



Above: A policeman breathalysing a motorist. The breathalyser gives an on the spot indication of whether the amount of alcohol in the driver's bloodstream is over the legal limit

GCSE key words

Alcohol
Circulatory system
Liver
Nervous system

Let us assume that someone has been stopped by the police and has given a roadside breath sample that registers positive. People giving a positive result used to be taken to a police station, where blood or urine samples were taken to measure the alcohol level accurately – how many milligrams of

Box 1 What is the legal limit?

In the UK the legal limit is as below, but in most EU countries the limits are lower.

- 80 mg of alcohol in 100 ml of blood
- 107 mg alcohol in 100 ml of urine
- 35 micrograms (μg) of alcohol in 100 ml of breath

A milligram is a thousand times smaller than a gram. A microgram is a thousand times smaller than a milligram.



Drink

Cutting down on drink driving may sound less glamorous than identifying a murderer but the truth could surprise you. As a forensic scientist, weighing up the evidence from a road accident could mean that you are doing just that. Since 1980, the British government reckons it has saved at least 20 000 lives by its high-profile campaign to cut down on drink driving.

alcohol in 100 ml of fluid. Nowadays most drivers suspected of being ‘over the limit’ (see Box 1) are taken to the police station for another breath test, this time with a *Lion Intoximeter*. This is a sophisticated piece of equipment which gives an immediate, accurate result of alcohol level in the body, so the police know straightaway if the driver is guilty.

But supposing the driver is injured and in hospital and not able to take a breath test? If this is the case, then blood or urine samples will be taken, and sent to the forensic lab for analysis. Or, there could be a delay. Perhaps the driver, in a panic, has driven home, running away from the scene (a criminal offence). He may then tell the police that he was too shocked to think straight, and although he was sober at the time of the accident, he stupidly then drank a glass of whisky to steady his nerves. The forensic scientist has to work out whether he is lying, and then possibly appear in court to explain the result.



driving

Careful calculations

It all depends on exactly how much alcohol the driver says he drank, and when. As soon as alcohol enters the stomach it starts to be absorbed into the bloodstream. It is very soluble in water and fats, so it easily diffuses through the walls of the stomach and small intestine. The small intestine is so long and folded that it has a huge surface area. A meal before drinking will slow the process down, but after an hour all the alcohol will have been absorbed, and the dilution around the body and in the vital organs will be the same everywhere. The central nervous system is affected straightaway. However, as soon as alcohol enters the body it starts to be broken down, because it is a poison (see Box 2).

The police will ask the driver many questions, and look for evidence to support everything he says. What was the time of the accident, when did he have the drink and what had he eaten beforehand? How much does he normally drink in a week? Has he any earlier convictions? Has he ever had hepatitis? The information and samples will go to the forensic scientist. Then, some careful calculations will be made.

Different drinks contain very different amounts of alcohol. The scientist will need to know how many **units of alcohol** (see Box 3 on page 18) the glass of whisky contained. The calculation for whisky is quite simple. A medium-sized glass holds about 100 ml of whisky, which is 40% vol/vol. This means that the driver claims to have drunk 40 ml of alcohol and 60 ml of flavoured water — 4 units of 10 ml altogether. By the time the police took the samples it

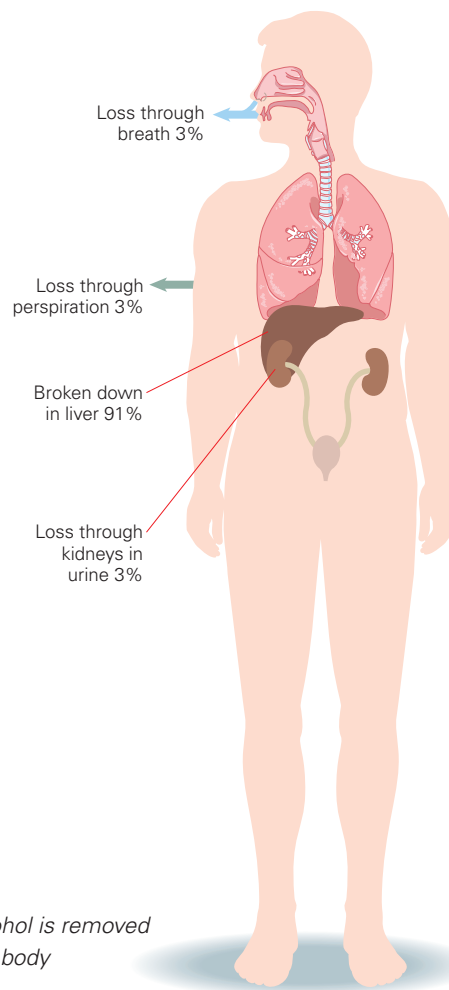


Figure 1
How alcohol is removed from the body

Above: An Intoximeter

Above left: The labels on many bottles and cans now indicate their alcohol content

On average, 3000 people in Britain are killed or seriously injured each year in drink-drive collisions.

15% of all road deaths are due to drink driving.

Some people think that strong coffee or a cold shower will help to speed up the breakdown of alcohol. This is not true — nothing you can do makes any difference.

Box 2 How does the body break down alcohol?

An enzyme, *alcohol(ethanol) dehydrogenase*, in the liver breaks down 91% of the alcohol in the body (see Figure 1). It breaks down the ethanol, C_2H_5OH in two stages into acetate which our bodies can use as a fuel. However, the breakdown can only occur at a certain rate, which is different for each person. Generally, less than 1 unit can be broken down in 1 hour. Hepatitis greatly reduces the rate of breakdown.

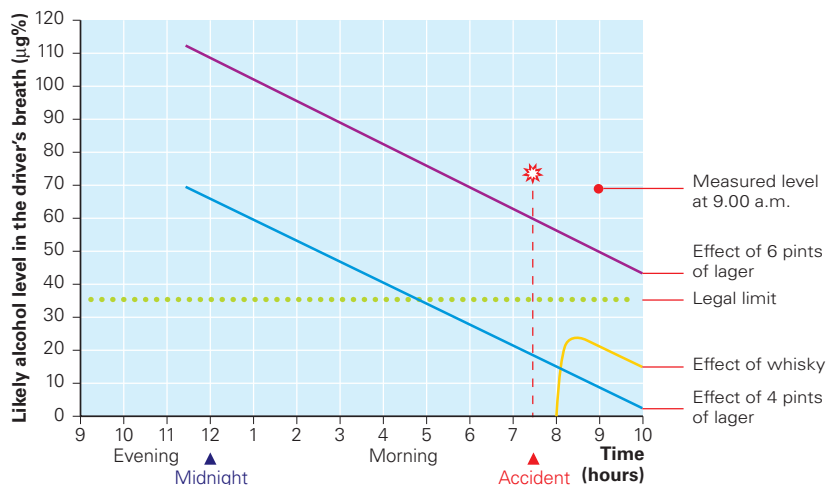


Figure 2 Alcohol level in the driver's breath for various amounts of drink. It is assumed that the driver's liver eliminates 6.5 µg% alcohol every hour

was an hour after he said he had the drink — what would have happened to the alcohol during that hour, assuming that the driver was telling the truth?

The driver's statement

The accident happened at 7.30 a.m. on his way to work. Just before leaving home, he had eaten a large breakfast of bacon and eggs. He says he drank the whisky at 8.00 a.m. and the police took samples at 9.00 a.m. The man weighed 11 stone and was fairly fit. The night before, he had been 'out for a few drinks' with his mates, but did not think he had drunk more than 4 pints of lager. He had been back home and asleep by midnight.

Box 3 How much is 1 unit of alcohol?

A **unit** of alcohol is approximately **10 ml**. People often think that a glass of wine or a half pint of lager each contain 1 unit, but this is not true. The strength of drinks and the sizes of glasses have both increased a lot since the unit was devised. Bottles and cans may be marked in ml, but pubs still serve beer in pints (1 pint = 568 ml). If you know the percentage of alcohol, and the size of the glass or can, you can work out how much alcohol was in the drink. For example:

One 440 ml can of cider, at 6% vol/vol, contains $\frac{440 \times 6}{100}$ ml alcohol = 26 ml.

This is equal to 2.6 units of 10 ml.

The effect of 1 unit of alcohol on the body depends on a wide range of factors. Women are usually lighter than men, and their bodies contain less water, so a small amount of alcohol causes a bigger concentration and effect (see Figure 3). Fatty tissue absorbs more alcohol than muscle, so fitness also makes a difference.

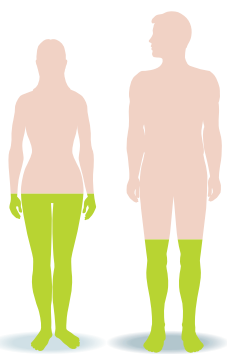


Figure 3 Level of intoxication in a 9-stone woman and an 11-stone man who have both had the same drink. The man is now only one third of the legal limit, but the woman is one half of the legal limit

Box 4 What is the sentence for drink drivers?

Drink drivers are disqualified for a minimum of 12 months and may get a £5000 fine and 6 months in prison. The endorsement on the licence lasts for 11 years. If the accident has killed someone, the fine, prison sentence and driving ban are all higher. These hefty penalties are the reason for the decrease in drink drive road deaths since 1980.

A breath test at 9.00 a.m. gave a result of 68 µg%, which is well over the limit of 35 µg%. Could this have been due to the whisky? You need to refer to Figure 2 as you read the next few paragraphs.

Forensic scientists would consult their records, and would know that in 1 hour, 4 units of alcohol from the whisky would have been completely absorbed by his body and would have caused approximately 28 µg% alcohol in the breath of an 11-stone, reasonably fit man. If his liver was normally healthy, 6.5 µg% would have already been broken down, so a result of 21.5 µg% would be expected, well below the limit. This means that 68 – 21.5 µg%, or 46.5 µg%, is unaccounted for.

Working backwards, allowing for his liver working normally, at 7.30 a.m. when the accident occurred, the amount of alcohol in his breath would have been 46.5 + (6.5 × 1.5) = 56 µg%, well above the limit. Could that have been left over from his evening out? If his memory was correct and he left the pub at 11.30 p.m., having drunk 4 pints of lager during the previous 2 hours he would have been well below the limit at 7.30 the following morning. The graph shows his body steadily eliminating the alcohol. But people 'out for a few drinks' often become confused. It is far more likely that he had 6 pints, not 4 pints. At 11.30 p.m. the concentration of alcohol in his breath would have been 112 µg%, and by 7.30 in the morning it would only have gone down to 60 µg%, still well above the limit. By 9 a.m. it would have been 50 µg%, which is close to the 46.5 µg% unaccounted for.

The outcome

If this man has an endorsement on his licence for a previous drink-driving offence, his licence will be taken away and he may get a £5000 fine and 6 months in prison (see Box 4). He is likely to lose his job if it involves driving. The forensic scientist has helped to get him off the road. A harsh sentence — but killing someone due to thoughtless behaviour is murder.

Now the police are looking at ways to combat driving under the influence of drugs. Techniques are improving all the time — maybe you could be responsible for the next major improvement?

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