SCIENCE & TECHNOLOGY IN SOCIETY

6

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 Teacher's Guide to the project 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 Teachers' Guide.

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SATIS 6
List of units in this book

601 ELECTRICITY ON DEMAND
Decision-making task concerning electricity generation and the use of different types of power stations

602 THE LIMESTONE INQUIRY
A role-play exercise concerning the quarrying of limestone

603 THE HEART PACEMAKER
Reading, questions and discussion concerning electronic heart pacemakers and their use in treating heart defects

604 METALS AS RESOURCES
Data analysis exercises on the prices, abundance and reserve lifetimes of metals, and problems associated with their depletion

605 THE GREAT CHUNNEL DEBATE
Information, questions and debate concerning the building of a fixed Channel link
CAN IT BE DONE? SHOULD IT BE DONE?

606 THE TRISTAN DA CUNHA DENTAL SURVEYS
A data analysis exercise concerning the effect of diet on dental decay

607 SCALE AND SCUM
Questions based on an advertising leaflet concerning water softening

608 SHOULD WE BUILD A FALLOUT SHELTER?
A role-play exercise concerning the building of a nuclear fallout shelter

609 HITTING THE TARGET — with monoclonal antibodies
Reading and questions concerning the production and uses of monoclonal antibodies

610 ROBOTS AT WORK
Reading, questions and discussion on industrial robots and their future implications

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Electricity on Demand

Contents: Decision-making task concerning electricity generation and the use of different types of power stations.

Time: 2 periods.

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

Aims:

- To complement prior work on electricity generation and energy changes
- To describe the different types of power stations in use in Britain, and their relative advantages and disadvantages
- To show the planning and decisions that have to be made to ensure a reliable and economic supply of electricity on demand
- To provide opportunities to practise skills in planning and decision-making.

Requirements: Students' worksheets No. 601. Scissors.

The unit is in two parts.

Part 1 gives information on electricity generation, with particular reference to the North West Region of the CEGB.

Part 2 is a decision-making task in which students plan which power stations to use at different times in order to generate sufficient electricity at an economic price.

Background information

In part 1 a certain number of simplifications have been made. Some of the power stations can in fact run on more than one type of fuel — for example, Padiham can use oil or coal. For simplicity only one fuel cost is given.

At some stations there are sets of equipment which use gas turbines. These are very expensive to run but in difficult situations they can be used to 'top up' the system. The gas turbines can be used in an emergency to start up the power stations themselves. The combined capacity is only 0.2 per cent of total capacity.

In Part 2 it is probably best if students work in pairs. With able students, teachers may wish to withhold Figure 11, which gives help with the answer.

Students should not find it hard to arrange power stations in order of cost to meet the demand. The most difficult part of the task is using the pumped storage capacity in the most cost-effective way, since it is difficult to quantify how much capacity is spare. Most students will do this approximately, by eye, but some may realize that the quantity of available spare energy is given by the area above the graph (the shaded area in Figure 11). For simplicity it is assumed that the pumped storage stations are 100 per cent efficient — in other words, they convert all the stored energy back into electricity. Their efficiency is in fact about 85 per cent, so this is not a bad approximation.

Further resources

Understanding Electricity, the educational service of the electricity supply industries, has a wide range of resource materials available which relate to electricity generation and distribution. Catalogue from: Understanding Electricity, Electricity Council, 30 Millbank, London SW1P 4RD. These resource materials include *Power Package,* a computer simulation of electricity generation and supply.

The Granada TV series *Physics in Action* includes two very useful programmes relating to electricity generation and supply, which can be recorded off-air for school use. Transmission times can be found in the ITV for Schools programme schedule.

Acknowledgements Figure 1 supplied by the Electricity Council; Figure 2 is reproduced by permission from *Science* by Graham Hill and John Holman (Nelson); Figures 3, 5 and 7 supplied by CEGB: Figure 4 supplied by the United Kingdom Atomic Energy Authority.

ELECTRICITY ON DEMAND

Part 1 Generating electricity

When you turn an electric switch, you expect an instant supply of electricity, at a constant voltage. You also expect the electricity to be cheap.

The Central Electricity Generating Board (CEGB) has the job of generating electricity in England and Wales. The CEGB is split up into regions (Figure 1). In this unit we will be concerned with the North West Region.

Electricity comes from a mix of different types of power station. In the North West Region, these are:

Nuclear
Coal
Oil
Hydro-electric
Pumped storage.

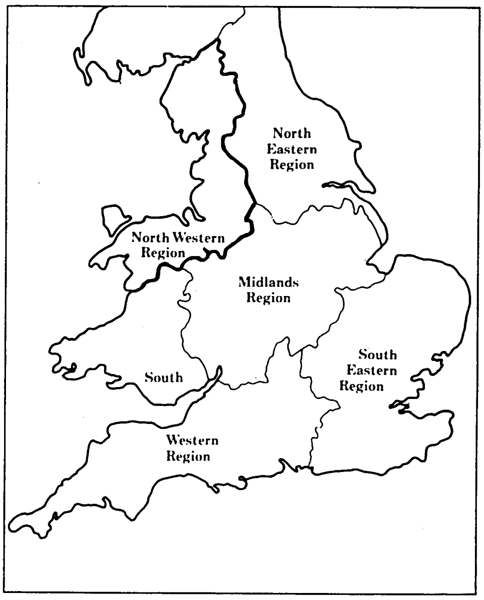


Figure 1 Regions of the CEGB

Electricity supply and the National Grid

All Britain's power stations are linked into the National Grid (Figure 2). This is a network of power lines that feeds electricity to all parts of the country. Electricity is moved around at 400 000 volts, 275 000 volts and 132 000 volts. It is transformed to lower voltages for use by the consumer.

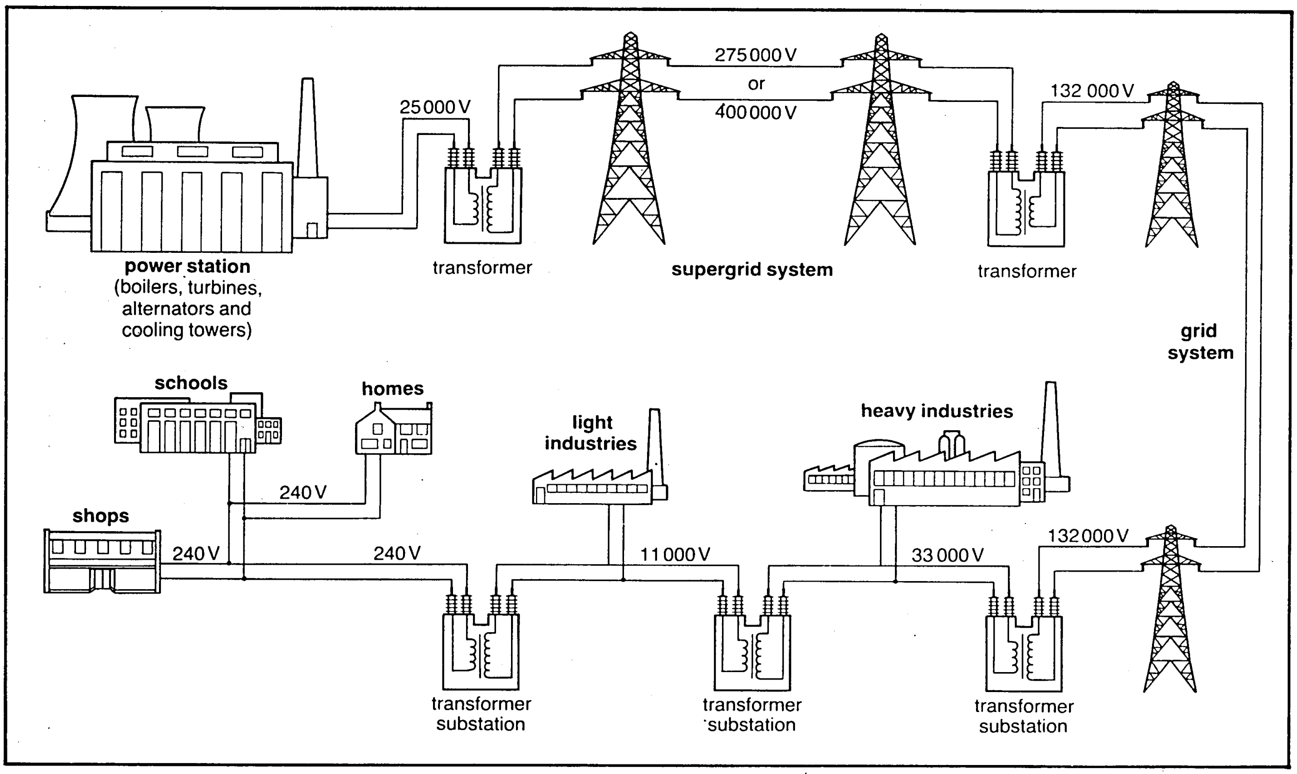


Figure 2 The National Grid

The CEGB must supply electricity on demand. It tries to do so at the lowest possible cost. Each power station produces electricity at different costs and in different quantities. When demand for electricity is low, only the cheapest power stations need be used. The more expensive power stations are only used when demand is high. In Part 2 of this unit you will make decisions on which power stations to use at different times.

The Regional Control Centre tells each power station when to operate and feed electricity into the Grid. There are times when the North West Region has to help other regions which may be short of power. At other times the North West Region may use excess power from other regions. This is controlled by a National Centre. As a general rule, though, the North West Region is fairly self-sufficient and able to look after its own electricity demand.

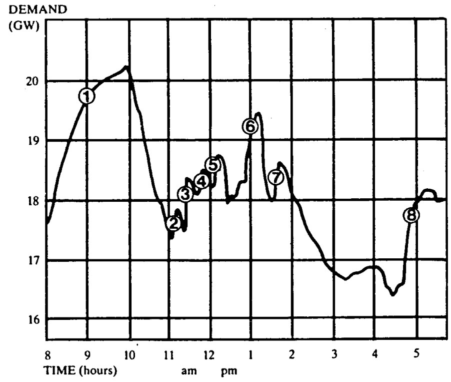


Figure 3 Changes in demand for electricity during Royal Wedding Day, 1981, when Prince Charles married Princess Diana. Notice how the demand jumped after each high point of the wedding, as people left their TVs to switch on kettles, etc:

1 *Television scene setting*
2 *Following bride's arrival at the altar*
3 *End of solemnisation of matrimony*
4 *End of prayers*
5 *Signing registers*
6 *Return of procession to Buckingham Palace*
7 *Last appearance on palace balcony*
8 *After couple left Waterloo Station*

Types of power stations

Before trying the decision-making task, you will need some information about the different types of power station.

Nuclear power stations

These make electricity relatively cheaply. They are used to provide the 'base-load' — they run all the time.

There are three nuclear power stations in the North West Region. Their total output is 2500 megawatts.

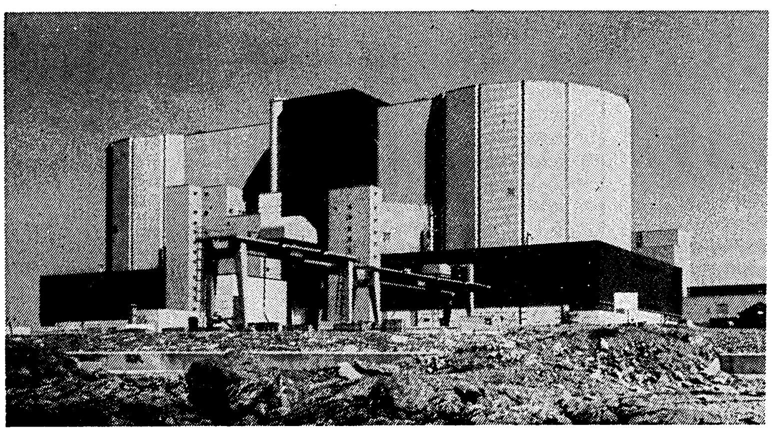


Figure 4 Wylfa nuclear power station

Coal-fired power stations

Before nuclear power stations were built in Britain most of our electricity was generated from coal. The older supply system used many small coal-fired stations each feeding customers in their locality. In the last twenty years large coal-fired power stations have been built. These are often near to Britain's major coal fields.

Generating costs are not as low as for nuclear stations, but usually cheaper than oil stations. The cheapest coal-fired power stations are the big modern ones. Older, smaller coal-fired stations are relatively expensive to run. It is possible to start up and shut down coal-fired stations in a few minutes if their boilers are kept ready at standby.

There are seven coal-fired power stations in the North West Region. Their total capacity is 2471 megawatts.

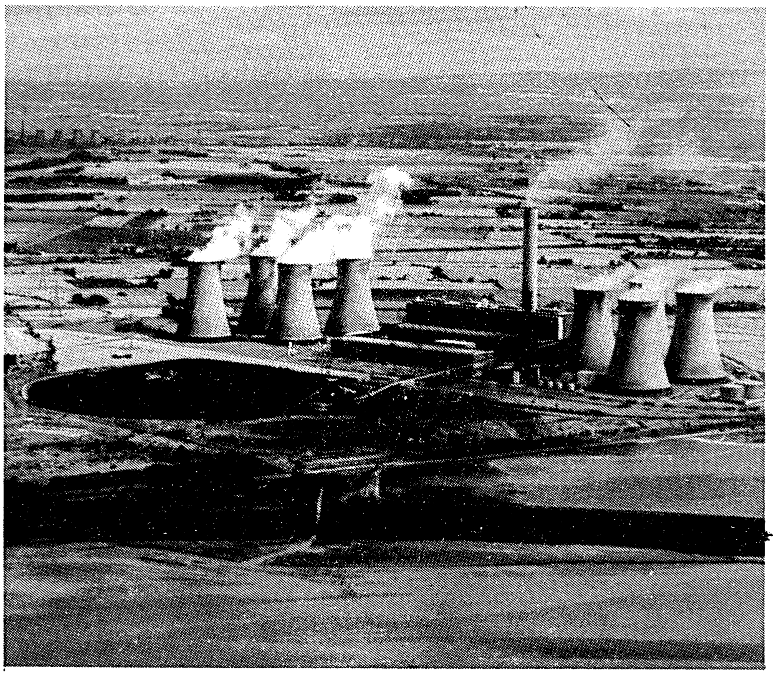


Figure 5 Fiddlers Ferry coal-fired power station

Oil-fired power stations

Britain built several large oil-fired power stations in the late 1960s. At the time they promised low-cost electricity because oil was cheap. Since 1973 the cost of oil has increased dramatically. So now the cost of electricity from this fuel is high. Oil stations are generally only used for peak demand or when other stations are under repair.

There are two oil-fired power stations in the North West Region. Their combined capacity is 1100 megawatts.

Hydroelectric power (HEP) stations

In some parts of the world with high rainfall, hydroelectric power stations provide very cheap electricity. In the North West Region of the CEGB there are only a few small hydroelectric power stations, in North Wales. Their combined capacity is 104 megawatts.

Pumped storage

The North West Region has two **pumped-storage schemes** which are the envy of the rest of the world. They provide a way of storing electrical energy when demand is low, ready to use when demand is high.

Figure 6 illustrates how the scheme works.

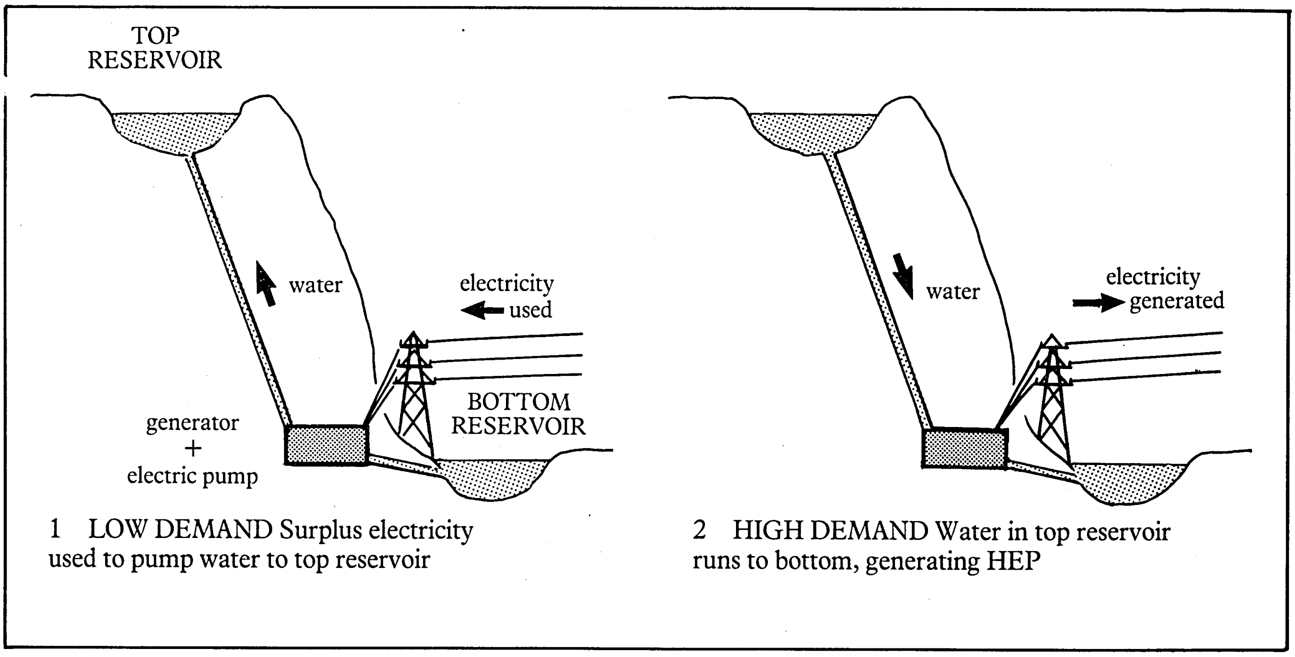


Figure 6 Pumped storage

At low demand times, there is spare electricity from other power stations. This is usually during the night. This electrical energy is used to pump water to the top reservoir. In this way energy is stored as gravitational potential energy. When demand is high, extra electricity is needed. The potential energy is converted back to electrical energy by allowing the water to flow back down, driving the generators.

There are two pumped-storage stations in the North West Region, both in the mountains of Snowdonia. The bigger of the two is at Dinorwig. The top reservoir at Dinorwig takes 5 to 6 hours to fill. When it is full, Dinorwig can generate 1800 megawatts for up to 5 hours. The combined capacity of the two pumped-storage stations is 2160 megawatts.

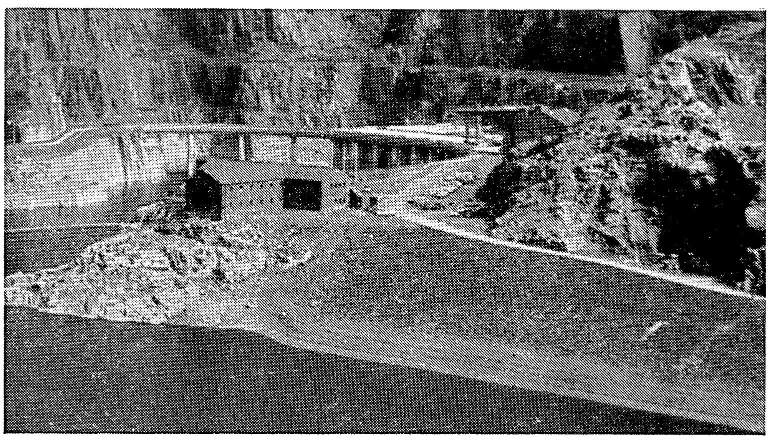


Figure 7 Dinorwig pumped-storage station — the bottom reservoir

Details of power stations in the North West Region

Table 1 gives information about all the stations.

Table 1 Power stations in the North West Region

Name of power station	*Type*	*Normal output /megawatts*	*Fuel cost per megawatt-hour*
Heysham 1	Nuclear	1320	£7.50
Trawsfynydd	Nuclear	380	£7.50
Wylfa	Nuclear	800	£7.50
Agecroft	Coal	215	£18.50
Bold	Coal	160	£21.00
Carrington	Coal	230	£21.00
Fiddlers Ferry	Coal	1700	£20.00
Huncoat	Coal	80	£21.00
Roosecote	Coal	60	£27.00
Westwood	Coal	26	£27.00
Ince B	Oil	1000	£26.00
Padiham	Oil/Coal	100	£26.00
Cwm Dyli	Hydro	5	nil
Dolgarrog	Hydro	25	nil
Maentwrog	Hydro	24	nil
Rheidol	Hydro	50	nil
Dinorwig	Hydro/Pumped-storage	1800	nil*
Ffestiniog	Hydro/Pumped-storage	360	nil*

* For the pumped-storage stations, fuel costs are nil when generating. When pumping water up, fuel costs depend on which other power stations are running.

The location of these power stations is shown on the map in Figure 8.

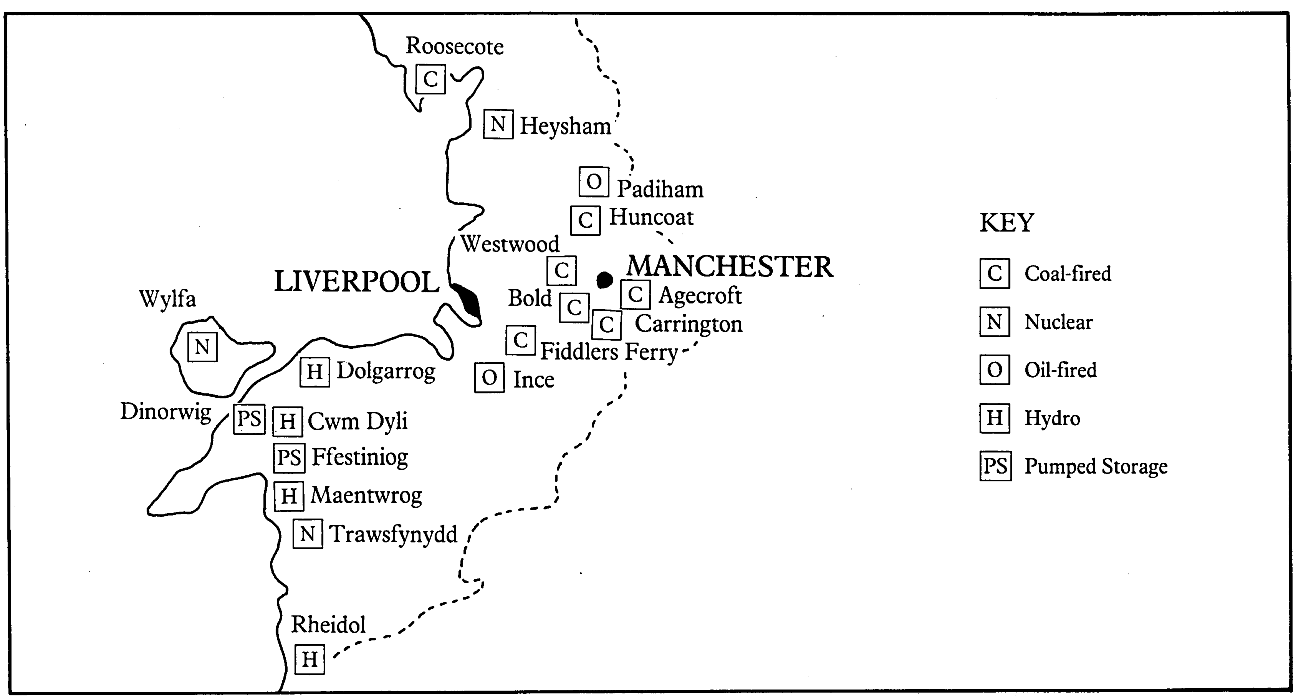


Figure 8 Power stations in North-West Region

Part 2 Task: Deciding which power stations to use

It is best to work on this task in pairs.

Imagine you are engineers in the Regional Control Centre. Your job is to make sure enough electricity is generated, at the lowest possible cost.

Look at the graphs in Figures 9 and 10 on the next two pages. They show the expected demand for electricity at different times of day. Figure 9 is for a typical summer day, and Figure 10 is for a typical winter day.

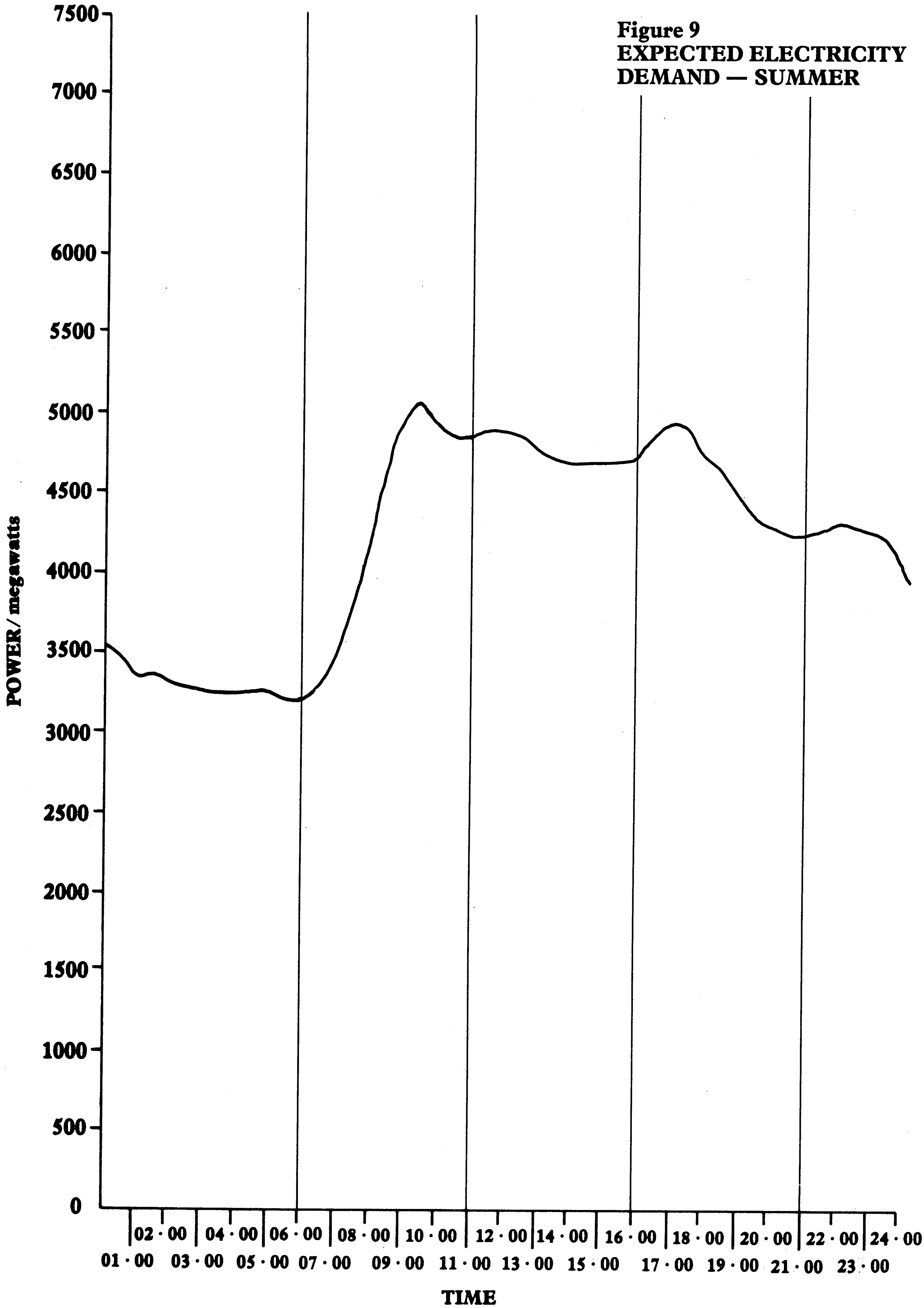
Your task is to plan which power stations to use during each five-hour period. You must choose your power stations to give the lowest cost electricity. At any time you must have a slight surplus over the expected demand. Do the task for the summer first, then for winter.

In Figure 11 an example has been done for you to show the idea.

Figure 12 has blocks to represent the capacities of the different power stations. The blocks are drawn to the same scale as the demand graphs. You can cut out the blocks and place them on the graphs to help with your planning. When you have planned each period, write in the power stations on the graph.

Remember to use the pumped-storage stations. When demand is low, you can use surplus electricity to store energy in them. You can then use this stored energy at high demand times.

Figure 9
EXPECTED ELECTRICITY DEMAND — SUMMER



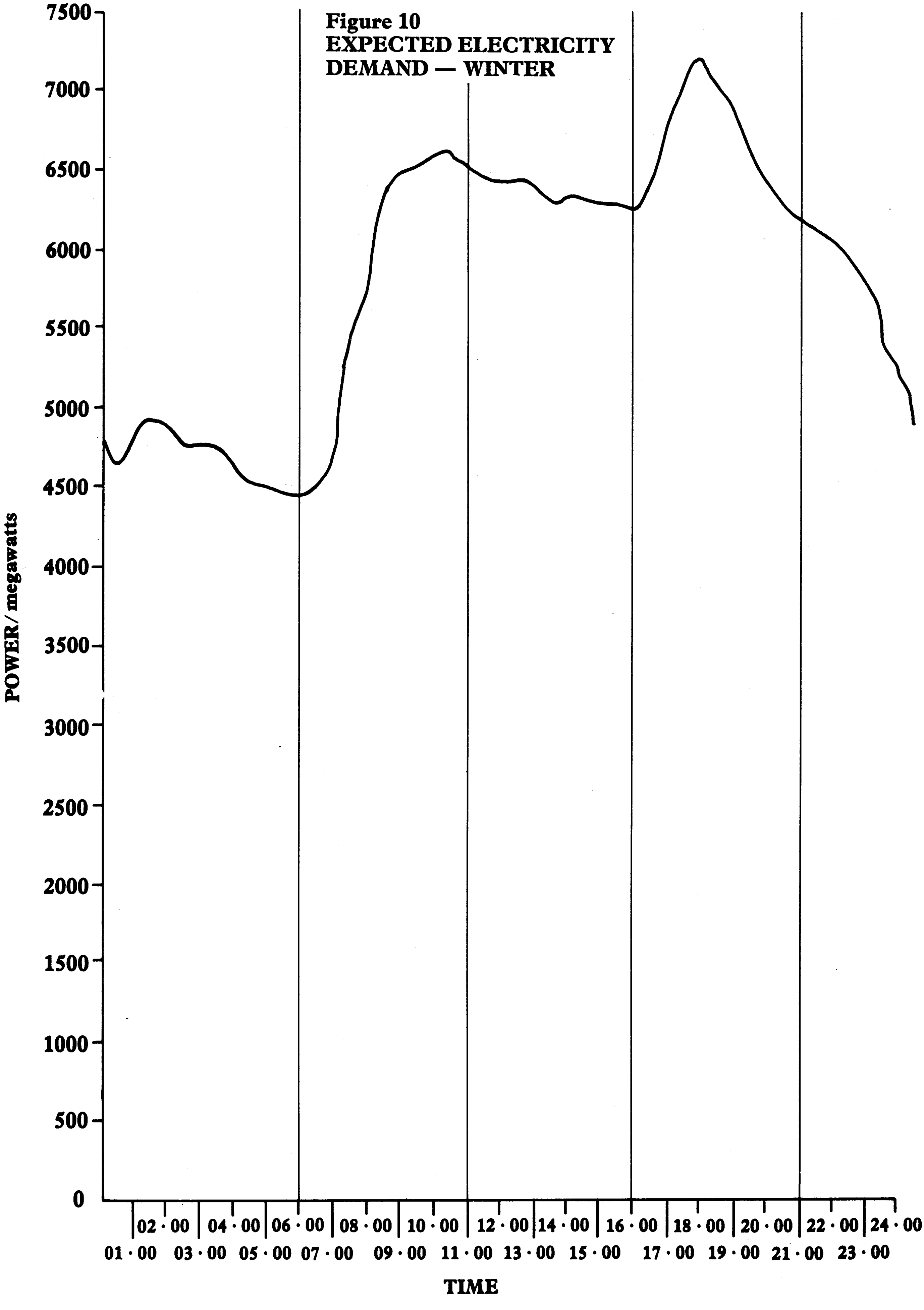


Figure 10
EXPECTED ELECTRICITY
DEMAND — WINTER
POWER/ megawatts
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01·00
02·00
03·00
04·00
05·00
06·00
07·00
08·00
09·00
10·00
11·00
12·00
13·00
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22·00
23·00
24·00
TIME

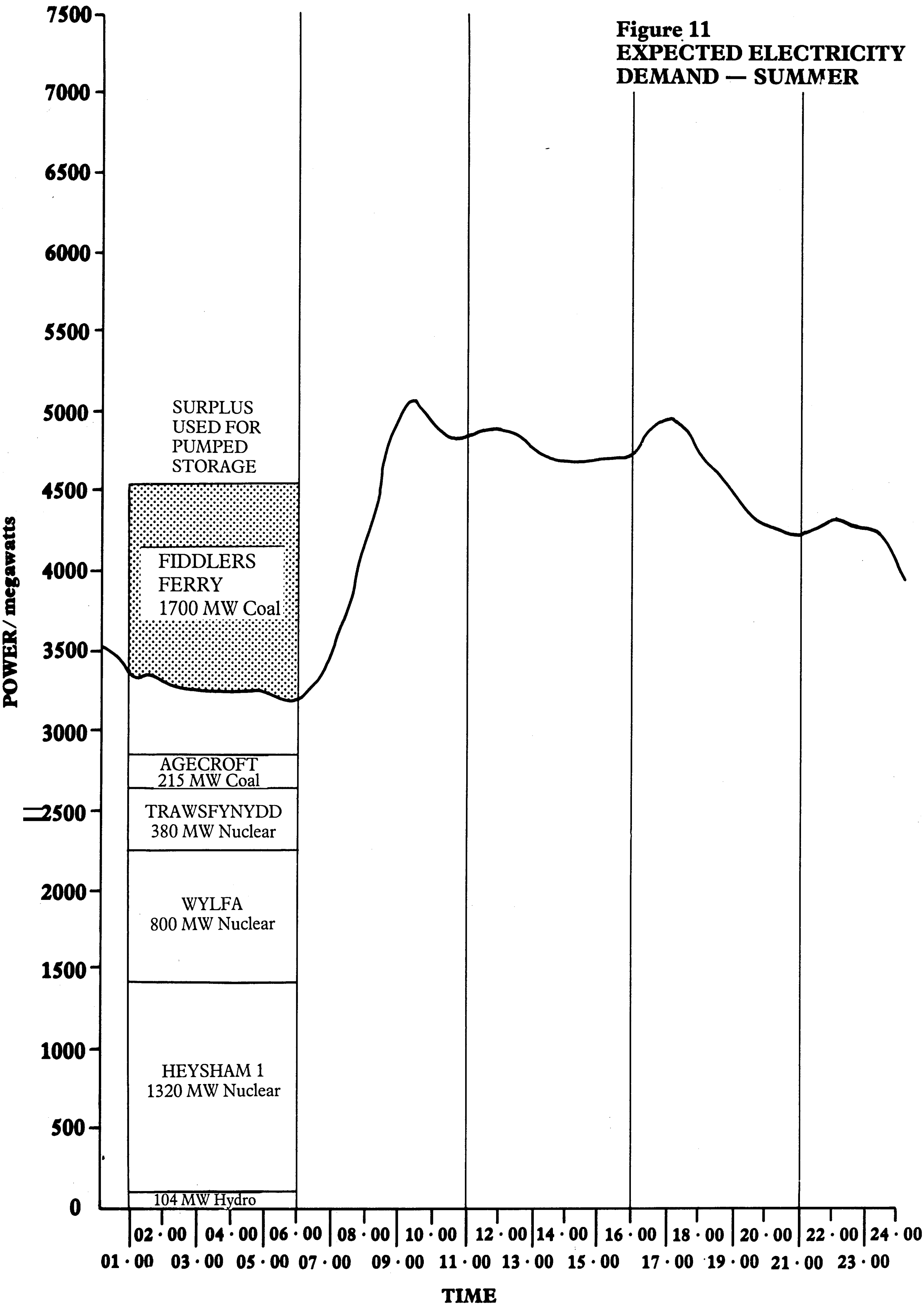


Figure 11
EXPECTED ELECTRICITY
DEMAND — SUMMER
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
POWER/ megawatts
SURPLUS
USED FOR
PUMPED
STORAGE
FIDDLERS
FERRY
1700 MW Coal
AGECROFT
215 MW Coal
TRAWSFYNYDD
380 MW Nuclear
WYLFA
800 MW Nuclear
HEYSHAM 1
1320 MW Nuclear
104 MW Hydro
02·00 04·00 06·00 08·00 10·00 12·00 14·00 16·00 18·00 20·00 22·00 24·00
01·00 03·00 05·00 07·00 09·00 11·00 13·00 15·00 17·00 19·00 21·00 23·00
TIME

Figure 12 Scale blocks to represent power station capacities. Cut them out to help you with the Task.

NUCLEAR

HEYSHAM 1
1320 MW
Nuclear

WYLFA
800 MW Nuclear

TRAWSFYNYDD
380 MW Nuclear

COAL

FIDDLERS
FERRY
1700 MW
Coal

BOLD 160 MW Coal

WESTWOOD
26 MW Coal

AGECROFT
215 MW Coal

ROOSECOTE
60 MW Coal

CARRINGTON
230 MW Coal

HUNCOAT
80 MW Coal

OIL

INCE B
1000 MW Oil

PADIHAM
100 MW Oil

HYDRO

CWM DYLI
DOLGARROG
MAENTWROG
RHEIDOL
COMBINED
104 MW Hydro

PUMPED STORAGE

DINORWIG
1800 MW
Pumped
Storage

FFESTINIOG
360 MW P. Storage

The Limestone Inquiry

Contents: A role-play exercise concerning the quarrying of limestone.

Time: 2 periods for the role-play. Preparation time (about 1 period or homework) needed beforehand.

Intended use: GCSE Chemistry and Integrated Science. Links with work on calcium carbonate, limestone and mineral resources.

Aims:

- To complement and revise prior work on calcium carbonate, limestone and its uses
- To develop awareness of issues involved in the responsible exploitation of mineral resources, particularly concerning environmental impact
- To provide an opportunity to practise skills in communication, in particular assembling and presenting an argument.

Requirements: Each student will need copies of the General Briefing (GB) and a copy of one of the Specific Briefing sheets (B1 to B7). For a class of 30, 30 copies of the GB sheets and 4 copies of each of the B sheets will be needed. If possible, the ICI video on Limestone (see 'Further resources').

It is assumed that students will already have done some work on the chemistry of limestone, including experimental work. If possible, they should have seen the ICI video, *Limestone*, which includes a certain amount of laboratory demonstration of the chemistry of limestone, as well as much information relevant to this simulated inquiry.

A suggested approach

1 Preliminary

Tell the class that next lesson they will be taking part in a Public Inquiry about a proposed extension of a limestone quarry.

Divide them into seven groups. One group will play the role of Inspectors and will organize the Inquiry. They should elect a chairperson to do the talking. Members of this group need copies of B1. The Inspectors play an important role because they control the Inquiry. It is important to have students with appropriate personal qualities in these roles, particularly the Chairperson.

Three groups will be in favour of the quarry extension. They will represent Limeco, the quarry operators (B2), the Industrial Users of Limestone (B3), and the Trades Unions (B4).

Three groups will oppose the extension. They will represent the National Park Authority (B5), Local Residents (B6), and the Local Conservation Group (B7).

Issue each member of the class with copies of the General Briefing sheets (GB), and their Specific Briefing sheets (B1 to B7) according to the group they are in. They should study these sheets in class or for homework (or both).

In school trials it was found to be very important to allow plenty of preparation time for students to assimilate the information and discuss it together.

2 On the day of the Inquiry

Each group should first spend some time together using the Briefing Sheets, their notes and other sources of information to plan how they are going to present their arguments.

The Public Inquiry itself should as far as possible be organized by the team of Inspectors. It may be better to do this in a classroom or laboratory where there is movable furniture so that the Inspectors can arrange the seating suitably. The Inspectors should be encouraged to take firm control of the Inquiry to ensure everyone gets a fair hearing.

A suggested sequence of events for the Inquiry is given in the Inspectors' Briefing sheet (B1).

Further resources

The ICI video, *Limestone*, is very useful and can be purchased at a subsidised price from: Argus Film and Video Library, 15 Beaconsfield Road, London NW10 2LE.

ICI Mond Division have some useful resource material relating to limestone:
Lime Products, an illustrated colour booklet
Limestone and Lime Products, a sheet showing uses.
Available from: ICI Mond Division, PO Box 13, The Heath, Runcorn, Cheshire WA7 4QF.

The Council for the National Parks has a kit, *Know your National Parks,* which includes factsheets on many aspects of the parks, including geology and mineral resources. Available for a small charge from: Council for the National Parks, 45 Shelton Street, London WC2H 9HJ.

Acknowledgement Figure 5 supplied by ICI Mond Division.

THE LIMESTONE INQUIRY

General Briefing

You are going to take part in an imaginary Public Inquiry concerning a limestone quarry.

Limeco Ltd have a large limestone quarry set in beautiful country in the Peak District National Park in Derbyshire. Limeco have asked the National Park Authority for planning permission to extend the quarry. They want to double the amount of limestone produced. The Authority has refused permission. Limeco have appealed against the decision, and now there is to be a Public Inquiry.

You will be playing a part in the Inquiry, and later you will have to read a special briefing about that part. But first you should read the rest of this General Briefing.

What is limestone?

Limestone is calcium carbonate, $CaCO_3$. It is formed from the remains of organisms that lived in ancient seas 300 million years ago. The limestone that occurs in the Peak District is especially pure, so it very useful, particularly for the chemical industry.

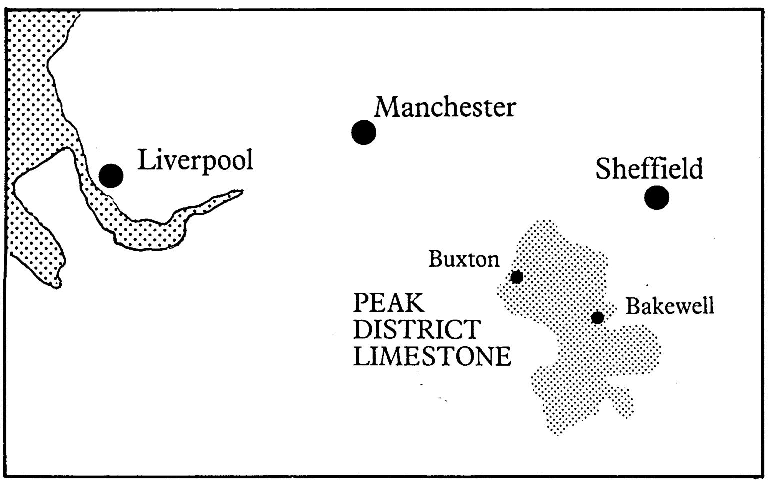


Figure 1 Map showing the Peak District

What happens in a limestone quarry?

Over a million tonnes of limestone are taken from the Limeco quarry every year. Explosives are used to blast the rock from the quarry face (Figure 2). The quarry face is 2 km long and 30m high.

The rock is loaded onto huge lorries and taken for sorting into pieces of different size. Part of the limestone is processed on the quarry site. It is used to make other things such as cement and quicklime. Part is carried away by rail or road to customers who use limestone itself. A lot of limestone is used for aggregate. Aggregate is lumps of rock or stone used to make concrete or in road-building.

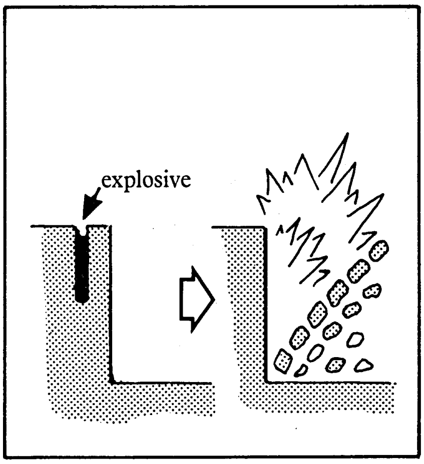


Figure 2 Blasting limestone. 60 000 tonnes are blasted at a time

What is limestone used for?

Figure 3 shows the main ways limestone is processed on the quarry site.

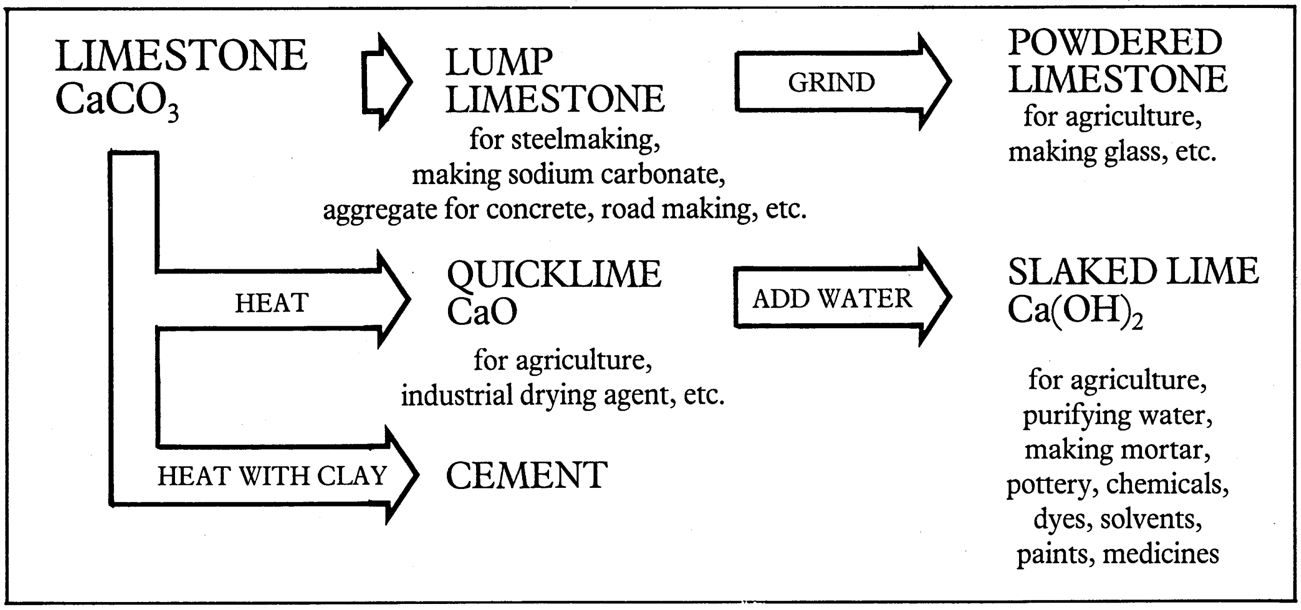


Figure 3 Some of the ways limestone is processed, and the main uses

Figure 4 shows the layout of the main parts of the Limeco quarry.

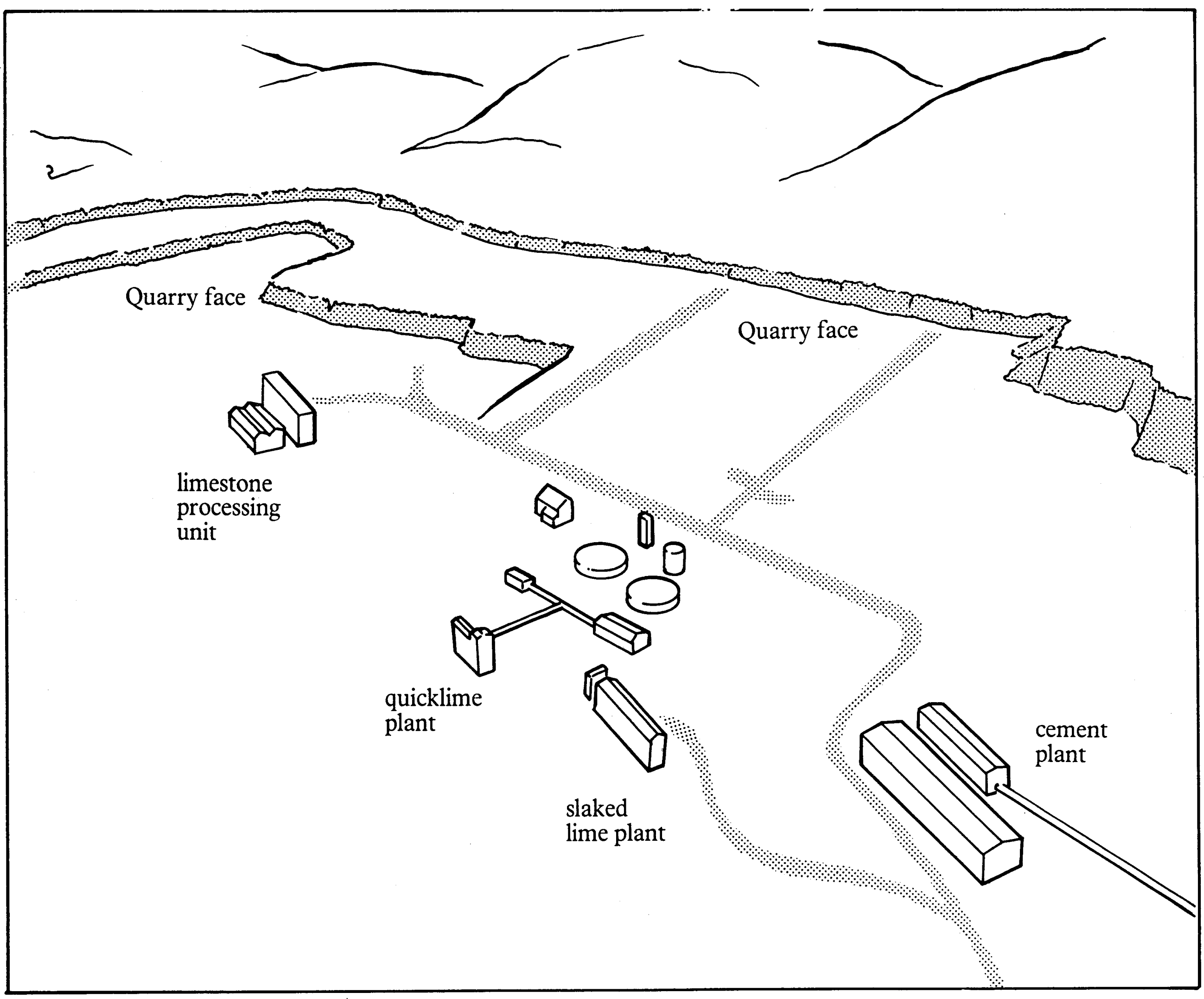


Figure 4 Layout of main parts of quarry

What you will be doing

At the Public Inquiry there will be a group of Inspectors who will listen to arguments for and against the quarry extension. These arguments will be put by the following groups:

For: Representatives of Limeco
Representatives of Industrial Users of Limestone
Representatives of Trades Unions

Against: Representatives of the National Park Authority
Representatives of Local Residents
Local Conservation Group

During the Inquiry you should bear in mind the 'Silkin Test'. This is three conditions which must be satisfied before planning permission can be given to extract minerals in a National Park.

1 There must be a clear need for the mineral which no other mineral can meet

2 There must be no other source of supply

3 The quarry company must guarantee to restore the site after use.

(These conditions are called the 'Silkin Test' after the Minister, Lewis Silkin who guided the 1949 National Parks and Access to the Countryside Bill through the House of Commons.)

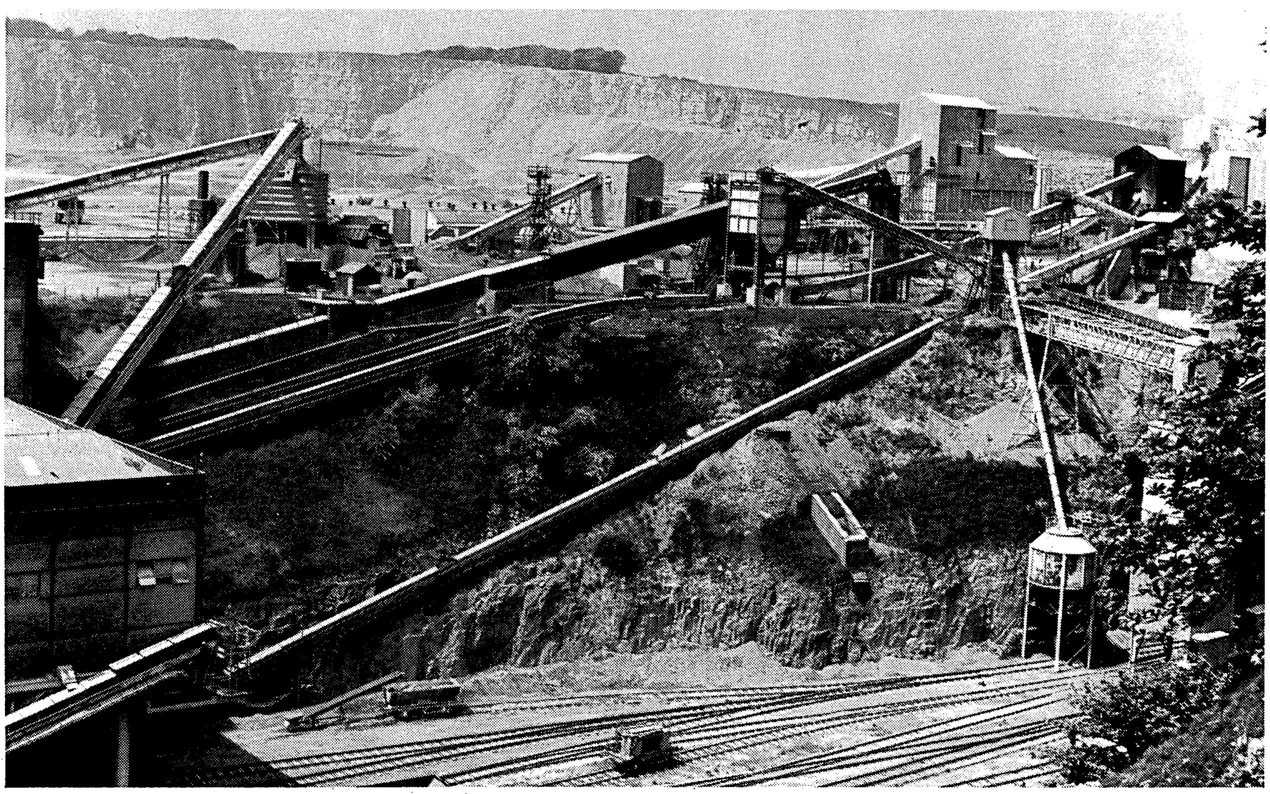


Figure 5 Limestone processing equipment at a large quarry in the Peak District

Briefing Sheet 1

The Inspectors

You are one of the panel of Inspectors in charge of the Public Inquiry. You have to listen to the various arguments put forward, then present a report to the Secretary of State for the Environment.

While listening to the arguments you must bear in mind the three conditions of the 'Silkin Test', given in the General Briefing.

Before the Inquiry starts you should decide who will be the Chairperson of the panel of Inspectors. Your Chairperson will do the speaking at the meeting.

It will be the job of the Inspectors to run the Inquiry and keep order. Much of the success of the Inquiry depends on you!

Organizing the Inquiry

Preparation

Arrange the seating in the room where the Inquiry will be held. Remember there will be three groups speaking in favour of the quarry extension (Limeco, the quarry operators; the Industrial Users of Limestone; and the Trades Unions). There will be three groups against (the National Park Authority; Local Residents; and the Local Conservation Group.)

The Inquiry

1 Call the meeting to order. Remind them that they should bear in mind the 'Silkin Test' when they present their arguments. A maximum of two minutes will be allowed for the presentation of arguments. During the speeches, do not allow anyone to interrupt.

2 Call on the representatives of Limeco to state their case appealing against the decision by the National Park Authority not to allow the quarry extension.

3 Call on the representatives of the National Park Authority to explain why they refused planning permission.

4 Call on first the Industrial Users of Limestone, then on the Trades Unions to support the case made by Limeco.

5 Call on first the Local Residents and then the Local Conservation Group to make their case against the extension.

6 Give everyone a final opportunity to answer points made by opposing groups. If you think there are any matters which have not been clearly explained, ask questions to help clear them up. Do not allow anyone to talk *too* much!

7 Close the Inquiry by saying when you will be publishing your report with its recommendations.

After the Inquiry

After the Inquiry you will consult together and write a short report stating whether or not planning permission should be granted. If permission is granted you should state any conditions to be met by the quarry operators. You will submit your report to the Secretary of State for the Environment (your teacher) who will announce the final decision in about six months time — or possibly sooner.

Briefing Sheet 2

Representatives of Limeco

You represent Limeco, the quarry operators. At the Inquiry you will have to present your arguments for extending the quarry.

You and the other representatives should first read this briefing. Then discuss the arguments you will put forward in a two-minute presentation at the Inquiry. You may want to elect a single person to speak, or share it between you.

The main points of your case

- You argue that the quarry has been a supplier of high quality limestone to industry for a long time. Transport links already exist and modern equipment (including kilns and crushing plant) is already on the site. To start a new quarry outside the Park would be very expensive because of the cost of new roads and new plant.
- It is unfortunate that the best, high purity limestone occurs in areas of natural beauty. However, extension of an existing quarry will have less effect on the environment than opening a new quarry somewhere else.
- New wheel-washing equipment will be installed to ensure that lorries do not deposit mud on the roads. New roads built to the quarry extension will be tarred to reduce the nuisance of dust and mud.
- Tree planting and landscaping will be carried out around the site before quarrying starts on the extension site. In the new part of the quarry the faces will be about 20 metres high instead of 30 metres as in the old quarry. This will reduce the visual impact of the extension.
- You consider that the extension will allow a much more natural restoration scheme for the whole site when quarrying ends. Restoration will produce a new dale which will in time look natural. You will restore the whole site for recreational use when quarrying finishes.
- If the quarry extension is permitted you will be able to increase your grants to two university groups who are investigating better ways of restoring quarries after use. You will also make grants to local trusts who are developing abandoned quarries in the area as nature reserves.

Note You may decide not to use all these arguments when making your initial presentation to the Inspector. You may want to keep some of the points in reserve, ready to answer points made by groups opposing the quarry extension.

Briefing Sheet 3

Industrial Users of Limestone

You represent some of the industrial users of the limestone quarried by Limeco. At the Inquiry you will have to present your arguments in support of the extension to the quarry.

You and the other representatives should first read this briefing. Then discuss the arguments you will put forward in a two-minute presentation at the Inquiry. You may want to elect a single person to speak, or share it between you.

The main points of your case

- For industrial purposes it is essential that the calcium carbonate used is pure. Any impurities have to be removed, and this requires extra and expensive processes. There is also the problem of disposing of the waste impurities.
- Limestone deposits are widely distributed in Britain and are quarried for many different uses. The deposits in the Peak District of Derbyshire are particularly useful. They are very pure. The deposits are easy to get at. They are near to the big industrial centres of the Midlands and the North, but unfortunately they are also in areas of outstanding beauty.
- Limestone from this district has supplied the chemical industry in Cheshire and South Lancashire since the early nineteenth century. The quarry operators understand the needs of the chemical industry. There are suitable transport links by rail and road. It would be very disruptive socially and economically if other supplies had to be found.
- The National Park Authority considers that too much of the limestone is being used for aggregate in road-building and for concrete. You will therefore wish to stress the important uses of limestone in the chemical industry, in agriculture and in steelmaking. Figure 3 in the General Briefing summarizes some of the uses of limestone and limestone products in industry. You can point out that it is unavoidable that some aggregate is produced. This is because only part of the limestone is of the right size for use in the chemical industry.

Briefing Sheet 4

Representatives of Trades Unions

You represent the trades unions involved in the work at Limeco's quarry. At the Inquiry you have to present your arguments in support of the extension to the quarry.

You and the other representatives should first read this briefing. Then discuss the arguments you will put forward in a two-minute presentation at the Inquiry. You may want to elect a single person to speak, or share it between you.

The main points of your case

- You represent the people who work in the quarry. The extension will safeguard their jobs for up to twenty years.
- You also represent the self-employed lorry drivers who transport two-thirds of the quarry output. The extension will safeguard their employment too.
- Limestone from the quarry is necessary for the steel, glass and chemical industries. It helps to maintain employment in these areas too.
- You realize that local people are affected by noise, dirt and the visual impact of the quarry. However, quarry operators make a big contribution to the local rates (Table 1).

Table 1 Where the local council get their money

	%
Household ratepayers	51
Quarry ratepayers	10
Other industrial ratepayers	8
Commercial ratepayers	11
Other non-domestic ratepayers (for example, water, gas, schools, etc.)	20

- You realize that local people are annoyed by dust and mud from lorries. Some of this is caused by workers who do not follow the rules about covering the lorries and washing mud off the wheels. You are prepared to support the employers to make sure the rules are followed. However, the workers must be allowed enough time in the work schedules.

Briefing Sheet 5

Representatives of the National Park Authority

You represent the National Park Authority, who have refused permission for Limeco to extend their quarry. At the Inquiry you will need to present your arguments supporting your refusal.

You and the other representatives should first read this briefing. Then discuss the arguments you will put forward in a two-minute presentation at the Inquiry. You may want to elect a single person to speak, or share it between you.

The main points of your case

- Your main concern is to preserve the natural beauty, scenery and wildlife of the National Park.
- You accept that some quarrying is necessary. The quarry produces very pure limestone which is needed by the chemical industry. However, you argue that the needs of the chemical industry can be met from the present quarry for many years.
- You consider that the extension is only required because too much stone is being used as aggregate for road building and concrete. Limestone for road building and concrete can be found outside the National Park. The figures show that over half the limestone output from National Park quarries is being used as aggregate for road building.
- Even if you lose the Inquiry, and permission for the extension is given, you feel there should be strict conditions. There should be conditions on the area of working and landscaping, and restoration when the quarry is worked out.
- You are convinced that there is no need to take a decision quickly. There is not enough information about the national need for limestone. A national survey of limestone deposits needs to be carried out. A long-term plan for the extraction of limestone should be developed. Until this is done no further permission for quarrying in National Parks should be granted.

Briefing Sheet 6

Representatives of Local Residents

You represent the residents living in the area around the Limeco quarry. At the Inquiry you will have to present your arguments against the extension of the quarry.

You and the other representatives should first read this briefing. Then discuss the arguments you will put forward in a two-minute presentation at the Inquiry. You may want to elect a single person to speak, or share it between you.

The main points of your case

- The quarry is ugly, dirty and noisy. It is only 150 metres from the nearest houses.

  Ugly — the quarry is a blot on the landscape, an ugly scar in otherwise beautiful countryside.
  Dirty — you suffer from dust falling in and around your homes. Dust comes from drilling, blasting and stone crushing. There is even more dust when they tip waste on dry and windy days.
  Noisy — you suffer from the noise of machinery and traffic.

- The quarry operators say they will restore the quarry at the end of its life. However, you are suspicious because in the past they have not restored quarries properly. They have left ugly heaps of waste.
- The lorries from the quarry are too big for the roads. They cause a lot of dirt in the air and mud on the roads. The lorries are not always covered as they should be. The wheel-washing equipment seems inadequate when the quarry is busy. The lorries are often driven too fast.
- Limeco say the quarry extension will create extra employment. But statistics show that employment in the quarries has fallen in the last thirty years (Table 1). So local people and local shops get less benefit from the quarry even if it does create employment further away.

Table 1 Employment statistics in the Peak National Park 1953-1976

Year	1953	1963	1970	1976
Number employed in quarries	4978	4042	3300	2180

Briefing Sheet 7

Local Conservation Group

You are a member of a local conservation group, concerned about the effect of the quarry extension on the local environment. At the Inquiry you will have to present your arguments against the extension of the quarry.

You and the other representatives should first read this briefing. Then discuss the arguments you will put forward in a two-minute presentation at the Inquiry. You may want to elect a single person to speak, or share it between you.

The main points of your case

- Quarrying limestone permanently changes the landscape. This area was made a National Park because it has some of the most beautiful scenery in Britain. It should be kept beautiful and natural for everyone to enjoy.
- Quarrying destroys the characteristic vegetation of the district and removes the habitat of wildlife.
- If permission to extend the quarry is granted, you are very concerned that the quarry site should be properly restored after use. This means making sure the disused quarry blends in with the landscape. A restoration plan must be produced before quarrying starts. The operators should also show how they will prepare for restoration during the working life of the quarry. For example, the planting of trees to screen the site needs to be planned up to thirty years ahead.
- You are worried that the quarry operators will be looking for the cheapest method for restoring the site. You insist that restoration must be done properly. You are particularly concerned that the disused quarry should not be used as a waste tip.
- If permission is granted, you insist that the quarry face should be shallow. Towards the end of the life of the quarry, the face should be left so that it will weather to look like a natural cliff. Ledges and screes should be left which will give opportunities for colonization by plants.

The Heart Pacemaker

Contents: Reading, questions and discussion concerning electronic heart pacemakers and their use in treating heart defects.

Time: 1 to 2 periods.

Intended use: GCSE Biology and Integrated Science. Links with work on the heart and circulation of the blood, and applications of electronics.

Aims:

- To complement and revise work on the heart and circulation of the blood
- To show an important application of electronics in medicine
- To develop awareness of the ways science and technology can be used to improve the quality of people's lives
- To provide opportunities to practise skills in reading, comprehension and the application of knowledge.

Requirements: Students' worksheets No. 603

Background notes on heart pacemakers

Pacemakers are required when the natural pacemaker and the normal electrical conductivity tissue of the heart are damaged through ageing or failure of the blood supply (anoxia).

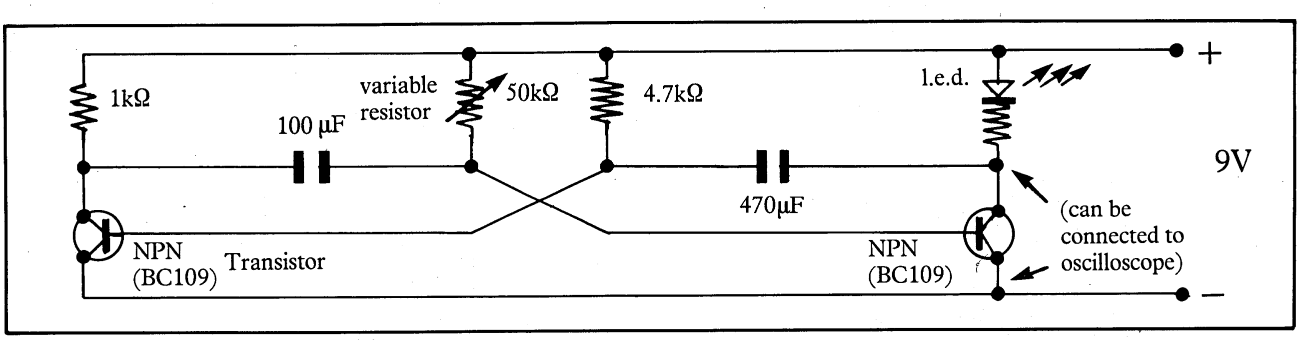
There are two types of pacemaker. The *Fixed-rate Pacemaker* puts out electrical impulses continuously at one pre-set rate, whether or not the heart is beating on its own. Its pulse generator does not sense the natural heartbeat, and the pacemaker overrides it. The *Demand Pacemaker* is more common. It senses the heart's natural rhythm, emitting pulses to stimulate the heart only when the natural rhythm falls below the pulse generator's set rate. Thus the Demand Pacemaker only works when it is needed — when the natural heartbeats are absent or too slow. This pacemaker can be either non-programmable (that is, its rate and other parameters cannot be changed), or programmable. A programmable pacemaker allows the doctor to alter the pulse generator's operation to fit changes in the patient's needs. This is done using an electronic programmer which transmits at radio frequency and is held on the patient's chest, over the implanted pacemaker unit.

A typical pacemaker might measure 5cm × 5cm × 1cm and weigh about 50g. The case material is titanium, with a coating of silicone rubber.

Most pacemakers are powered by batteries such as lithium-iodide or mercury-zinc cells. Nuclear power sources can also be used. These involve a tiny plutonium source generating heat and warming a stack of thermocouples to produce electricity.

A simple electronic pulsing circuit

The circuit below demonstrates how regular pulses of current can be generated. Some students might like to try building it. By varying the resistor, the rate of flashing of the light can be speeded up or slowed down. This is comparable with variation of heart rate at rest and during exercise.



Notes on some of the questions

Q.5 By fitting the pacemaker unit on the front of the chest, major surgery can be avoided. It also makes it easier to service the unit and change the batteries.

Q.9 The figures are taken from Davidson's *Principles and Practice of Medicine.* They raise the difficult question of whether it is justifiable to devote resources to the treatment of diseases which it is within many people's own control to avoid in the first place. The same question arises in the case of diseases related to smoking and drug abuse. Heart disease treatment makes particularly heavy demands on resources, needing highly qualified staff and expensive equipment. On average there is one nurse to every two patients in a coronary care ward, compared with one to every six or seven patients in a normal ward.

Q.10 There are many examples. Kidney machines, body scanners, radiotherapy and spare part surgery might all be mentioned.

Acknowledgements Figure 2 is reproduced by courtesy of Bill Wheat; Figure 3 is reproduced by permission from *Science* by Graham Hill and John Holman (Nelson); Figure 7 supplied by Medtronic Pacing Products; Figure 8 reproduced by permission from *Medtronic Currents: an Overview of Pacing.*

THE HEART PACEMAKER

Do you know a person who has been fitted with a heart pacemaker? It is quite possible that you do, because around 400 000 are fitted every year throughout the world.

Pacemakers are fitted to people whose hearts do not beat regularly. Before pacemakers were developed, these patients could not expect to live long, as you can see from the graph in Figure 1. For tens of thousands of people it means the difference between death and a normal, active life.

The heart pacemaker is an artificial heart stimulator. It sends small electric pulses to the heart to make it beat regularly. It is fitted when the normal, healthy rhythms of the heart have been disturbed. In most cases a patient needs the pacemaker for the rest of his or her life.

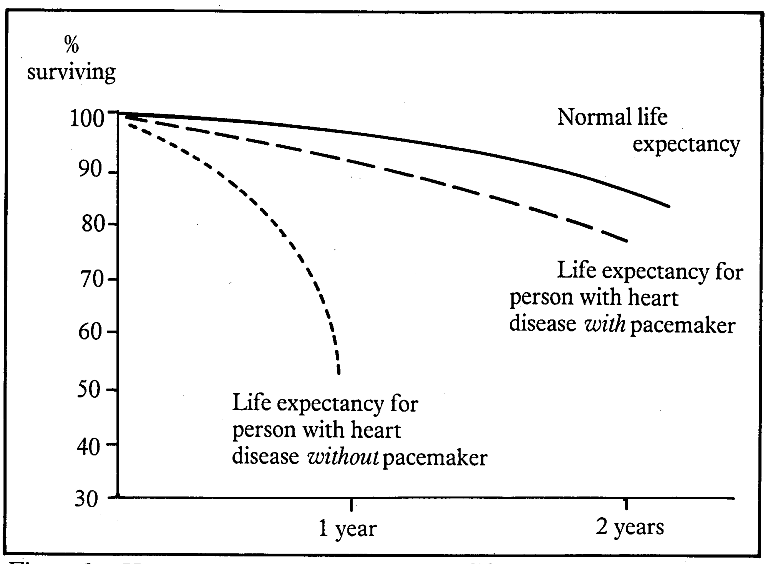


Figure 1 How a heart pacemaker increases life expectancy

Living with a pacemaker

Bill Wheat is 77 years old and lives near Walsall in the West Midlands. He still works in his own florist's business and enjoys life to the full. He was fitted with a heart pacemaker about two years ago. We met him one lunch-time at his local pub. He talked enthusiastically about his pacemaker and how it has affected his life.

Figure 2 Bill Wheat

We first asked Bill how he felt before he had the pacemaker fitted.

> 'Well, mine was an unusual case because I wasn't aware that I had a heart condition. I'd been involved in a car accident and was in hospital recovering from an operation. I was feeling tired and getting out of breath from the slightest activity. I thought this was due to the accident and through trying to do too much — I'm not as young as I used to be! When you've always been active like me it's very difficult to accept getting out of breath and having to take regular rests after doing little jobs or even just walking around. The doctor in the hospital decided to do some tests on my heart and found that it was not functioning efficiently. That was the cause of my tiredness and breathlessness.'

'How did you feel about having a pacemaker fitted?'

'Well, at first I was a little worried but I remember talking to the chap in the next bed who had been using a pacemaker for five years. He said it was marvellous and that he could run up and down hills! He also said that last week when he found he couldn't run up the hill as fast as normal he knew that his battery must be running down and he was in now to have it changed! After talking to him for a while he cheered me up no end and I realised how beneficial pacemakers could be.'

'What was it like having it fitted?'

'I think I could best describe it as being a little worse than having a tooth pulled. It was a local anaesthetic and they gave me three injections just below my right shoulder. After that I hardly felt a thing. The doctor made a small cut just below my right shoulder and introduced the lead into a vein. It was fed down through the vein into the heart itself. You can lie there and watch it on a television screen. A cut was next made in the right upper part of my chest and the pacemaker unit was implanted under the skin and the lead was attached.'

Bill then showed where the pacemaker was fitted and it was possible to feel its outline under his skin. You couldn't tell by looking that he had a pacemaker fitted.

'How has the pacemaker affected your life?'

'It's absolutely marvellous. Of course I'm still working and I do take it easy — I have to pace myself. But you feel like living and you feel good to be alive. I can now feel my pulse beating in the tips of my fingers. I can continue to live a normal active life for a man of my age, thanks to the pacemaker.'

Before looking a little more closely at pacemakers, let's see how the heart itself works.

How does the heart work?

The heart is a muscular organ about the size of a fist. It pumps freshly oxygenated blood from the lungs to the body's tissues, so that they can survive and do work. Carbon dioxide is returned in the blood to the lungs where it is breathed out.

The heart-beat rate changes with demand. Exercise causes the heart to beat faster as more oxygen is needed. Rest means the heart can beat more slowly.

Figure 3 shows the structure of the heart. The right side of the heart collects blood from the body and sends it to the lungs. The left side collects oxygenated blood from the lungs and sends it to the body. On each circuit of the body, therefore, the blood passes through the heart twice. The two atria beat first, then the ventricles. The heart beats 60 to 100 times a minute at rest — over 100 000 times a day. It sends the equivalent of 8000 litres of blood a day through the system.

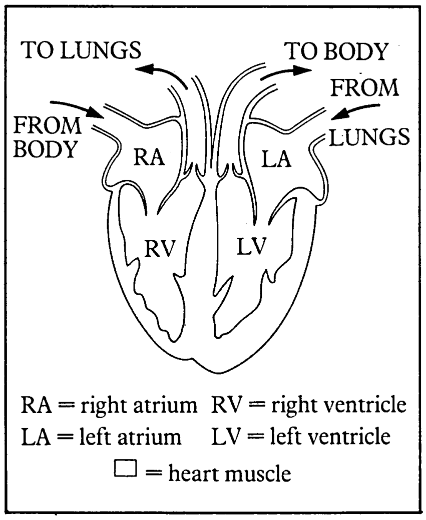


Figure 3 The structure of the heart

The beating of the heart is controlled by a 'natural pacemaker'. This sends a wave of electrical impulses through the heart (Figure 4). These impulses pass first through the two atria, causing them to contract. This squeezes the blood through valves into the two ventricles. After a short delay, the electrical impulses pass into the ventricles. This makes the ventricles contract and squeeze the blood into the lungs or the body. The rate of heart beat can be increased by sending messages from the brain along nerves to the natural pacemaker.

Occasionally something goes wrong with the natural pacemaker or the conduction pathways which carry the electrical impulses. The heart rate then becomes very slow or even stops. A slow heart rate leads to dizziness, drowsiness or shortage of breath. This is where an electronic pacemaker can take over the function of the natural pacemaker.

Answer questions 1 to 4.

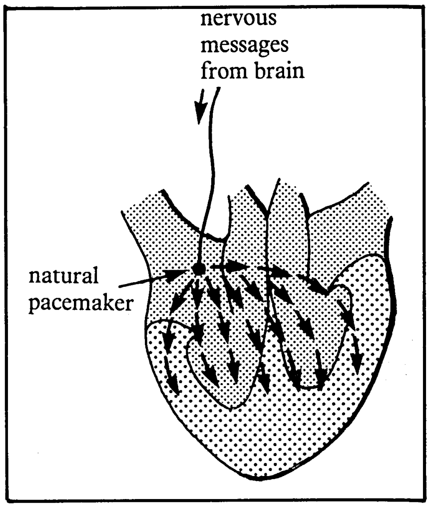


Figure 4 Electrical impulses passing through the heart from the natural pacemaker

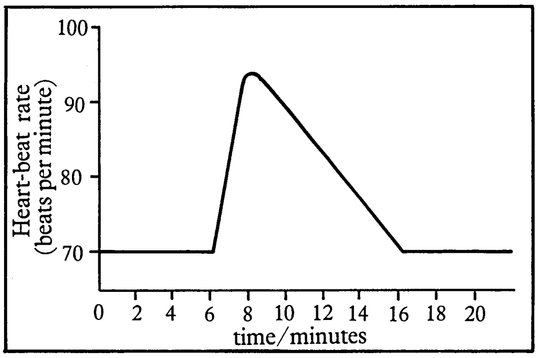


Figure 5 The woman's heart-beat rate at different times. (See Question 3.)

What can go wrong with the heart?

There are many causes of heart disease. It can be:

- Lifestyle — stress, diet, smoking, etc.
- Hereditary — passed on
- Congenital — developed when the baby is still growing in the womb, for example, as a result of the mother getting German measles during pregnancy.

It is possible to decrease the risk of heart disease by having a healthy lifestyle. This means taking plenty of exercise, eating a healthy low-fat diet, avoiding getting overweight, and not smoking.

Questions

1 *Which ventricle sends blood to the lungs? Which sends it to the body?*

2 *Why does the pacemaker send electrical impulses to the atria* before *the ventricles?*

3 *A woman's heart-beat rate was measured at different times. The results are shown in Figure 5.*
   (a) *What was: (i) the slowest rate; (ii) the fastest rate?*
   (b) *What might have caused the heart-beat rate to increase?*
   (c) *How long did it take before the heart-beat returned from the maximum rate to its original level?*

4 *Look again at the graph in Figure 1. What percentage of people survive for two years after having a pacemaker fitted?*

The electrical activity in the heart can be recorded on a machine called an **electrocardiogram (ECG).** This shows a trace on a screen or a sheet of paper. A typical trace is shown in Figure 6. A doctor can look at an ECG and tell whether a patient has problems with his or her heart.

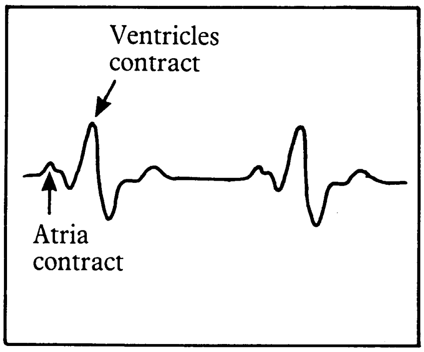


Figure 6 An ECG trace

When are pacemakers used?

Pacemakers can be used to treat several different heart disorders. For example:

- *Heart block* — when the electrical impulses do not pass properly along conduction pathways from the atria down to the ventricles.
- *Failure of the heart's own natural pacemaker* to function properly.
- *In some heart attacks* — when the blood supply to part of the heart muscle is cut off. This is usually because of a blockage in the coronary artery, and it may prevent electrical impulses being carried efficiently.

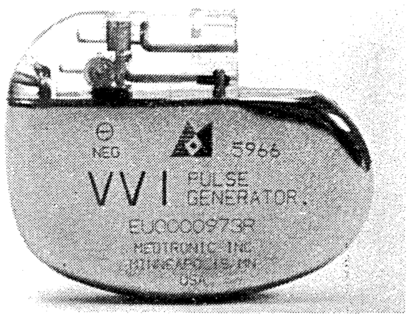


Figure 7 A heart pacemaker

How does a pacemaker work?

The pacemaker supplies properly timed electric impulses to the heart muscle. This keeps the heart beating at the proper rate. It is rather like touching an electric wire to a muscle to make it contract. Electric impulses from the pacemaker travel down a wire lead to an electrode touching the heart wall

It is quite easy to build a simple electronic circuit to provide pulses of current. If you are interested, ask your teacher for a circuit diagram.

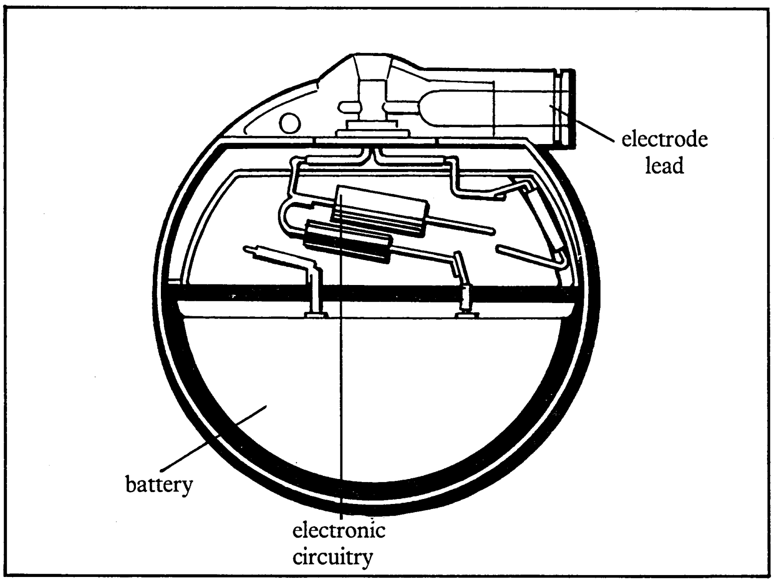


Figure 8 The main parts of a heart pacemaker unit

Fitting a pacemaker

A small cut is made and one of the large veins is exposed. The lead is then passed down inside the vein into the inside of the heart (Figure 9).

The tip of the electrode is lodged firmly at the bottom of the right ventricle, touching the muscle.

The pacemaker unit is placed under the skin of the upper chest.

The whole operation can take as little as 20 minutes to complete. It is carried out using a local anaesthetic.

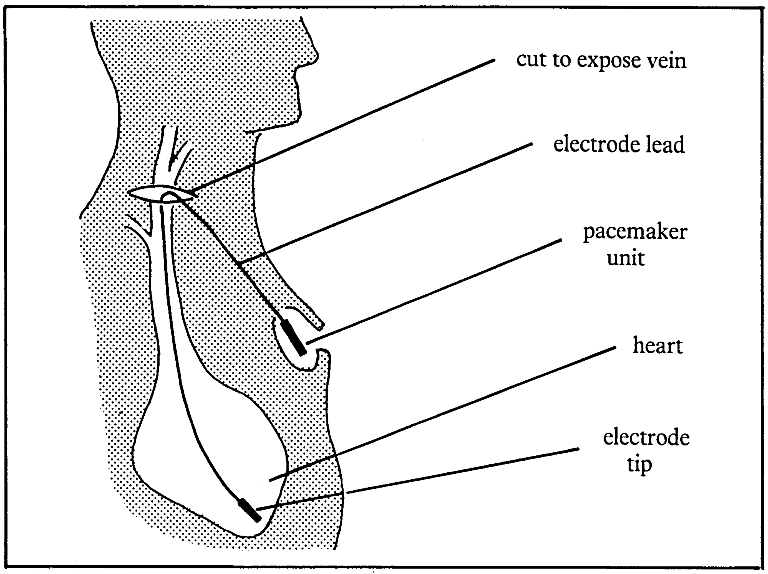


Figure 9 How a pacemaker is fitted

Questions to answer and discuss

These questions are best tackled in small groups of three or four.

5 *Why do you think the pacemaker unit is fitted on the front of the chest, and not inside the chest, nearer the heart itself?*

6 *Why is the electrode lead passed down a vein, not an artery?*

7 *What do you think Bill Wheat's life would be like without a pacemaker?*

8 *Imagine you have a serious heart condition. What things would you be unable to do? How would it affect your general lifestyle?*

9 *An expert has suggested that the causes of heart disease are:*

Lifestyle (stress, diet, smoking, etc.)	*55%*
Congenital (develops before baby is born)	*3%*
Other	*42%*

In other words, a lot of heart disease could be avoided by more healthy living.

It costs a lot of money to run a heart disease unit in a hospital. Do you think this is justified, given that the major cause of heart disease is people's own lifestyle?

10 *Heart pacemakers are an example of the way modern technology can make a major contribution to medicine. What other examples can you think of?*