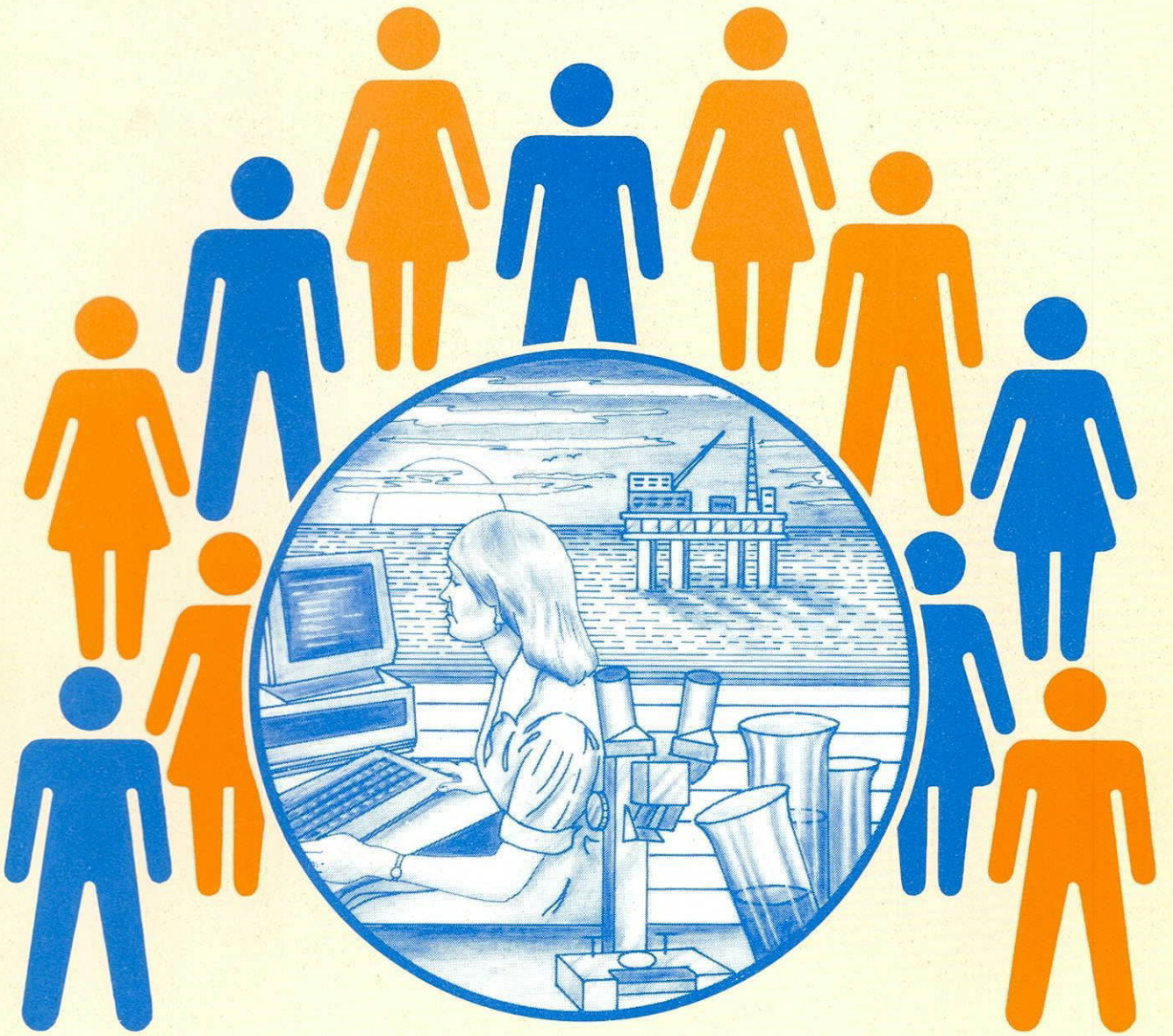
SCIENCE & TECHNOLOGY IN SOCIETY

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

701 ELECTRICITY IN YOUR HOME

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

702 THE GAS SUPPLY PROBLEM

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

703 VEGETARIANISM

Information, questions and discussion concerning vegetarianism.

704 ELECTRIC LIGHTS

Home survey, reading and questions concerning artificial electric lighting.

705 PHYSICS IN PLAYGROUNDS

A series of structured questions on energy, forces and motion based upon the experiences children gain using swings, slides and see-saws.

706 DRY CELLS

Reading, questions and practical work concerning the nature of dry cells.

707 ARTIFICIAL LIMBS

Reading, questions and discussion on artificial legs and arms.

708 APPROPRIATE PUMPS

Information, questions and discussion on appropriate technology as applied to water pumps for developing countries.

709 WHICH ANTI-ACID?

Survey, practical work and questions on consumer testing of anti-acids.

710 WHAT IS BIOTECHNOLOGY?

Reading and questions on the history and nature of biotechnology, including case studies.

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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.

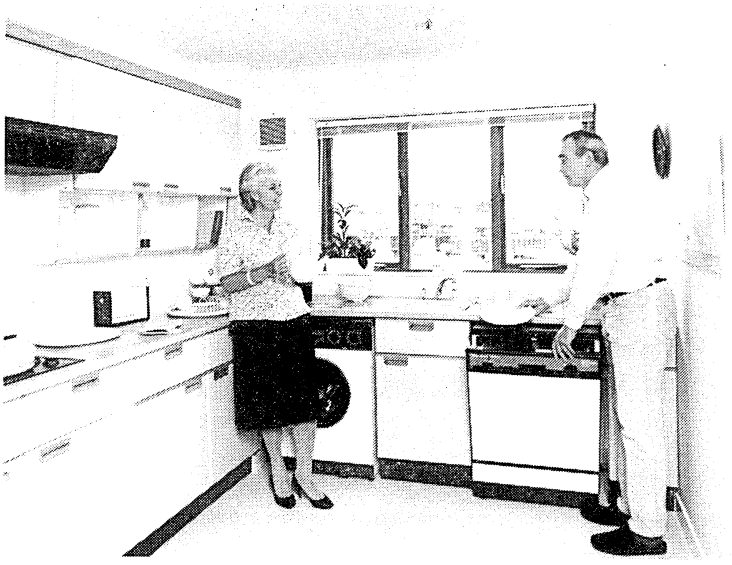

Figure 1 A modern kitchen like this has many electrical appliances

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.

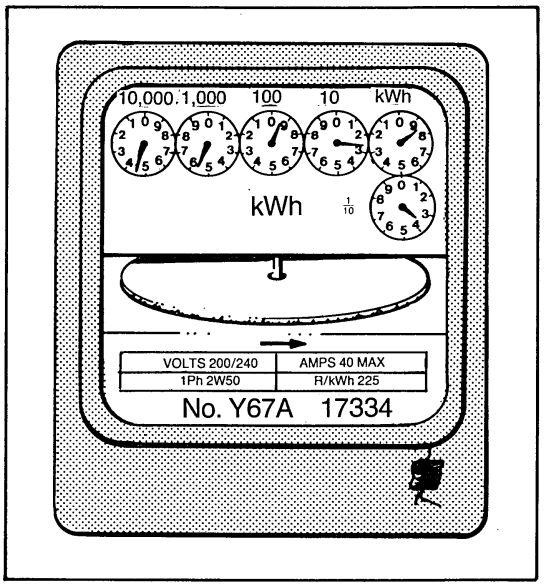

Figure 2 A dial-type meter

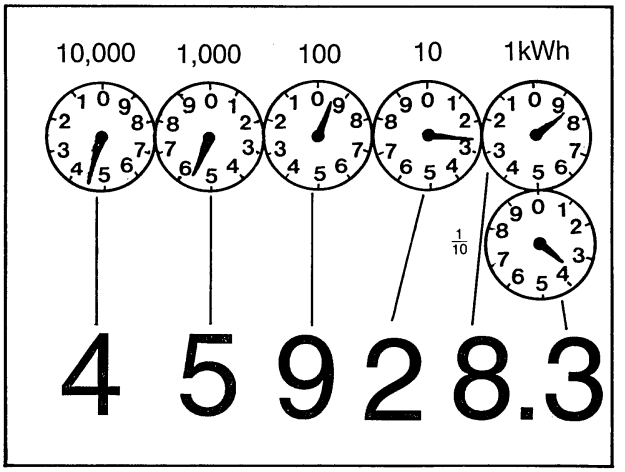

Figure 3 An example of a dial meter reading

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.

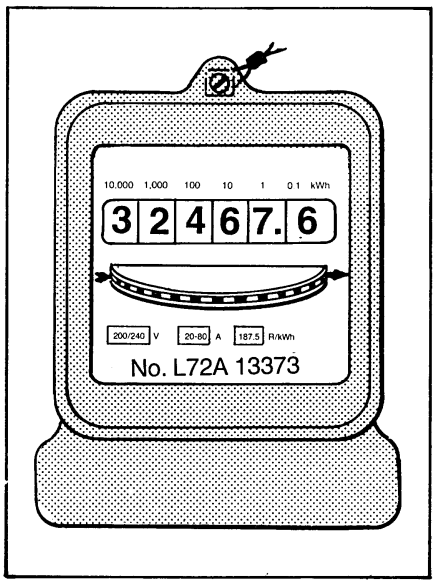

Figure 4 A digital meter

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.

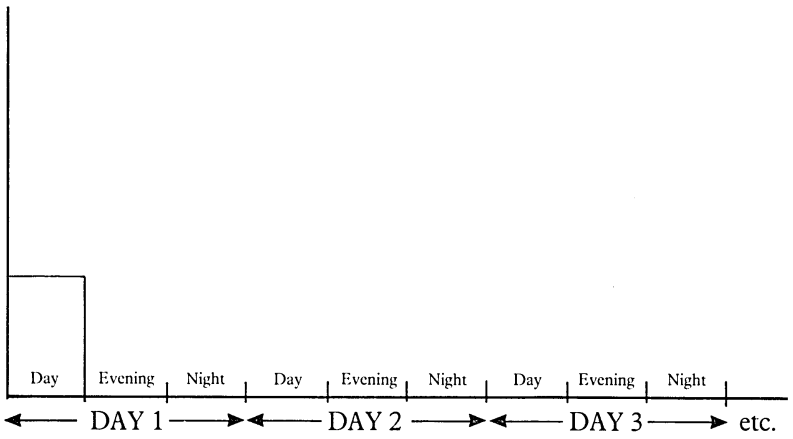

Figure 5 How the bar chart should be arranged (only one bar has actually been filled in)

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.

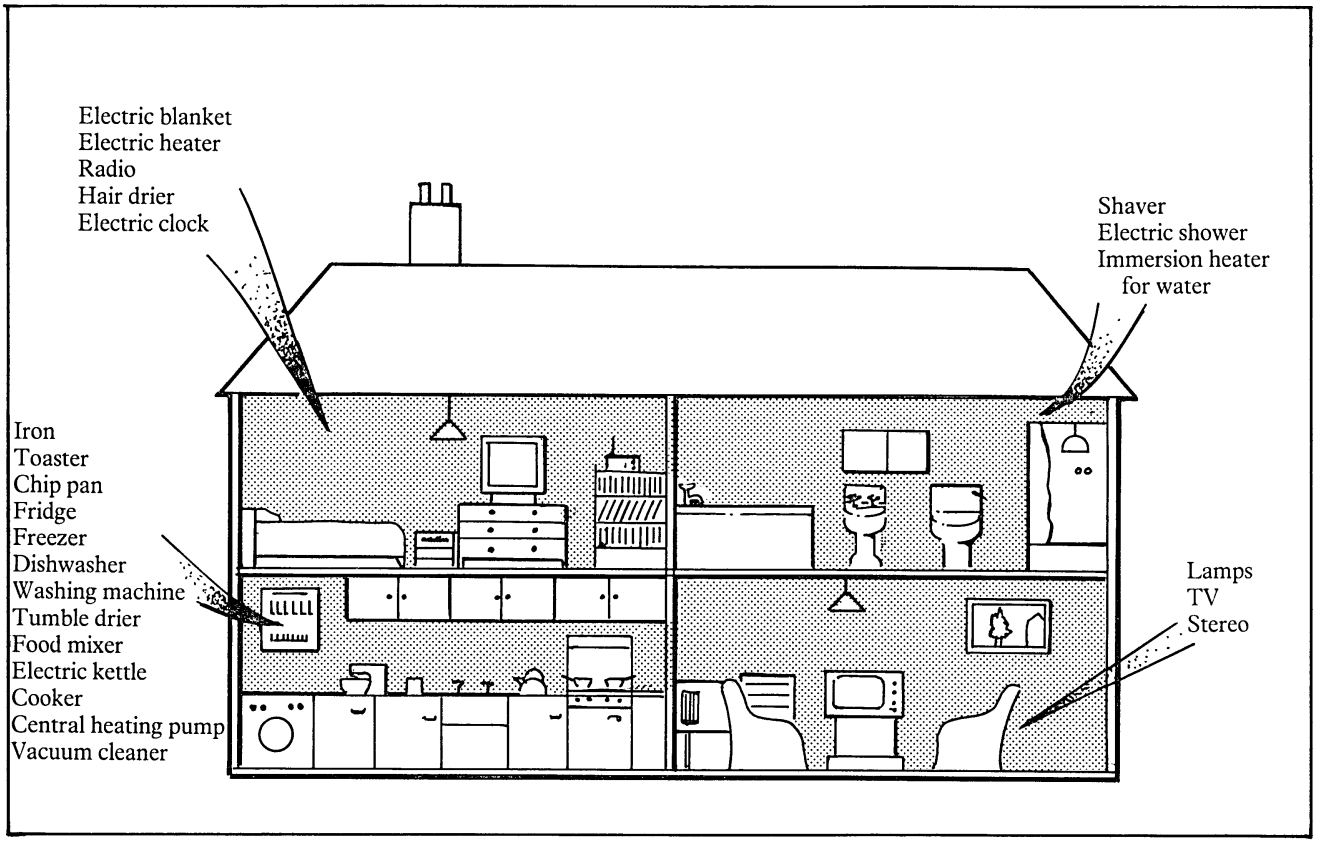

Figure 6 Some electrical appliances in the home

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?