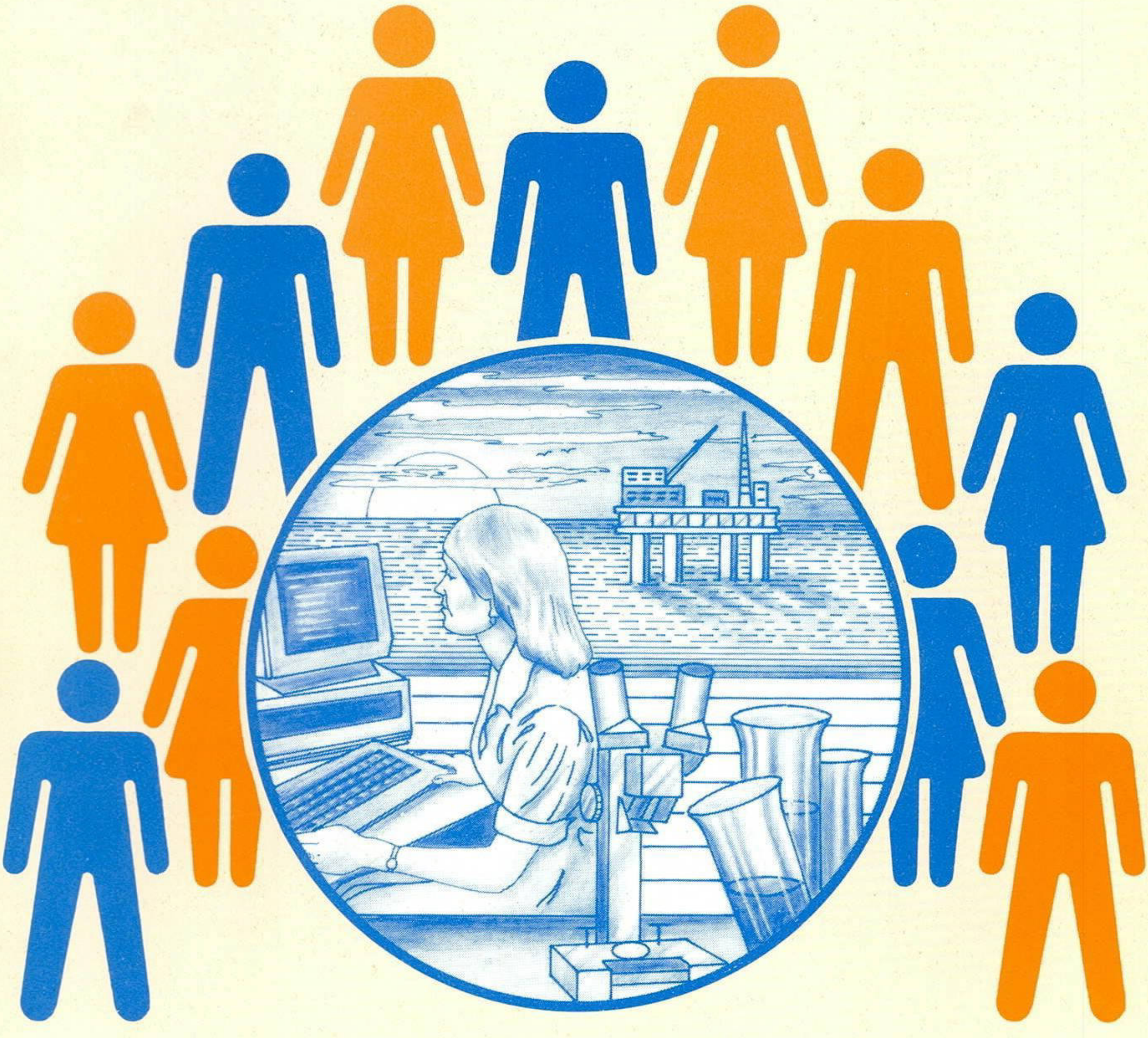
SCIENCE & TECHNOLOGY IN SOCIETY

7
& INDEX



SATIS

ABOUT SATIS

Science and Technology in Society units are designed to be used in conjunction with conventional science courses, particularly those leading to GCSE examinations. Each unit has links to major science topics as well as exploring important social and technological applications and issues.

The units are self-contained and generally require about 2 periods (around 75 minutes) of classroom time. Each unit comprises Teachers' Notes (blue sheets) and Students' materials (white sheets). Full guidance on use is given in the Teachers' Notes accompanying each unit, which also include background information and suggest further resources.

Each SATIS book contains ten units. The units are numbered in a system giving the number of the book followed by the number of the unit within that book. Thus the first unit in the first SATIS book is numbered 101.

In addition to the SATIS books, a General Guide for Teachers is available, giving guidance on some of the teaching techniques involved as well as ideas for further activities.

Many people from schools, universities, industry and the professions have contributed to the writing, development and trials of the SATIS project. A full list of contributors appears in the General Guide for Teachers.

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SATIS 7 and Index

List of units in this book

List of units in the SATIS series

Electricity in your Home

Contents: Exercises using the electricity meters in students' homes to find out about electricity consumption.

Time: Several homeworks plus 1 or 2 periods of classroom time.

Intended use: GCSE Physics and Integrated Science. Links with work on electricity, energy and power.

Aims:

- To complement and extend prior work on domestic electricity, energy and power
- To develop awareness of the daily pattern of domestic energy consumption, and its significance in relation to electricity generation
- To develop awareness of the relative costs of running different items of electrical equipment
- To provide opportunities to practise skills in observation and data analysis.

Requirements: Students' worksheets No. 701.

This unit is in two parts:

Part 1 How much electricity does your family use?
Part 2 How much electricity is used by different appliances?

The activities depend on students having electricity meters to which they can gain access in their homes. This is likely to be so in the large majority of cases. However, the teacher should be aware of the possibility that some students living in rented accommodation or mobile homes might not be able to gain access to a meter. Some homes may have coin-in-slot meters, but these can be read in just the same way as ordinary meters.

Students with dial meters may have some difficulty reading them at first, particularly since adjacent dials revolve in opposite directions. It is also sometimes difficult to tell whether the pointer on a dial is just before or just after a number.

A few students may have economy or off-peak meters. Economy meters record night-time use of electricity on a separate scale. The reading on this scale will need to be included in the night-time consumption of electricity.

In Part 1, the meter should ideally be read at 8am, 4pm and midnight, in order to divide the day into three 8-hour periods. In practice this will not be possible, but the general pattern of consumption should nevertheless be apparent.

In Part 2, students may find it surprisingly difficult to stop the meter wheel turning completely. 'Hidden users' of electricity include electric clocks, central heating pumps and video recorders. Students should appreciate the importance of switching back on any appliances which were switched off during the activity. The advantages of making the measurements during daylight hours are considerable. Certain electrical appliances which do not consume electricity at a single uniform rate (for example, washing machines, refrigerators) may cause irregularities in the readings.

Notes on some of the questions

Q.5 The cost of electricity varies according to geographical location. 5 pence per unit is an average 1985 price, but it would be best to find the current local price from an electricity bill.

Qs 6 and 7 This is a good opportunity to discuss some of the economics of electricity generation. In general, the 'base load' is carried by the large, modern, efficient coal-fired and nuclear power stations which run continuously, and the 'peak load' by the less efficient stations which are run intermittently. To encourage the use of electricity at times of low demand, the electricity boards sell power to industry and homes at low night-time rates. For example, in 1985, Eastern Electricity charged domestic consumers on the economy tariff 2.04p a unit for the 7-hour night period compared with 5.13p by day. Consumers on the normal tariff paid 5.13p at all times, with a lower standing charge.

Q.9 The rate at which the meter turns should correlate roughly with the power rating of the appliance. For some appliances it may be difficult to find the power rating: the table below may help in this respect.

Appliance	*Typical power rating/W*
Immersion heater	3000
Vacuum cleaner	600
Bar heater or fan heater	1000, 2000, or 3000
Electric iron	1000
TV	300
Washing machine	2500 max
Cooker (all heaters on)	12 000 max
Lamps	60–100
Fridge	150
Electric kettle	2000–3000
Power drill	250
Stereo system	100

With some students this work could be put on a more quantitative basis (see 'Further activities' 4, below)

Q.10 There is plenty of scope here for discussion of energy-saving measures. The important general principle that students should appreciate is that any appliance that produces a *heating effect* tends to use a lot of electricity.

Further activities

There is a great deal more work that could be done as extension of this unit.

1. The work in Part 1 could be extended by looking at electricity bills.
2. In Part 2, students could use the power ratings of appliances to work out and compare the cost of running appliances for one hour. (Cost per hour = power in kilowatts × unit price of electricity.)
3. The work in Part 2 could be extended to a consideration of the appropriate fuse ratings for different appliances.
4. For more able students, it would be possible to make the work in Part 2 more quantitative.

   Electricity meters are calibrated individually, and each one has its rating stamped on the front, as 'R/kWh' (revolutions per kilowatt-hour). This indicates the number of revolutions of the horizontal wheel per kilowatt-hour, and makes it possible to calculate directly the number of kilowatt-hours used in unit time by each appliance. Hence a value for the power of the appliance can be calculated.

Further resources

Understanding Electricity, the educational service of the electricity supply industry, has a wide range of resource materials relating to domestic electricity, most of them free. Details are available from: Understanding Electricity, The Electricity Council, 30 Millbank, London SW1P 4RD.

The Granada Television series *Physics in Action* includes a useful programme entitled *Electricity in the Home.* It can be recorded off-air for school use. See ITV for Schools annual programme booklet for transmission times.

Acknowledgements Much of this unit is based on ideas from the 'Energy at Home' unit of the PLON physics project based at the State University of Utrecht, 3508 TA Utrecht, The Netherlands. Figure 1 supplied by the Electricity Council.

ELECTRICITY IN YOUR HOME

Most homes with an electricity supply have an electricity meter. The meter measures how much electricity you use, so the Electricity Board know how much to charge. Using the electricity meter you can find out quite a lot about the electrical equipment in your home.

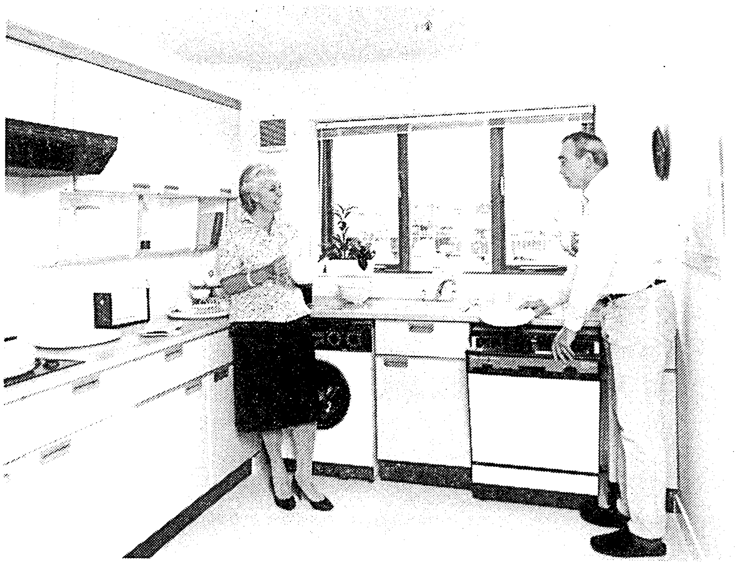


Figure 1 A modern kitchen like this has many electrical appliances

Electricity is sold in units called **kilowatt-hours (kWh)**. A kilowatt-hour is a unit of energy. 1 kilowatt-hour = 3600 kilojoules. When you read the meter, you read off the number of kilowatt-hours, to the nearest tenth. In 1985, 1 kWh cost about 5 pence.

During this activity you will need to read the meter a lot. So first, read through the next section on 'How do you read the meter?' to make sure you know how to do it.

How do you read the meter?

There are two kinds of electricity meter — the dial type and the digital type. The total amount of electricity used is recorded on dials in the dial type, and as figures in the digital type. You will be using these to make readings in Part 1. In both types, there is a horizontal wheel that goes round whenever electricity is being used. You will be making measurements using this wheel in Part 2.

Dial type meters (Figure 2 on the next page)

This is the more common type. It has a series of dials giving 10 000s, 1000s, 100s, 10s, units and tenths of a kWh. You read the dials from left to right. You have to be a bit careful, because some of the dials revolve clockwise and some revolve anti-clockwise. When you read a dial, write down the number the pointer has *passed.* If the pointer seems to be *right on* a number, look at the next dial to check whether it is really just before that number. Figure 3 on the next page gives an example.

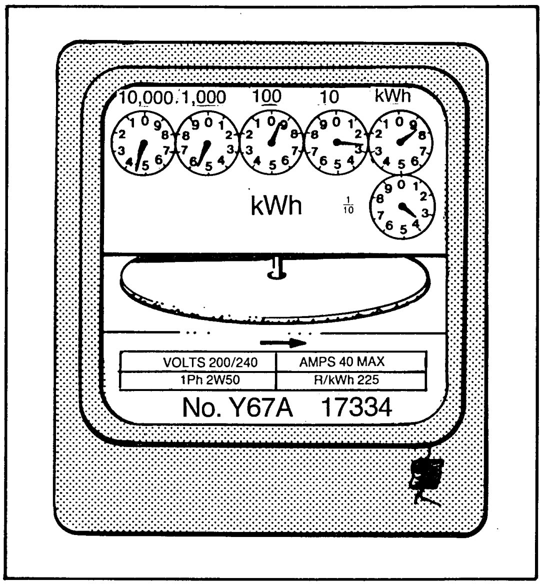


Figure 2 A dial-type meter

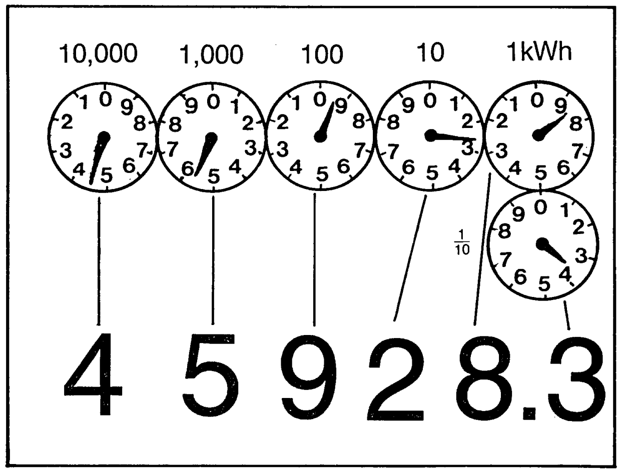


Figure 3 An example of a dial meter reading

Digital meters (Figure 4)

These are much simpler. You just read off the numbers. The last number is a tenth of a kWh.

Economy meters

Some homes have economy meters. These record the amount of electricity used at night when electricity is cheaper. They have two sets of numbers, one for daytime and one for night.

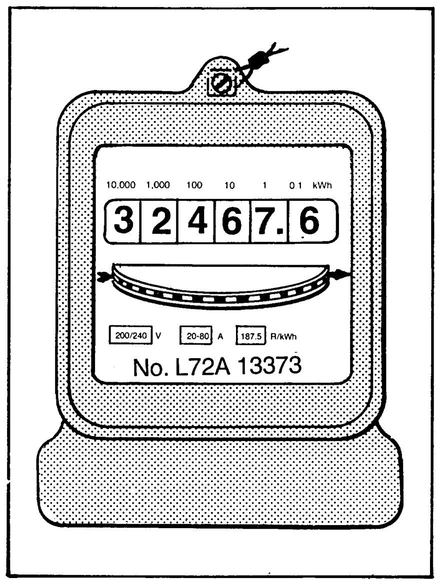


Figure 4 A digital meter

Part 1 How much electricity does your family use?

You will need to carry out this activity at home.

A For several days (at least two) read the electricity meter three times every day. Do this early in the morning, about 4pm in the evening and before you go to bed at night. Try to read it at the same times each day. If possible, include a weekend in your readings.

Draw up a table like Table 1 and put your readings in it.

Table 1 Electricity meter readings (kWh)

	Day 1	*Day 2*	*Day 3*	*Day 4*	*etc.*
Readings: Early morning					
4pm					
Before going to bed					
Amount used: **Day** (early morning till 4pm)					
Evening (4pm till bedtime)					
Night (bedtime till early morning)					

B Use your results to work out how much electricity was used in each of the three periods:

Day (early morning till 4pm)
Evening (4pm till bedtime)
Night (bedtime till early morning)

Put this in the table as well.

C Plot a bar chart showing the numbers of kWh used in each of the three periods for Day 1, Day 2, etc. Your chart should be arranged like the one in Figure 5.

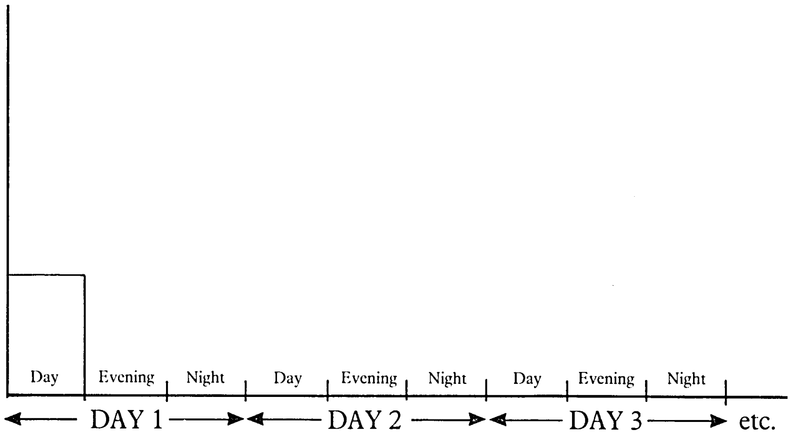


Figure 5 How the bar chart should be arranged (only one bar has actually been filled in)

D Compare your bar chart with other members of the class. Is the general pattern similar?

Now answer questions 1 to 7.

Questions

1 *In which period does your home generally use* most *electricity? Suggest a reason why.*

2 *In which period does your home generally use* least *electricity? Suggest a reason why.*

3 *If you included a weekend in your measurements, what difference did you notice between weekdays and weekend days?*

4 *In what ways might your results have been different if you had made the readings at a different time of year? Explain your answer.*

5 *Try working out how much your home spent on electricity each day. Assume electricity costs 5 pence per kWh.*

6 *Electricity is generated at power stations. There are power stations at different places around the country, all feeding electricity into the National Grid. The National Grid distributes electricity around the country. Some power stations run all the time, and some only run at certain times of day. Explain why.*

7 *Electricity boards have a special cheap price for electricity used at night. Why?*

Part 2 How much electricity is used by different appliances?

Every home has many different kinds of electrical equipment, or appliances. Some are shown in Figure 6.

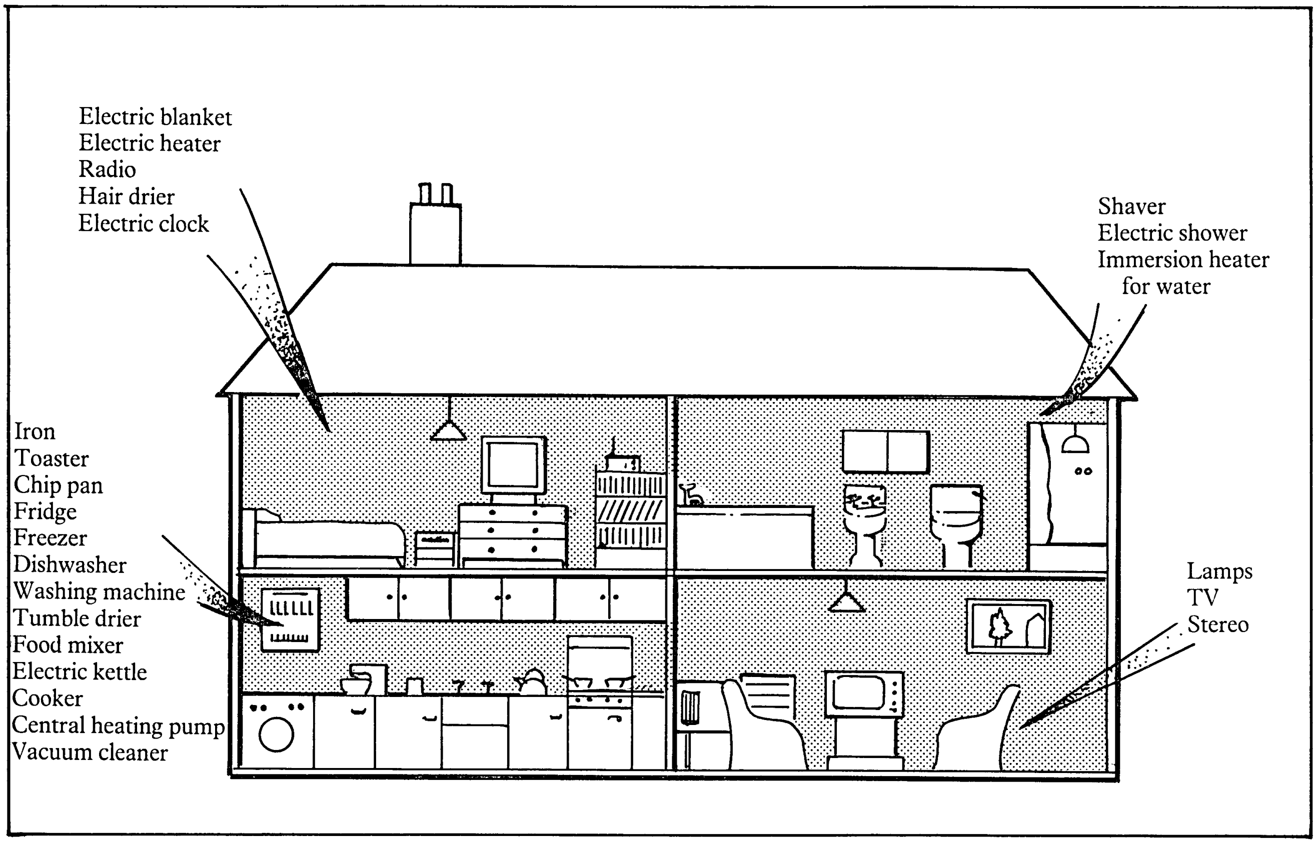


Figure 6 Some electrical appliances in the home

In this part you will be using the electricity meter in your home to get an idea of how much electricity different appliances use. You should do the readings while it is daylight if possible.

A Look at the meter. In this part you are going to see how many times the horizontal wheel goes round in one minute. The faster the wheel turns, the more electricity you are using. There is a red or black line painted on the wheel, and you can use this to count the turns of the wheel.

Using a watch or clock, see how many times the wheel goes round in a minute. Ignore fractions of a turn. Draw up a table like Table 2 on the next page and put the figure in the table, in row **A**.

B Now walk round your home and make a note of all the electrical appliances that are switched on. Write this information in Table 2, in row **B**.

C Now switch off as many of the appliances as possible. Go back to the meter and see if the wheel has stopped. If it has not, it means some appliances are still switched on. Try to decide which these are, and switch them off.

D Now you are going to switch on a number of different electrical appliances one by one. You can then see what difference they make to the rate of turning of the wheel.

For as many as possible of the appliances in **a** to **e**, turn on the appliance. Wait a moment, then count the number of turns per minute and write it in the table. Turn off the appliance afterwards.

- **a** An electric light
- **b** An electric immersion heater
- **c** An electric kettle
- **d** A TV set
- **e** Any other appliances you like to try.

Table 2 Rate of turning of meter with different appliances

A	Turns per minute at start
B	Appliances switched on at start
C	Turns per minute with different appliances:
	Electric light
	Electric immersion heater
	Electric kettle
	TV
	Others:

Now use your results to answer questions 8 to 10.

But first remember to turn back on any appliances that you turned off at the beginning.

Questions

8 Arrange the appliances in order of how fast they use electricity (fastest first).

9 The rate at which an appliance uses electricity is called its power. Power is measured in watts or kilowatts. Appliances usually have their power marked somewhere on them. For each of the appliances you tested, try to find out their power. Compare the power figures with your own measurements, and see if they roughly agree.

10 Which do you think would be the most effective ways of saving electricity in your home?

The Gas Supply Problem

Contents: Information and problem-solving exercise concerning the distribution and use of natural gas.

Time: 1 to 2 periods.

Intended use: GCSE Chemistry, Physics and Integrated Science. Links with work on fuels, natural gas and pressure.

Aims:

- To complement prior work on gaseous fuels and their uses
- To show in outline how natural gas is produced, distributed and used
- To provide an opportunity to practise problem-solving skills.

Requirements: Students' worksheets No. 702

Suggested use

Students should read the introductory material before tackling the problem-solving task. The task itself will probably take 20 to 30 minutes, and is best done by students working in groups of 2 or 3.

It would be useful to follow up the task with a discussion of the different designs. How do they compare? What problem might arise with each? Which is the best design?

General notes on the task

It is not expected that students will arrive at the exact 'answer' to the gas supply problem as used by British Gas (this 'answer' is given in Figure 8 of the students' materials, for teachers to duplicate and distribute if they wish). But good solutions to the problem should incorporate the following features:

(a) A high-pressure long-distance transmission network, with compressors every 65km or so (see note (1) below)

(b) A low-pressure distribution system for houses, and intermediate pressure distribution to factories (see note (2) below)

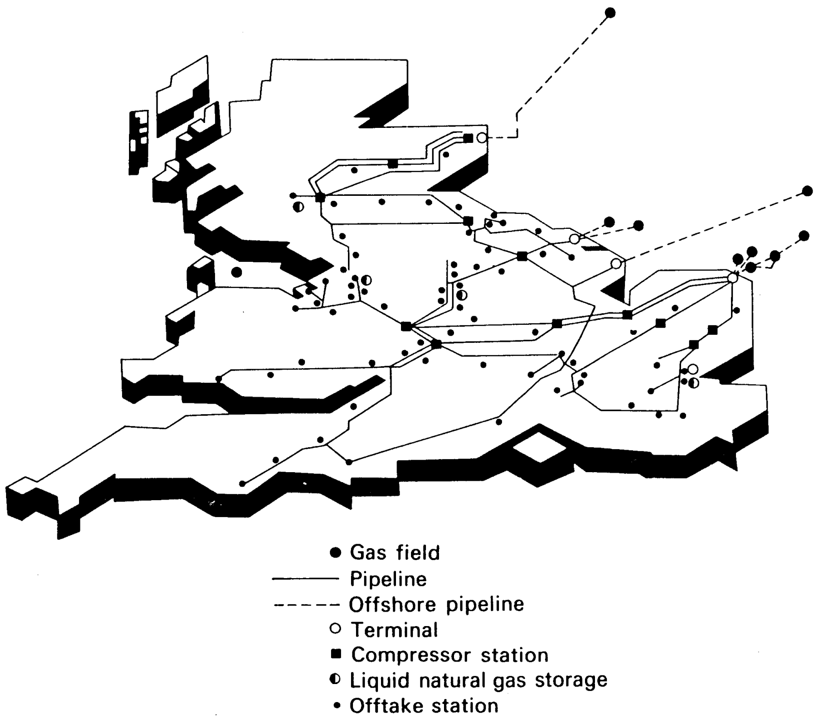
(c) Some kind of storage facility to cope with variations in demand (see note (3) below)

(d) Some kind of pressure-reduction stations between the different parts of the system (see note (4) below).

The information given in the students' materials is limited and simplified. The notes which follow provide further information for the teacher, which can be supplied to students as the teacher considers appropriate.

Further notes

1 The map below shows the National Gas Transmission System, the high-pressure, long-distance network distributing gas around the country.



The compressors are driven by gas turbines resembling jet engines, fuelled by the gas itself. Their noise is attenuated by acoustic insulation of the station.

2 Many urban areas have a 'ring main' system, with a loop, working at intermediate pressure and fed by the National Transmission System, running around the area. Low-pressure domestic distribution networks are fed from this ring through pressure-reducing regulators. Industrial users are fed direct from the intermediate pressure ring main. Flow within the ring can be in either direction, so interruption at a particular part of the ring will not necessarily result in general failure.

3 Variation in demand is considerable, according to the time of year (Table 1), the day of the week (Table 2) and the time of day.

Table 1 Variation in monthly demand for gas, April 1984—March 1985/10^9 cubic metres

Month	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*
Demand 10^9 m^3	4.1	3.4	2.3	2.0	1.9	2.8	3.9	5.0	5.9	7.2	6.2	6.3

Table 2 Variation in daily demand for gas, August 4th—13th 1984 and February 1st—10th 1985/10^9 cubic metres

Day	*Average outdoor temperature/ °C*	*Gas demand/10^9 m^3*
Fri Aug 4th 1984	14	0.058
Sat Aug 5th 1984	14	0.065
Sun Aug 6th 1984	15	0.071
Mon Aug 7th 1984	14	0.073
Tues Aug 8th 1984	16	0.071
Wed Aug 9th 1984	17	0.069
Thurs Aug 10th 1984	16	0.063
Fri Aug 11th 1984	16	0.059
Sat Aug 12th 1984	17	0.061
Sun Aug 13th 1984	17	0.069
Fri Feb 1st 1985	10	0.19
Sat Feb 2nd 1985	8	0.16
Sun Feb 3rd 1985	8	0.17
Mon Feb 4th 1985	7	0.19
Tues Feb 5th 1985	6	0.20
Wed Feb 6th 1985	6	0.20
Thurs Feb 7th 1985	3	0.23
Fri Feb 8th 1985	1	0.24
Sat Feb 9th 1985	−2	0.24
Sun Feb 10th 1985	−3	0.25

British Gas buys gas from North Sea producers under contract. According to these contracts British Gas is able to vary the amount of gas it takes, but only within certain upper and lower limits. In times of high demand, too little gas will be coming ashore; in times of low demand, there will be too much. To overcome these problems, bulk storage of gas is essential.

Several kinds of storage are used:

(a) In large tanks
(b) In underground salt cavities
(c) Storage as liquefied gas at low temperatures
(d) In depleted gas fields
(e) By 'line pack' — pressurizing parts of the transmission system near areas of high demand to above normal pressure, thus 'packing' more gas into the transmission system.

The first three of these storage methods are indicated in the 'answer' on Figure 8.

Some kind of low-pressure local storage is also needed, to cope with short-term fluctuations in demand, since it takes several hours for gas to travel from the East Coast terminals to the various parts of the country. Thus, gas-holders can still be seen in some urban areas, though they are far less common than in the days when gas was made from coal.

4 Pressure-reduction systems work on the general principle of passing the gas through a constriction. This creates two problems: considerable noise, and icing due to the rapid expansion of the gas. The first is overcome by sound insulation at the pressure reduction stations; the second by suitable heat-transfer measures. Both points can be illustrated by blowing up a balloon, then allowing the air to escape through the neck.

Further activities

If time and interest permit, students could tackle further questions relating to gas supply, for example:

1 By the end of this century, supplies of gas from the North Sea reserves will begin to fall below demand. What will Britain do for gas supplies then? *(Gas will be produced from coal, since supplies of coal are sufficient to long outlast those of gas and oil.)*

2 Try to explain the trends in gas demand at different times of year shown in Table 1.

3 Try to explain the trends in gas demand at different times of the week shown in Table 2.

4 Compare the advantages and disadvantages of (a) polythene pipes, (b) steel pipes for (i) low-pressure local networks, (ii) long-distance, high-pressure pipelines.

Further resources

Two useful sources of information concerning various aspects of the gas industry are:

1 *The Gass Book*, a joint publication of ASE and British Gas, available from ASE, College Lane, Hatfield, Herts AL10 9AA.
2 *Science in Society Book O: Engineering 3*, published by ASE/Heinemann.

The British Gas Educational Service has a wide range of printed and audio-visual materials available free of charge or at subsidized prices. Their catalogue can be obtained from: British Gas Educational Service, PO Box 46, Hounslow, Middlesex TW4 6NF. The catalogue also contains details concerning visits to gas industry establishments, and of visiting lecturers.

The British Gas Film Library includes a range of films and videos on free loan. The catalogue can be obtained from: British Gas Film Library, Park Hall Road Trading Estate, London SE21 8EL.

Acknowledgements The data in Tables 1 and 2 in the Teachers' Notes is taken from *UK Times British Gas Worksheet 2;* Figures 1 and 6 supplied by British Gas; Figures 2, 3, 4, 7 and 8 and the map in the Teachers' Notes are reproduced by permission from *Science in Society, Book O: Engineering 3* (ASE/Heinemann); Figure 5 supplied by Norwest Holst Ltd.

THE GAS SUPPLY PROBLEM

Natural gas occurs in large amounts below the North Sea. It is the job of British Gas to bring it ashore and distribute it to the fifteen million customers who use gas. This is not quite as simple as it sounds, as you will find out when you try the Gas Supply Problem later in this unit. First, read the following background information about gas.

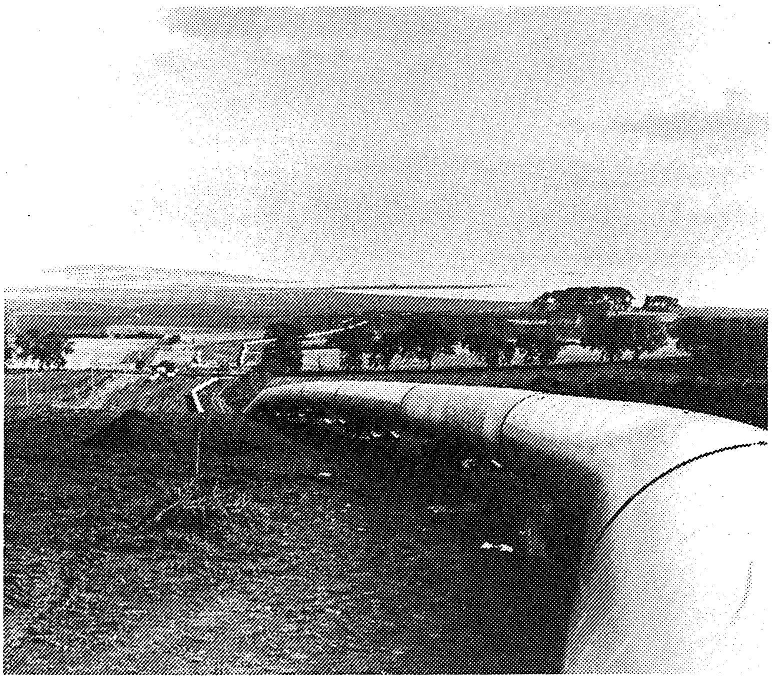


Figure 1 Part of the metre diameter pipeline which carries gas from the North Sea down the east coast of Britain. Here the pipeline is strung out before being buried.

Who uses gas?

Natural gas is almost pure methane, CH_4. It is an excellent fuel. It burns with a hot, easily controllable flame, forming carbon dioxide and water.

$$\underset{\text{methane}}{CH_{4(g)}} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$$

Provided the burner is properly adjusted, very few pollutants are formed when gas burns. Natural gas has no smell — in fact, a small amount of a smelly substance has to be added to it to help people detect leaks. It is important to prevent leaks, because gas can form explosive mixtures in air.

As Figure 2 on the next page shows, homes are the biggest users of natural gas. But industry uses a lot of gas too, especially where a clean, pure fuel is needed. Natural gas can also be used to make organic chemicals. Figures 3 and 4 on the next page give more details of how gas is used in homes and in industry.

How is gas supplied?

Customers expect the gas supply to be completely reliable, and never fail. To make sure of this, a carefully planned and designed supply system is needed.

Gas is supplied in pipes. There are 210 000 km of gas pipes in Britain — enough to reach more than half way to the moon. The more gas there is to carry, the bigger the pipes have to be. The largest pipes are over a metre in diameter and are made of steel. These carry gas long distances around the country. This gas is at high pressure — over 70 atmospheres.

The smallest pipes are the local service pipes which carry gas to individual houses. They are about 10 cm diameter. Some of these are quite old and may be a little leaky. To cut down leaks, the gas in these local pipes has to be at low pressure. The pressure is just over one atmosphere — about the same as the pressure inside a party balloon. These local pipes used to be made of cast-iron or steel, but this is being replaced by polythene. Polythene is strong and flexible and does not corrode. The pipes can be joined together by melting the plastic.

Figure 5 Local service pipes — under the roadway on Westminster Bridge

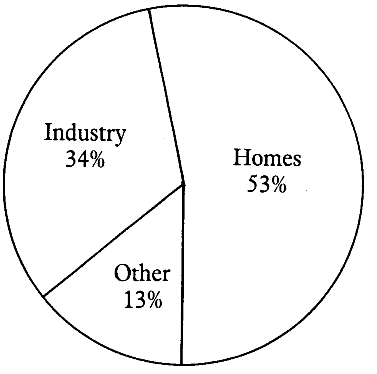


Figure 2 Where natural gas is used

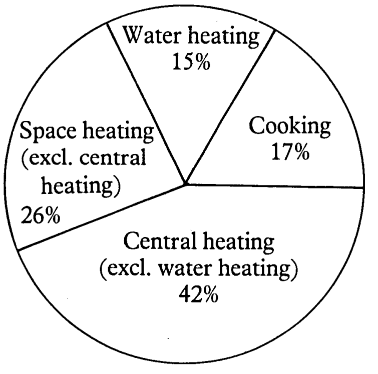


Figure 3 Uses of natural gas in the home

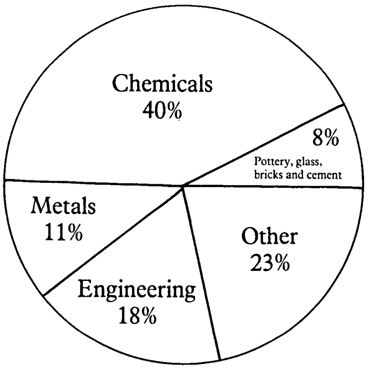


Figure 4 Uses of natural gas in industry

The corrosion problem

Gas pipelines are buried underground. The soil is usually damp and may also be acid or alkaline. With polythene pipes this is no problem, but the large high pressure pipes made of steel tend to corrode quickly under these conditions. The pipes have to be protected by special waterproof wrappings or coatings.

Checking for leaks

Small leaks in the local, low-pressure network of pipes are wasteful, but not particularly dangerous. They can be detected by sensitive 'gas sniffing' equipment, and the leaking pipe can then be dug up and repaired. But a leak in one of the large, high-pressure pipes would be very wasteful and dangerous. These pipes have to be checked regularly for corrosion, so that faults can be spotted before the pipe starts leaking.

But the pipes are buried underground, which makes checking difficult. To get over this problem, a machine called an 'intelligent pig' is used (Figure 6).

It travels *inside* the pipe, pushed along by the pressure of the gas. Magnetic and electronic equipment on board checks the pipe walls for faults as the machine moves along. Once a fault has been located, a hole is dug and the pipeline is repaired.

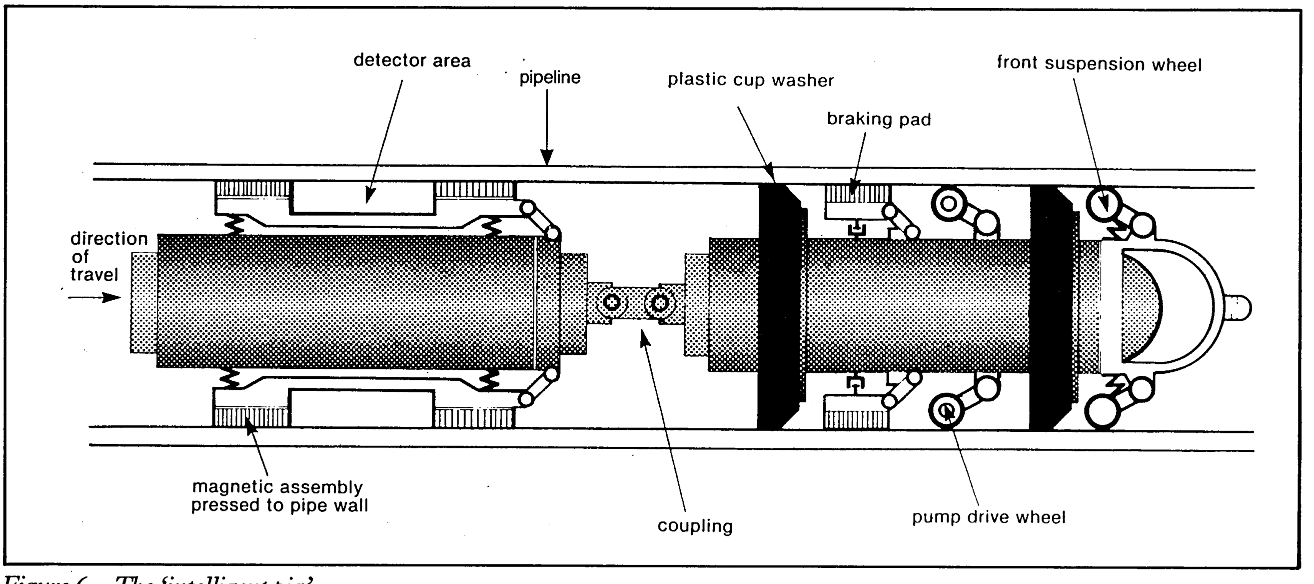


Figure 6 The 'intelligent pig'

The Gas Supply Problem — your task

North Sea Gas comes ashore at a high pressure (70 atmospheres). It is distributed to users in pipes.

Your problem is to design a distribution system. Your design must bear in mind all the following points:

- Homes use gas at low pressure (just over one atmosphere).
- Factories use gas at medium pressure.
- Gas forms explosive mixtures with air.
- More gas is needed in winter than in summer.
- The demand for gas varies according to the time of day.
- Gas needs to be kept at high pressure for long-distance travel. However, because of friction with the walls of the pipe, the pressure of gas falls the further it flows. Compressor stations are needed every 65 km to keep the gas at high enough pressure.
- When gas is carried in pipes, the more gas that is carried, the wider the pipe must be.
- Your design should be unobtrusive wherever possible.

What you do

This task is best tackled working in groups of 2 or 3.

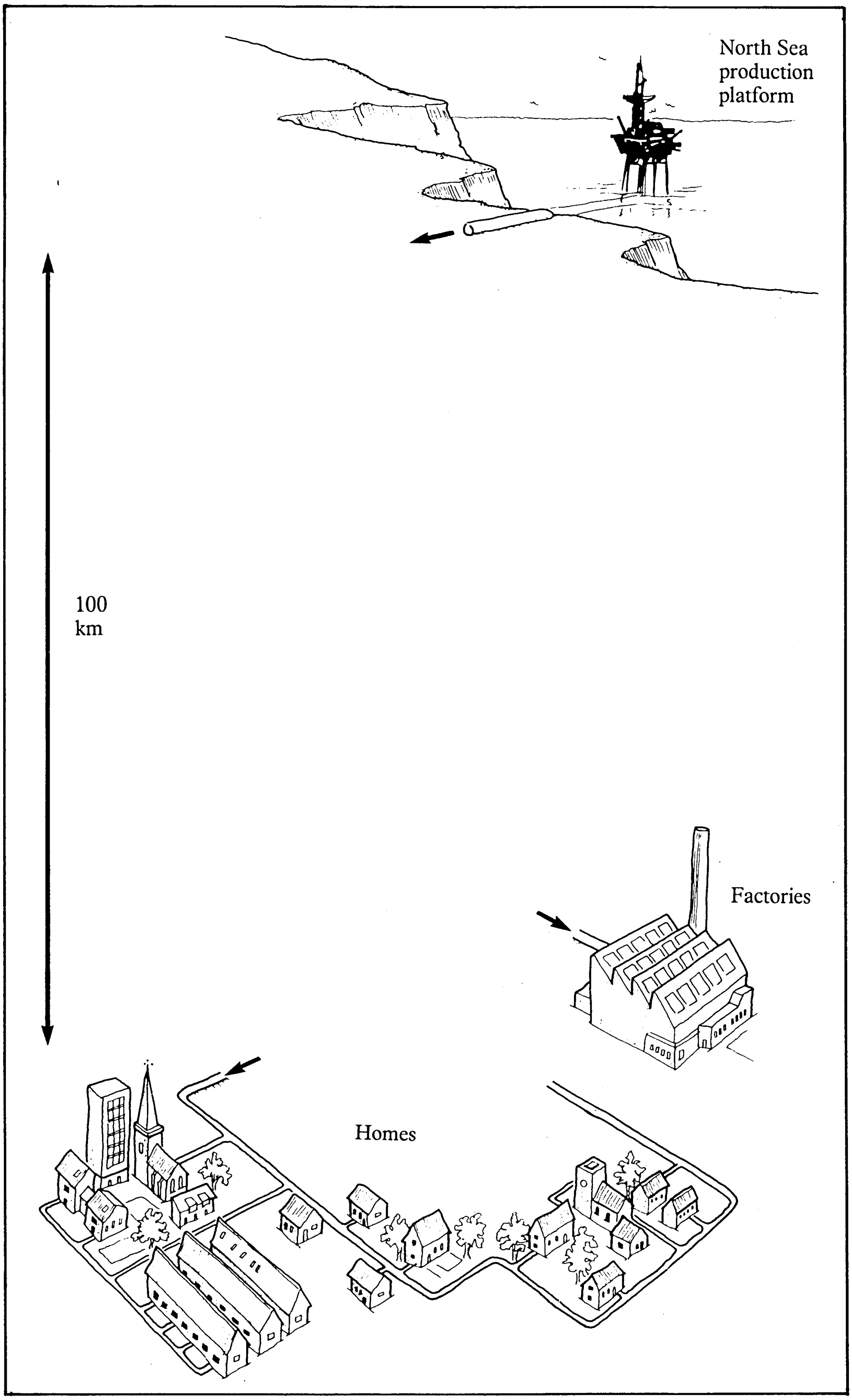
Look at Figure 7. On the blank part of the diagram, draw in *pencil* your design for the system to distribute gas between start and finish. Remember — your design must meet *all* the points mentioned above.

When you are happy with your pencilled design, go over it in ink, and perhaps colour it.

Figure 7 The Gas Supply Problem

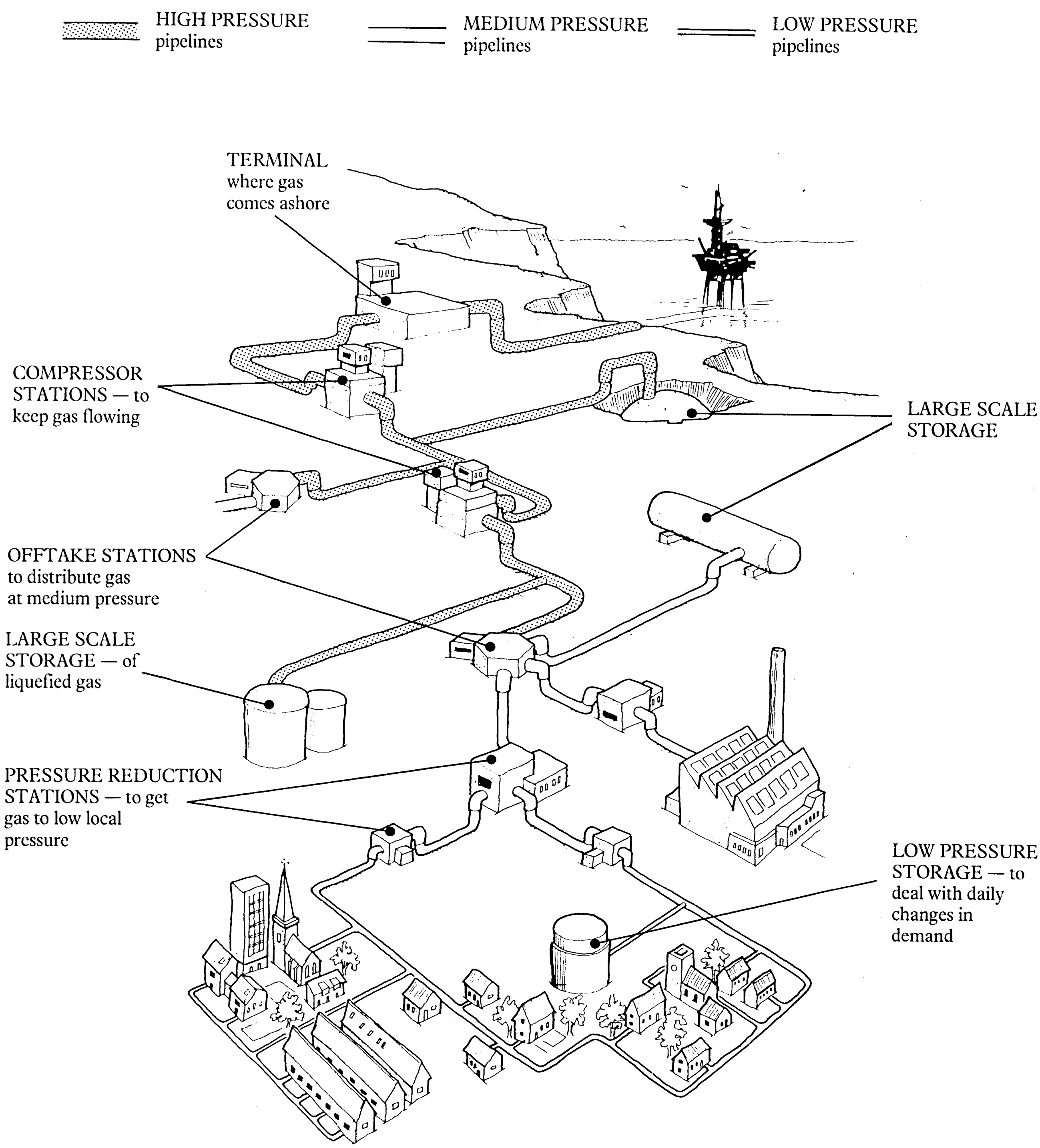
START
The gas
comes ashore
at 70 atmospheres
pressure

FINISH
The gas is
supplied to
homes and
factories



WHAT GOES IN BETWEEN?

Figure 8 The Gas Supply Problem — British Gas's answer



Vegetarianism

Contents: Information, questions and discussion concerning vegetarianism.

Time: 2 periods.

Intended use: GCSE Biology, Human Biology and Integrated Science. Links with work on nutrition, digestion, food chains and land use.

Aims:

- To complement and revise prior work on nutrition, digestion and food chains
- To describe the two main types of vegetarianism, and the reasons people adopt them
- To develop awareness of the advantages and disadvantages of being a vegetarian
- To provide opportunities to practise skills in comprehension and data analysis, and certain communication skills.

Requirements: Students' worksheets No. 703

Notes on some of the questions

Q.2 Although wool production does not directly involve slaughter, vegans consider it involves exploitation of the animal and often causes suffering. Wool production is also linked to the meat industry: sheep are raised for meat as well as for their fleeces. Much depends on the person's reason for becoming a vegetarian. A compassionate or ethical vegetarian would avoid wool, but a person who is a vegetarian for health reasons may prefer wool because it is a natural fibre.

Q.3
(a) (i) Using more agricultural land for plant food production could mean less food imports were needed, provided people were prepared to change their eating habits. If they were not, it would simply cause more imports of meat and dairy products, or a reduction of choice.

(ii) Such a change could in principle benefit other countries, though in practice this might not happen. For example, Brazil exports soya to Britain to make animal feed. With less animals in Britain, this soya might no longer be needed, but it is debatable whether this would benefit Brazil. In principle hungry people might benefit, but in practice the country might suffer because of the loss of foreign exchange earned by soya exports.

It is interesting to look at the figures for cereal use in Britain. In 1984/85, about 29.6 million tonnes of cereals were available in Britain. This includes both home-produced and imported cereals. Of this 29.6 million tonnes:

11.5 million went to export and EEC Intervention Store (the 'grain mountain')
8.3 million were used for human consumption (bread, cakes, etc.)
9.8 million were used for animal feed, of which
  5.2 million were for poultry
  3.0 million were for pigs
  1.6 million were for cattle (mainly for milk production).

If the 9.8 million had not been used for animal feed, they would presumably have gone to Intervention Store, in the absence of a radical swing to vegetarianism.

It is also important to note that nearly half of Britain's grazing land is rough pasture which can *only* be used for grazing, an important example being sheep grazing in upland Britain. If this land were no longer used for sheep raising, it would become completely unproductive in agricultural terms. For this reason, some people consider the consumption of sheep meat more acceptable than beef, pork or poultry.

Q.4 Egg-milk (*ovo-lacto*) vegetarians run little risk of malnutrition. Vegans risk Vitamin B12 deficiency, though this vitamin can be artifically produced using micro-organisms and is added to savoury spreads such as Barmene. Vitamin D deficiency is another risk, though in most cases enough of the vitamin is made by the effect of sunlight on the skin. There have, however, been a number of cases of Asian vegetarians in urban areas suffering from rickets. Problems can also arise with people who are recent converts to vegetarianism: for example, rickets is quite common among Rastafarians who are new to vegetarian diets.

At one time it was considered that vegetarians ran a serious risk of protein deficiency. This is now considered unlikely, partly because nutritionists have revised downwards their earlier estimates of daily protein requirements, and partly because shortage of essential amino acids can be compensated for by eating balanced combinations of protein sources (for example, nuts with cereals).

Qs 5 and 6 It is of course perfectly possible for omnivores to eat healthily by reducing their consumption of saturated fats from certain dairy and meat products, and including plenty of high-fibre food.

Other activities

It is likely that there will be vegetarian students in the class, and they could tell the others about the food they eat, and perhaps bring in samples.

Other resources

The Vegetarian Society can provide extensive information. Write to The Vegetarian Society, Parkdale, Dunham Road, Altrincham, Cheshire WA14 4QG, enclosing a stamped addressed envelope.

Likewise the Vegan Society, 33/35 George Street, Oxford OX1 2AY.

Information on the case for animal food production can be obtained from The Meat and Livestock Commission, PO Box 44, Queensway House, Bletchley MK2 2EF.

Acknowledgements Figure 1 supplied by The Vegetarian Society; Figure 2 supplied by Berrow's Newspapers; Figures 3 and 4 are reproduced by permission from *Science* by Graham Hill and John Holman (Nelson).

VEGETARIANISM

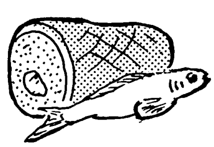
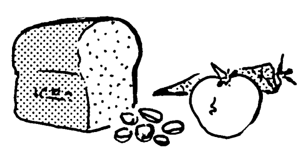
About three in every hundred people in Britain are vegetarians — and the number is growing. What makes people become vegetarians? What are the advantages and disadvantages?

Figure 1 A selection of vegetarian dishes

Types of vegetarians

There are two main types of vegetarians. Neither type lives on vegetables alone. All vegetarians eat a wide variety of plant foods. This includes bread, cereals, nuts, pulses (peas, beans, lentils, etc.) as well as fruit and vegetables. **Vegans** eat only plant foods. Most vegetarians are **'egg-milk' vegetarians** who eat eggs and milk products as well. Table 1 sums it up.

Table 1

	MEAT and FISH 	EGGS, MILK, CHEESE, etc. 	PLANT FOODS: nuts, cereals, vegetables, fruit, etc. 
OMNIVORES (meat eaters)	√	√	√
EGG-MILK VEGETARIANS	×	√	√
VEGANS	×	×	√

Why be a vegetarian?

Vegetarianism may be quite new in Britain, but in parts of the world it has been the normal diet for centuries. About two-thirds of all the people in India, for example, are vegetarians.

There are a number of reasons for becoming vegetarians. For many people the most important reason is moral — to prevent cruelty to animals.

The cruelty argument

Vegetarians believe it is wrong to make animals suffer to provide our food. Eating meat means slaughtering animals, and in Britain animals are often kept in unpleasant conditions in 'factory farms'. Vegans go further. They say that although milk and eggs do not directly involve slaughtering animals, they do cause suffering. To produce milk, for example, farmers separate cows from their calves shortly after birth.

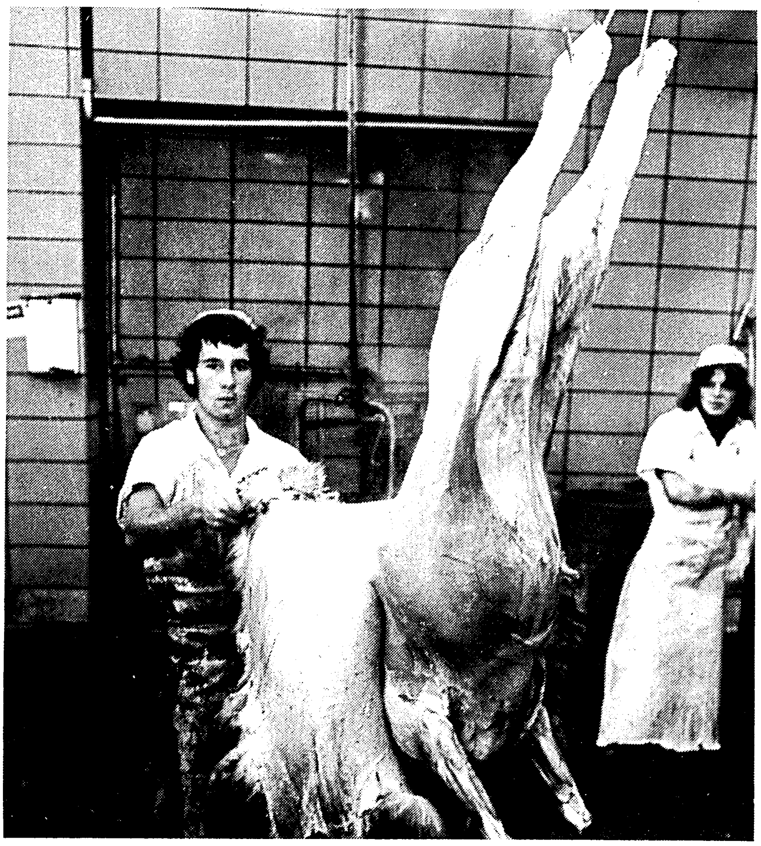


Figure 2 Inside a slaughterhouse

> *Questions*
>
> *1 Many vegetarians refuse to wear leather. Why?*
>
> *2 Most vegans refuse to wear wool. Why? Why don't* all *vegetarians object to wool?*

The health argument

Vegetarians believe their diet is healthier in many ways. Three important points are:

- *Fat* Most food experts recommend that people should cut down the amount of fat they eat. Vegetarians generally eat less fat, because meat products often contain a lot of fat. Sausages and burgers are particularly fatty. What is more, animal fats tend to be of the *saturated* type, which many doctors believe may help cause heart disease.
- *Fibre* Dietary fibre is the part of food that cannot be digested. It passes practically unchanged through the gut from the mouth to the anus (Figure 3). Many doctors now believe fibre is an important part of the diet. It keeps the contents of the gut moving, preventing constipation. It may also help prevent more serious diseases like cancer of the large intestine.

  You can only get fibre from vegetable foods. There is none in meat. Vegetarians generally eat about twice as much fibre as omnivores.

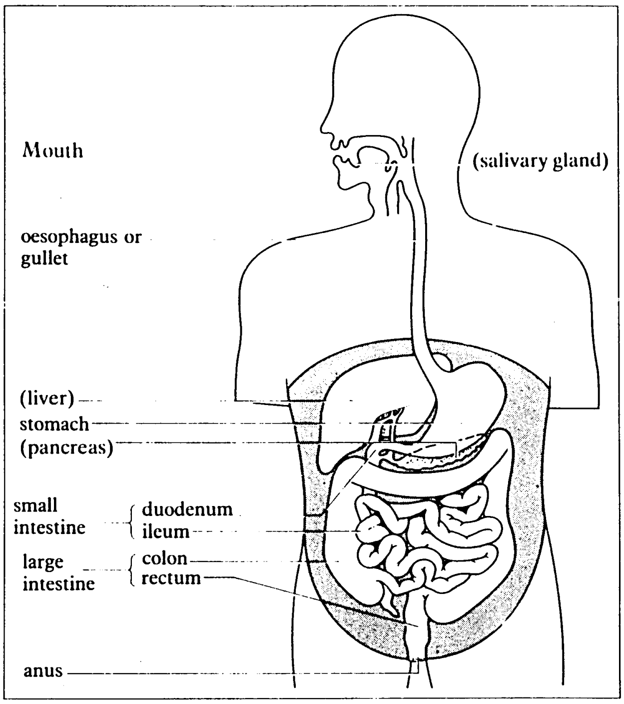


Figure 3 The human digestive system. Fibre passes through unchanged, from mouth to anus.

- *Obesity* Vegetarian meals tend to contain more bulky high-fibre foods which make you feel full. This makes vegetarians less likely to over-eat and get fat (obese). On average, vegetarians have 30 per cent less body fat than omnivores.

  However, vegetarians may have to be more careful than omnivores to make sure they get all the nutrients they need.

The economic argument

Using farmland to raise animals is an inefficient use of land. Figure 4 illustrates what happens when a cow grazes in a meadow, turning grass to beef. Only a very small part of the energy available in the grass gets converted to beef. Most of the available energy is used by bacteria and other herbivores, and in the cow's own respiration, faeces and urine.

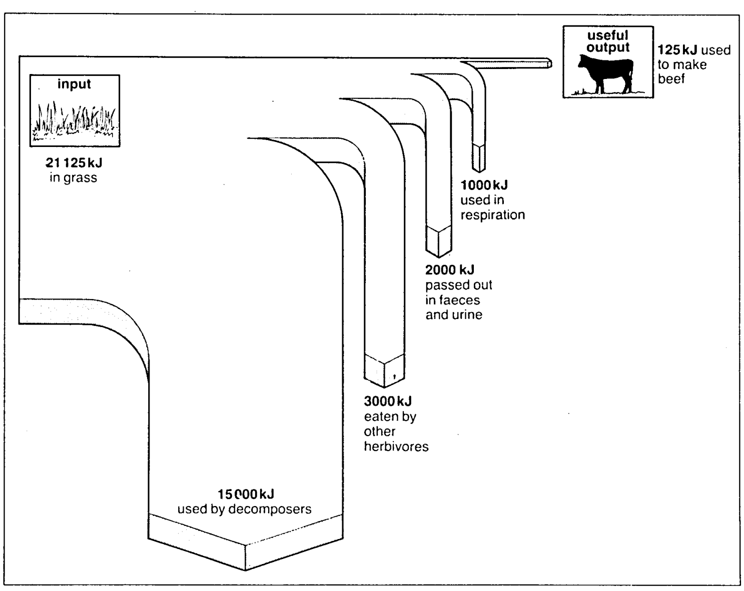


Figure 4 Converting grass to beef

As Figure 5 shows, most of Britain's agricultural land is used for raising animals, either directly or indirectly.

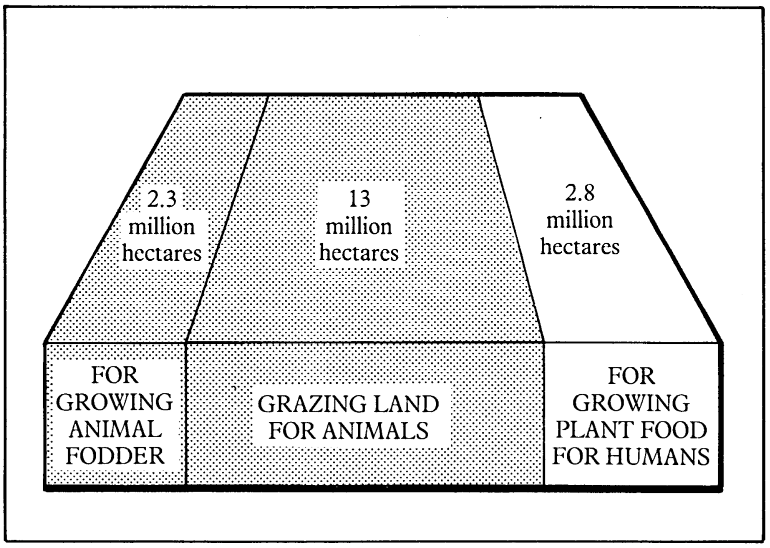


Figure 5 How Britain's 18 million hectares of agricultural land are used

Britain has 18 million hectares of agricultural land. It has been estimated that just 5 million hectares of this land would be enough to feed the whole population if we all ate plant foods alone. Figure 6 shows this idea in a different way.

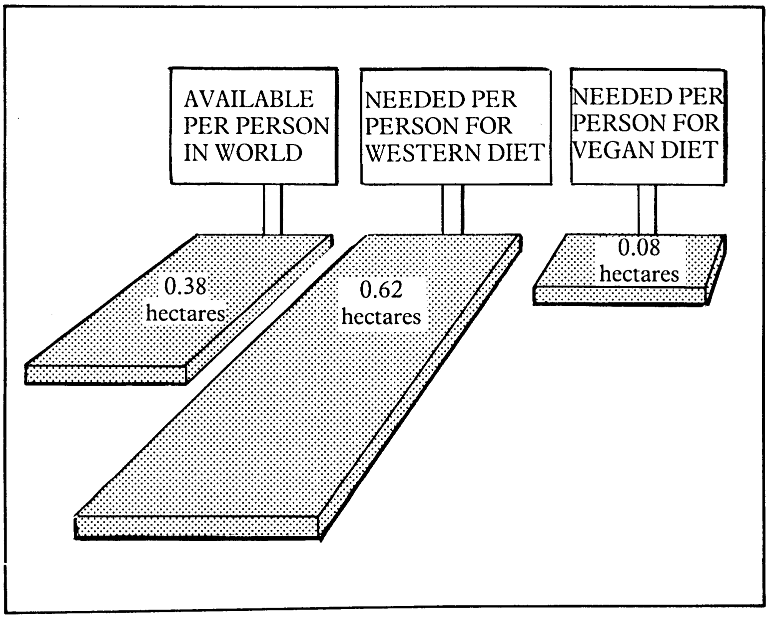


Figure 6 Comparing the land needed to support a person on different diets

All this means two things. First, a vegetarian diet is cheaper for a person to live on. Second, if more people were vegetarians, there would be more agricultural land available. This could help to feed the world's growing population.

Question

3 *Suppose Britain used more of its agricultural land for growing plant foods for humans instead of animals.*

(a) *What might be the advantages and disadvantages to*
  (i) *British people*
  (ii) *Hungry people in other parts of the world?*

(b) *Would there by any* disadvantages *in doing this?*

Are there any objections to being a vegetarian?

As we have seen, there are a number of positive reasons for being a vegetarian. But from the point of view of an omnivore there are also a number of objections.

Variety

Meat and animal products add variety to food. Vegetarian food often seems dull to omnivores, though in fact there is a wide range of interesting vegetarian dishes.

Health

We have already seen that a vegetarian diet *can* be more healthy. But it is *easier* to get all the nutrients and other substances you need if you are an omnivore.

Table 2 shows *some* (but not all) of the nutrients needed for a healthy diet. It also shows some of the foods that are particularly good sources of these nutrients.

Table 2 Some of the components of a healthy diet, and foods that are particularly good sources of these nutrients

	Protein	*Carbohydrate*	*Fat*	*Vitamins*			*Minerals*	
				C	*D*	*B12*	*iron*	*calcium*
Animal products	meat, fish, milk, eggs, cheese, etc.		meat, butter, cheese	liver	liver, fish oil, cheese, eggs	meat, cheese, eggs	meat, eggs	milk, eggs, meat, fish, cheese
Plant products	nuts, pulses, cereals	cereals, pulses, fruit, potatoes	butter, cheese, nuts	fruit, vegetables			pulses, green vegetables	green vegetables, bread, potatoes

Answer questions 4 to 6.

In fact it is perfectly possible for vegetarians, including vegans, to get all the nutrients they need. Some people belong to communities with traditions of vegetarianism. They have developed the recipes needed to make sure they get all the nutrients they require. But people who have just changed to being vegetarians from an omnivorous diet do need to be careful to eat the right things.

Questions

4 *Which of the nutrients in Table 2 is each of the following groups of people likely to be short of: (a) Omnivores, (b) Egg-milk vegetarians, (c) Vegans?*

5 *How could an omnivore avoid eating too much fat?*

6 *How could an omnivore make sure of plenty of fibre?*

Points for discussion

These points are best discussed in small groups of three, four or five.

- Which of the different arguments for vegetarianism do you find most convincing?
- It is impossible to eat without killing *some* kind of living thing. Omnivores are generally prepared to kill cows, pigs, sheep, chickens and fish for food, but not usually horses or humans. Vegans only kill plants, but not animals. How do we decide where to draw the line? When is it immoral to kill for food, and when is it all right?
- If people enjoy eating meat, is there any reason why they shouldn't?
- What kind of compromises are possible? Is it possible for an omnivore to go some of the way towards being a vegetarian?
- Animals kill each other for food, so why shouldn't we kill them?
- Few omnivores would enjoy working in a slaughterhouse. If you are going to eat meat, should you be prepared to kill animals yourself?
- Do you approve of people going fishing for their food?
- Would the world be a happier place if everyone was vegetarian?