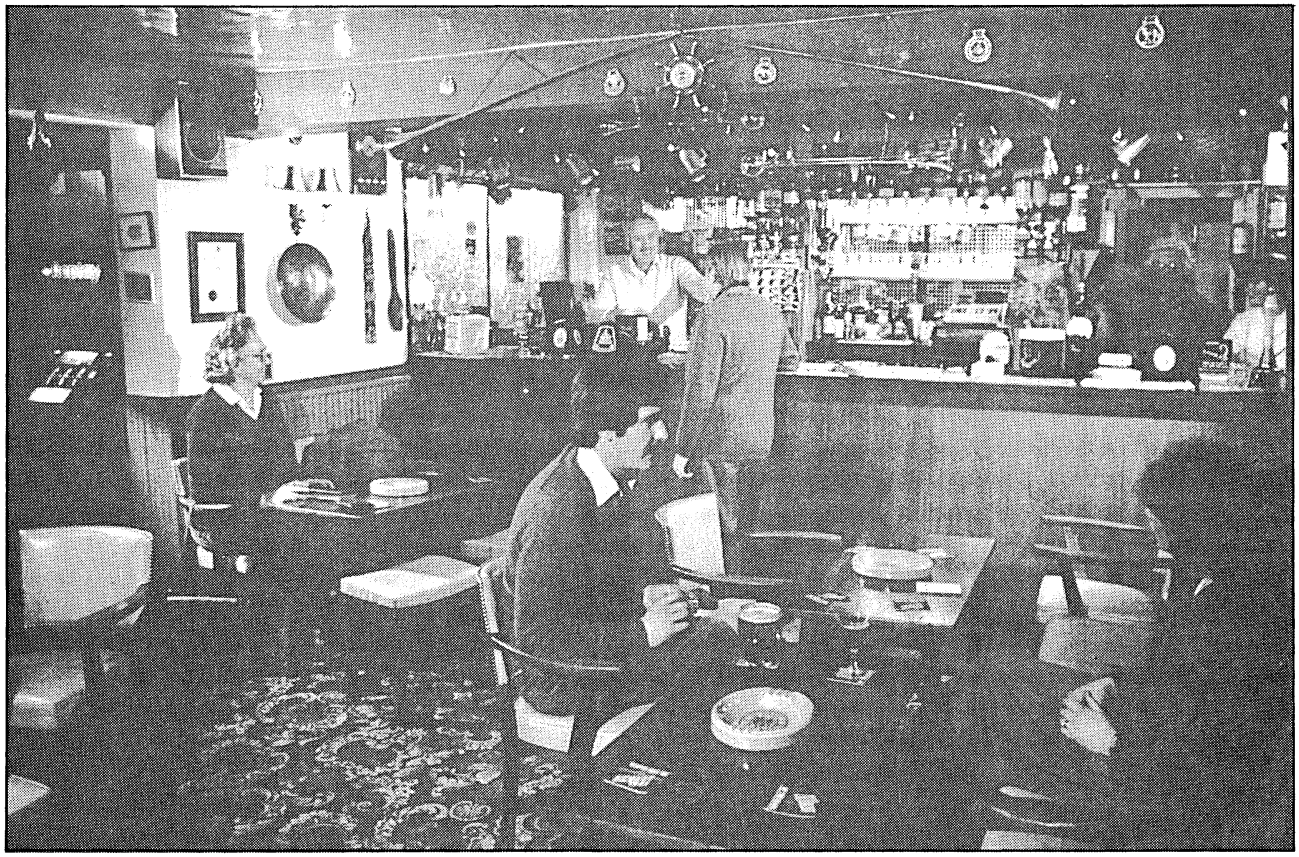

Figure 2 The sociable atmosphere of the local pub

Part 1 How much alcohol is in a drink?

Different drinks contain different amounts of alcohol. Many people drink without knowing how strong their drink is. In this activity you will be finding out the amount of alcohol in different drinks.

You will need

measuring cylinder (100cm^3 or 250cm^3)
evaporating basin or other heatproof dish of at least 100cm^{3}capacity
heatproof mat

access to:
half-pint beer glass
wine glass
small sherry glass
spirits measure, or glass marked off with the correct measure (a single measure of spirit is about 25cm^3)
laboratory alcohol

What you do

A Copy out the table below.

Drink	*Percentage of alcohol in the drink*	*Volume of drink*	*Volume of alcohol in the drink*
Beer (half pint)	4		
Wine (one glass)	10		
Sherry (one small glass)	20		
Spirit — whisky, gin or vodka (single measure)	40		

B Collect one of the glasses and measure the volume of drink, in cm^3, that it holds. You can do this by finding the volume of water needed to fill the glass. Enter the result in the 'Volume of drink' column.

C Repeat this for the other glasses.

D You have now found the volume, in cm^3, of each of the four drinks. All drinks are a mixture of water, alcohol and other substances.Calculate the *volume of pure alcohol* in each drink. You can do this using the 'Percentage of alcohol in the drink' figures in the table. Enter your results in the last column of the table.

E To get an idea of what these amounts of alcohol look like, try measuring it out. Choose one of the drinks in the table, and collect the appropriate glass. Using a measuring cylinder and a bottle of pure alcohol, measure out the correct volume of pure alcohol and pour it into the glass. Remember, this is the amount of pure alcohol that goes into your body every time you have the drink. Read the note on 'Alcohol you cannot drink' in the box on the next page.

F Alcohol may look like water, but it behaves very differently. For one thing it is a fuel.

Get an evaporating basin or other heatproof dish. Stand it on a heatproof mat. Pour the pure alcohol from the glass into the dish, making sure you do not spill any.

Wearing safety goggles, carefully set light to the alcohol using a burning splint. How long does it burn for? What does the flame look like?

Questions

1 *All the drinks investigated contain a similar volume of alcohol. Very roughly, to the nearest whole number, what is this volume?*

2 *David and Susan went to a party. David drank two pints of beer and a double whisky. Susan drank three glasses of wine. What volume of pure alcohol did each of them drink?*

3 *You have found that alcohol is a good fuel. In fact, it is used to fuel motor cars in some countries. When you have alcohol in your body, your body also uses it as a fuel. The oxidation of alcohol is slower in your body, but it still gives out energy. What happens to this energy if your body does not use it in exercise?*

Alcohol you cannot drink

Alcohol has many important uses apart from drinking. It is an important solvent in perfumes, paints and polishes, and of course it is a fuel.

The Government puts a tax on all alcohol sold for drinking. This raises money, and it helps to stop people drinking too much. But 'non-drinking' alcohol carries no tax, so it is much cheaper. To stop people drinking this cheap **industrial alcohol**, poisonous substances are added to it. The substance most usually added is methanol. Methanol is a member of the family of alcohols, and similar to ethanol, but it is much more poisonous. Alcohol with methanol added is called **methylated spirit.** Drinking it can make you very ill.

Sometimes methylated spirit has a coloured dye added, to put you off it even more. The alcohol used in school laboratories is methylated spirit but usually without the dye added.

Part 2 What does alcohol do to your body?

Alcohol is a drug.

Like all drugs, alcohol stops your body working properly. Taken in large quantities, it is a poison and can do permanent harm to your body. But in small quantities it does no permanent damage.

Alcohol and the nervous system

Your body is controlled by nerves. Like tiny telephone wires, nerves run all over the body, carrying messages. Your brain is a mass of nerve fibres connected together. Just as a computer depends on electrical impulses carried along conductors, your brain uses impulses sent along nerves.

There are millions of nerve fibres in the brain, and millions of connections between them. These connections are called **synapses**. Impulses are carried across synapses by messenger molecules (Figure 3).

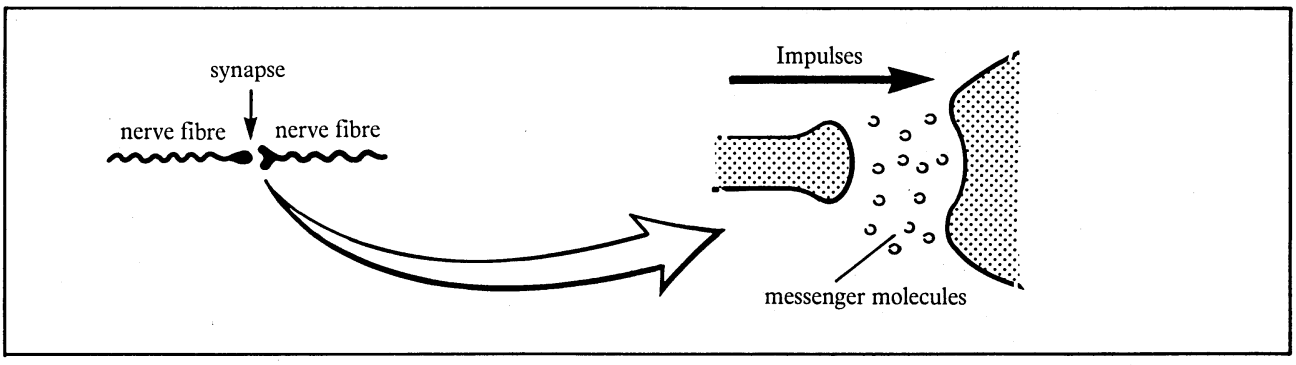

Figure 3 How nervous impulses travel across synapses.

Scientists believe that drugs like alcohol interfere with the nerves. Somehow the alcohol molecules stop the messenger molecules carrying their messages efficiently. This slows down the messages passing across synapses.

In this way, alcohol slows down the messages being sent around the body and brain. It 'damps down' the brain and nervous system, so it is called a *sedative*. In small amounts, it helps people feel less tense and worried, and it makes them more sociable. However, with the nerves sending their messages more slowly, driving and operating machinery can be dangerous.

As the amount of alcohol inside you increases, you start to lose control of your body. Your speech becomes slurred, you lose your sense of balance, and your vision becomes blurred. Very large amounts of alcohol cause unconsciouness, and eventually death.

How does your body get rid of alcohol?

After you have taken a drink, alcohol passes quickly into your bloodsteam. Alcohol molecules are small, so they are quickly absorbed through the walls of the stomach and gut. Once in the blood, alcohol is carried to all parts of your body (Figure 4).

Alcohol is removed from the blood in the liver. It is oxidized to give carbon dioxide and water, releasing energy. This is very like the oxidation of sugars during respiration. If the energy is not needed for exercise, it will be stored as fat.

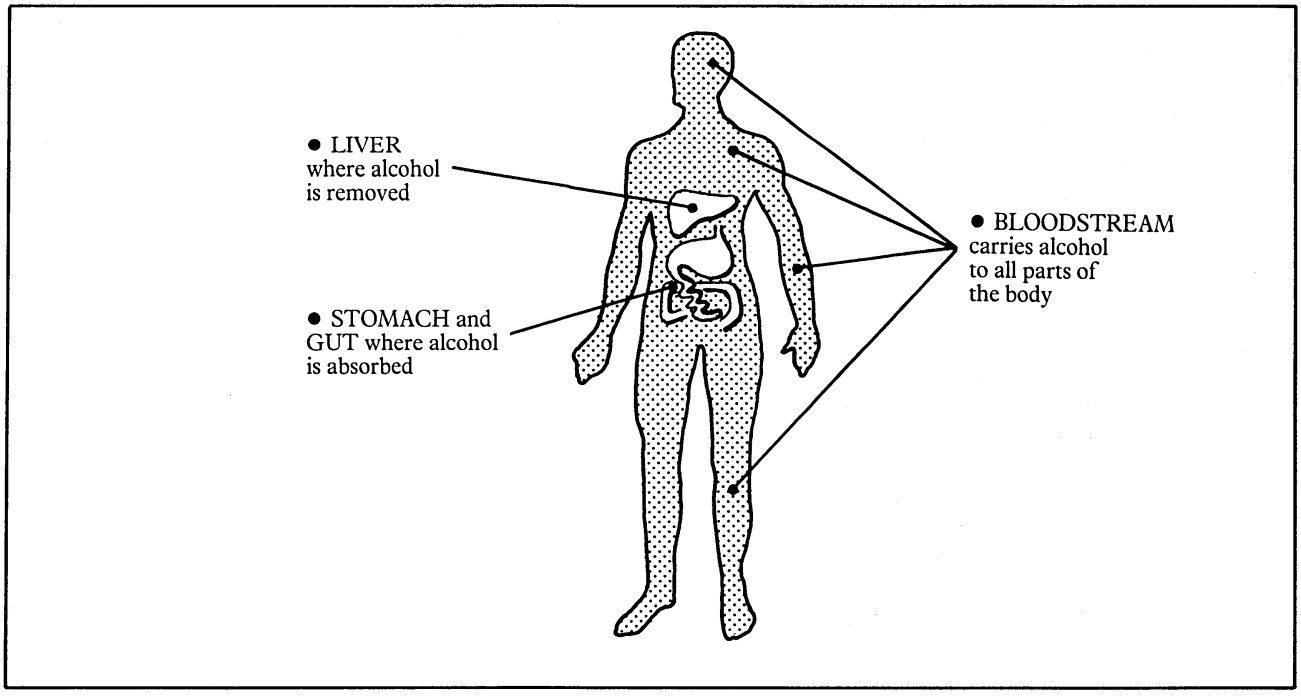

Figure 4 How alcohol gets around your body

Your liver can only deal with about $10cm^3$ of alcohol per hour. If your blood regularly has a lot of alcohol in it, the liver begins to get damaged by it. This can cause a disease called **cirrhosis of the liver**.

What other damage does alcohol do?

People who have drunk too much often wake up next day with a hangover. The headache and feeling of sickness soon wear off, but people who regularly drink too much may damage their bodies permanently. Apart from damaging the liver, alcohol can cause brain damage, stomach damage and problems with the nervous system. Excessive drinking can also cause sexual difficulties, depression and other mental problems. Some people get so they cannot manage without alcohol. They are addicted, and they are called alcoholics.

Alcohol in a pregnant woman's blood can pass into the blood of the unborn baby. When the mother drinks, the baby gets a drink too. Doctors therefore advise pregnant women not to drink alcohol at all.

Questions

4 *Drivers who have been drinking are much more likely to have accidents. This is because their reaction time is slowed down. It takes longer for them to react to information received by their eyes. Explain why.*

5 *Explain why the liver is especially likely to be damaged by heavy drinking.*

6 *Explain why alcohol makes you sleepy.*

7 *John drinks three pints of beer. How long will it take before all the alcohol has been removed from his blood by his liver? (Assume half a pint of beer contains 10cm^3 of pure alcohol.)*

Part 3 Safe drinking

Drinking and driving

Alcohol is a major cause of road accidents. The law sets a legal limit on how much you can drink if you are driving. If you have more than 80 milligrams of alcohol in every 100cm^3 of blood, you are not legally fit to drive. Police use breath tests and blood tests to check motorists' blood alcohol levels. Even when the level is just below the legal limit, you are still four times more likely to crash than when you have had no alcohol. One in three of all drivers killed in road accidents has an alcohol level over the legal limit.

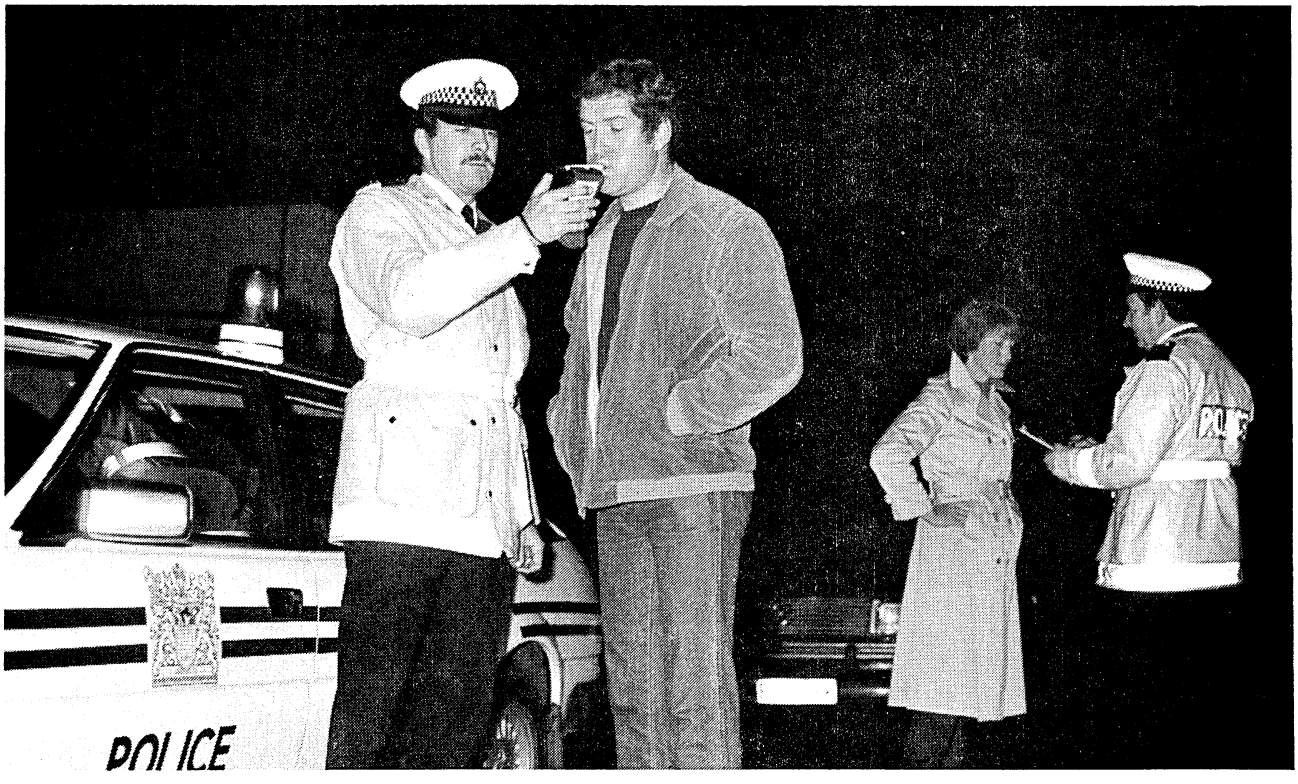

Figure 5 Police giving breath test to motorist

Counting the drinks

In Part 1 of this unit, you probably found the four drinks all contained roughly the same amount of alcohol. This is about $10cm^3$ of pure alcohol. This is sometimes called *one unit* of alcohol (Figure 6).

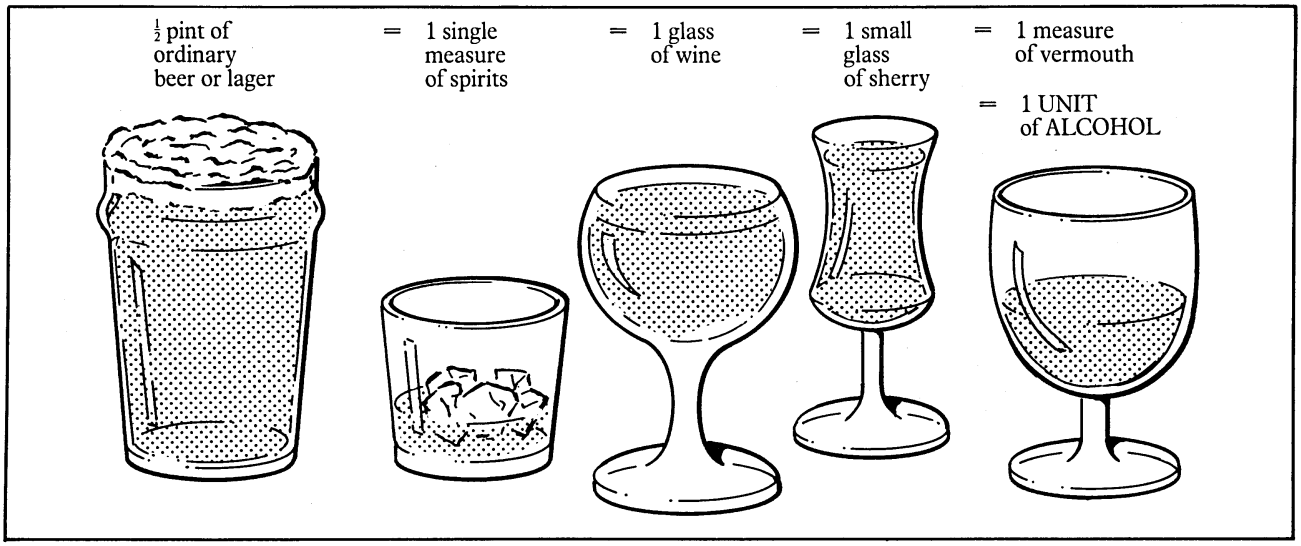

Figure 6 These drinks all contain 1 unit of alcohol

People who want to keep an eye on their drinking can count the units they have drunk. The more units of alcohol you drink, the higher your blood alcohol level becomes (Figure 7). But the blood alcohol level also depends on other factors, such as body size. Small, light people have less fluid in their bodies. This means their blood alcohol level goes up faster than for larger people.

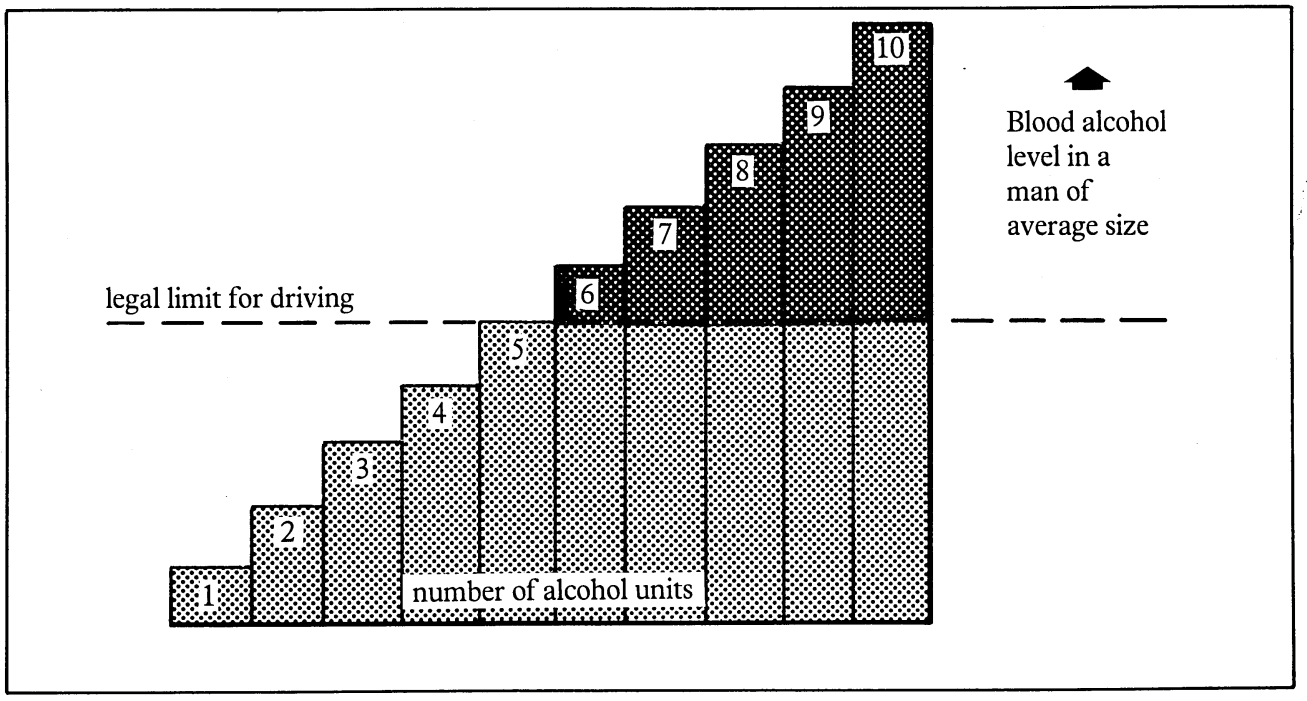

Figure 7 The effect of drinks on blood alcohol level

As Figure 7 shows, an average man reaches the legal limit for driving after about five alcohol units.

Each alcohol unit takes about an hour to get broken down in the liver. So a person who has had, say, two pints of beer will need about four hours before their blood is clear of alcohol.

How much alcohol is safe?

If you are driving or operating machinery, it is safest not to drink at all. At other times, a few units of alcohol are quite safe. In fact, many doctors believe alcohol helps people relax, and may even protect against heart attacks and high blood pressure. Certainly a few units help make you more sociable.

But regular *heavy* drinking can damage your health. Doctors say that an average man who drinks more than eight units a day is risking his health. Women tend to be affected more by alcohol than men, and for them the figure is lower — about 5 units a day.

Questions

Karen, Jane, Paul and Scott got together for a few drinks one evening. This is what each drank:

Karen: *three glasses of wine and a double vodka and tonic*
Jane: *one glass of sherry and three glasses of orange juice*
Paul: *five pints of beer*
Scott: *two pints of beer and a single whisky.*

8 *Work out how many alcohol units each had.*

9 *Who is* legally *fit to drive home?*

10 *Who is* most *fit to drive home?*

11 *How long would Paul have to wait until he is legally fit to drive home? (Assume he is an average size man.)*

12 *Suppose these people drink this amount of alcohol* every *night. What advice might their doctor give to each?*