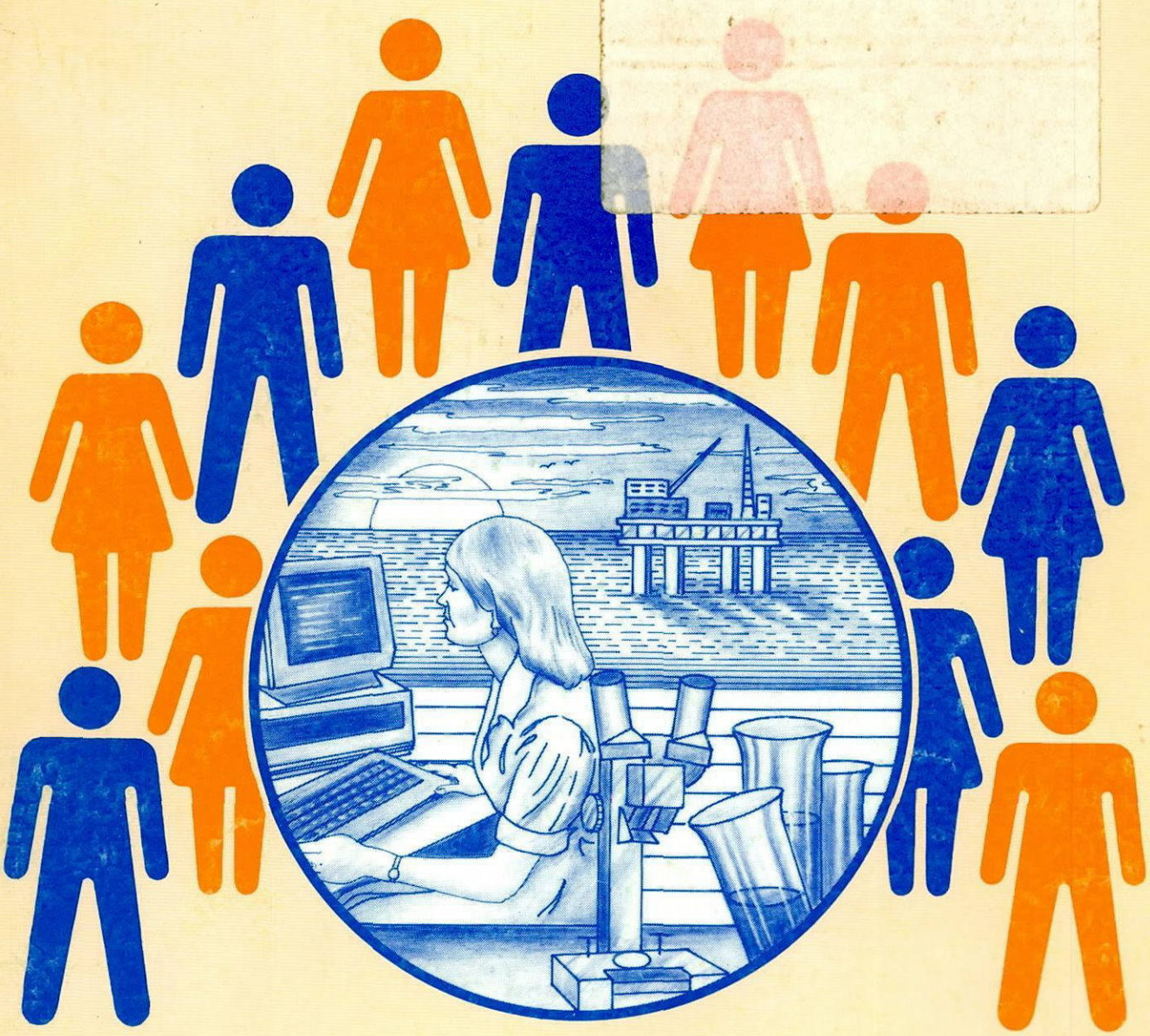
SCIENCE & TECHNOLOGY IN SOCIETY

8



ASE

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, there is a *General Guide for Teachers* which gives 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 *General Guide for Teachers*.

The names of contributors to this particular book are given on the inside of the back cover.

First published 1988 by The Association for Science Education

Designed by P & PS (Cambridge) Ltd.

SATIS 8

List of units in this book

EVALUATION OF SATIS UNITS

Users of the units in this book are invited to evaluate them by completing the questionnaire on the next page. Such feedback is of great value in helping to revise and improve the units and in determining future policy.

The Association for Science Education
College Lane
Hatfield
Herts AL10 9AA

ISBN 0 86357 045 3

List of units in the SATIS series

SATIS 1
101 Sulphurcrete
102 Food from Fungus
103 Controlling Rust
104 What's in our Food? — a look at food labels
105 The Bigger the Better?
106 The Design Game
107 Ashton Island — a problem in renewable energy
108 Fibre in your Diet
109 Nuclear Power
110 Hilltop — an agricultural problem

SATIS 2
201 Energy from Biomass
202 Electric Vehicles
203 Drinking Alcohol
204 Using Radioactivity
205 Looking at Motor Oil
206 Test-tube Babies
207 The Story of Fritz Haber
208 The Price of Food
209 Spectacles and Contact Lenses
210 The Pesticide Problem

SATIS 3
301 Air Pollution — where does it come from?
302 Living with Kidney Failure
303 Physics and Cooking
304 A Medicine to Control Bilharzia — Part 1
305 A Medicine to Control Bilharzia — Part 2
306 Fibre Optics and Telecommunications
307 Chemicals from Salt
308 The Second Law of — What?
309 Microbes make Human Insulin
310 Recycling Aluminium

SATIS 4
401 Fluoridation of Water Supplies
402 DDT and Malaria
403 Britain's Energy Sources
404 How would you Survive? — an exercise in simple technology
405 The Label at the Back — a look at clothing fibres
406 Blindness
407 Noise
408 Industrial Gases
409 Dam Problems
410 Glass

SATIS 5
501 Bridges
502 The Coal Mine Project
503 Paying for National Health
504 How Safe is Your Car?
505 Making Fertilizers
506 Materials for Life — new parts for old
507 Computers and Jobs
508 Risks
509 Homoeopathy — an alternative kind of medicine
510 Perkin's Mauve

SATIS 6
601 Electricity on Demand
602 The Limestone Inquiry
603 The Heart Pacemaker
604 Metals as Resources
605 The Great Chunnel Debate
606 The Tristan da Cunha Dental Surveys
607 Scale and Scum
608 Should we Build a Fallout Shelter?
609 Hitting the Target — with monoclonal antibodies
610 Robots at Work

SATIS 7 and Index
701 Electricity in Your Home
702 The Gas Supply Problem
703 Vegetarianism
704 Electric Lights
705 Physics in Playgrounds
706 Dry Cells
707 Artificial Limbs
708 Appropriate Pumps
709 Which Anti-Acid?
710 What is Biotechnology?
Index to SATIS 1 to 7

SATIS 8
801 The Water Pollution Mystery
802 Hypothermia
803 The Technology of Toilets
804 Electrostatic Problems
805 The Search for the Magic Bullet
806 Stress
807 Radiation — how much do you get?
808 Nuclear Fusion
809 Ball Games
810 High Pressure Chemistry

SATIS 9
901 The Chinese Cancer Detectives
902 Acid Rain
903 What are the Sounds of Music?
904 Which Bleach?
905 The Impact of Information Technology
906 IT in Greenhouses
907 Your Stars: Revelation or Reassurance?
908 Why not Combined Heat and Power?
909 AIDS
910 Disposable Nappies

SATIS 10 and Index
1001 Chocolate Chip Mining
1002 Quintonal: an industrial hazard
1003 A Big Bang
1004 Lavender
1005 Mental Illness
1006 As Safe as Houses
1007 240 Volts Can Kill
1008 Why 240 Volts?
1009 Trees as Structures
1010 Can it be done? Should it be done?
Index to SATIS 1 to 10

Evaluation of SATIS units

Your opinions as an experienced teacher will help to revise and improve the SATIS units in this book and to influence the style of future units.

Please
- Complete a response table (overleaf) for any unit you have used. If you need more response tables, please make photocopies.
- Return the completed sheet(s) to:

SATIS Evaluation, ASE, College Lane, Hatfield, Herts AL10 9AA

Information about your school

Name of SATIS contact person: .....

Role: .....

Name of school: .....

Address: .....

.....

Type of school *(Please circle):*

Comprehensive Grammar Secondary Modern Independent Other

Boys only Girls only Mixed

Age range: ..... Total school roll: .....

Your opinions about the SATIS units in this book

The aspects for comment are listed below and we have provided response tables on the other side of this sheet. For each unit:

Please
- Complete the headings
- Tick the box which most closely reflects your opinion about each aspect of the unit you have taught
- If you have 'no opinion', or do not wish to give one, please tick the box on the extreme right.

Aspects for comment

(a) Relevance for GCSE courses (Is the unit relevant to your course?)
(b) Students' apparent interest (Did the unit stimulate interest in your students?)
(c) Language level (Is the unit written at a suitable level for your students?)
(d) Concept level (Were the conceptual demands appropriate?)
(e) Suggested amount of time (Was there enough time to complete the unit?)
(f) Recommended teaching/learning method (Was this appropriate for the unit?)
(g) Presentation (layout, diagrams, photos, print size) (Was all this suitable?)
(h) Teachers' notes (blue sheets) (Did you find these useful?)
(i) The teaching sequence in the unit (Was the unit organised suitably?)
(j) Requirements for students' response (Did the unit require suitable activities and feedback from students?)

I intend to use the following units again without revision. (Please quote unit number only.)
I intend to use the following units again, with revision.
I do not intend using the following units again.

SATIS unit number .....

Years and abilities used with .....

(a) Relevance for GCSE	Very relevant	Relevant	Little relevance	Not relevant	No opinion
(b) Students' apparent interest	Very interested	Interested	Little interest	Bored	No opinion
(c) Language level	Very suitable	Suitable	Quite difficult	Very difficult	No opinion
(d) Concept level	Very appropriate	Appropriate	Not appropriate	Completely in-appropriate	No opinion
(e) Suggested amount of time	Very satisfactory	Satisfactory	Difficult to meet	Badly estimated	No opinion
(f) Recommended teaching/learning method	Very appropriate	Appropriate	Needs improving	Not at all appropriate	No opinion
(g) Presentation (Layout, diagrams, photos, print size, etc.)	Excellent	Good	Needs improving	Poor	No opinion
(h) Teachers' notes (the blue sheets)	Very useful	Useful	Need improving	Of little use	No opinion
(i) The teaching sequence in the unit	Very suitable	Suitable	Needs some reorganising	Needs much reorganising	No opinion
(j) Requirements for students' response	Very suitable	Suitable	Need improving	Unsuitable	No opinion

Further comment:

SATIS unit number .....

Years and abilities used with .....

(a) Relevance for GCSE	Very relevant	Relevant	Little relevance	Not relevant	No opinion
(b) Students' apparent interest	Very interested	Interested	Little interest	Bored	No opinion
(c) Language level	Very suitable	Suitable	Quite difficult	Very difficult	No opinion
(d) Concept level	Very appropriate	Appropriate	Not appropriate	Completely in-appropriate	No opinion
(e) Suggested amount of time	Very satisfactory	Satisfactory	Difficult to meet	Badly estimated	No opinion
(f) Recommended teaching/learning method	Very appropriate	Appropriate	Needs improving	Not at all appropriate	No opinion
(g) Presentation (Layout, diagrams, photos, print size, etc.)	Excellent	Good	Needs improving	Poor	No opinion
(h) Teachers' notes (the blue sheets)	Very useful	Useful	Need improving	Of little use	No opinion
(i) The teaching sequence in the unit	Very suitable	Suitable	Needs some reorganising	Needs much reorganising	No opinion
(j) Requirements for students' response	Very suitable	Suitable	Need improving	Unsuitable	No opinion

Further comment:

SATIS unit number .....

Years and abilities used with .....

(a) Relevance for GCSE	Very relevant	Relevant	Little relevance	Not relevant	No opinion
(b) Students' apparent interest	Very interested	Interested	Little interest	Bored	No opinion
(c) Language level	Very suitable	Suitable	Quite difficult	Very difficult	No opinion
(d) Concept level	Very appropriate	Appropriate	Not appropriate	Completely in-appropriate	No opinion
(e) Suggested amount of time	Very satisfactory	Satisfactory	Difficult to meet	Badly estimated	No opinion
(f) Recommended teaching learning method	Very appropriate	Appropriate	Needs improving	Not at all appropriate	No opinion
(g) Presentation (Layout, diagrams, photos, print size, etc.)	Excellent	Good	Needs improving	Poor	No opinion
(h) Teachers' notes (the blue sheets)	Very useful	Useful	Need improving	Of little use	No opinion
(i) The teaching sequence in the unit	Very suitable	Suitable	Needs some reorganising	Needs much reorganising	No opinion
(j) Requirements for students' response	Very suitable	Suitable	Need improving	Unsuitable	No opinion

Further comment:

SATIS unit number .....

Years and abilities used with .....

(a) Relevance for GCSE	Very relevant	Relevant	Little relevance	Not relevant	No opinion
(b) Students' apparent interest	Very interested	Interested	Little interest	Bored	No opinion
(c) Language level	Very suitable	Suitable	Quite difficult	Very difficult	No opinion
(d) Concept level	Very appropriate	Appropriate	Not appropriate	Completely in-appropriate	No opinion
(e) Suggested amount of time	Very satisfactory	Satisfactory	Difficult to meet	Badly estimated	No opinion
(f) Recommended teaching learning method	Very appropriate	Appropriate	Needs improving	Not at all appropriate	No opinion
(g) Presentation (Layout, diagrams, photos, print size, etc.)	Excellent	Good	Needs improving	Poor	No opinion
(h) Teachers' notes (the blue sheets)	Very useful	Useful	Need improving	Of little use	No opinion
(i) The teaching sequence in the unit	Very suitable	Suitable	Needs some reorganising	Needs much reorganising	No opinion
(j) Requirements for students' response	Very suitable	Suitable	Need improving	Unsuitable	No opinion

Further comment:

The Water Pollution Mystery

Contents: A data-analysis exercise about solving the problem of death of fish in a river.

Time: 2 periods for Part 1 followed by another period, or homework, for Part 2.

Intended use: GCSE Biology, Chemistry and Science.

Aims:

- To complement work on water pollution, water supply and the solubility of gases
- To develop awareness of the different types of water pollutants and their effects
- To provide opportunities to practise the skills involved in analysing data and using graphs
- To give an opportunity for writing about a technical subject for non-specialist readers.

Requirements: Students' worksheets No. 801. The graph for Lab. Report 4 should be duplicated separately, one per student. This will allow each student to plot the points and examine the results. Part 2 (if used) should be kept separate and retained by the teacher until the students have worked through Part 1.

Authors: This unit was adapted by Tom Kempton from the American Chemical Society publication *Chemistry in the Community* (ChemCom), by kind permission.

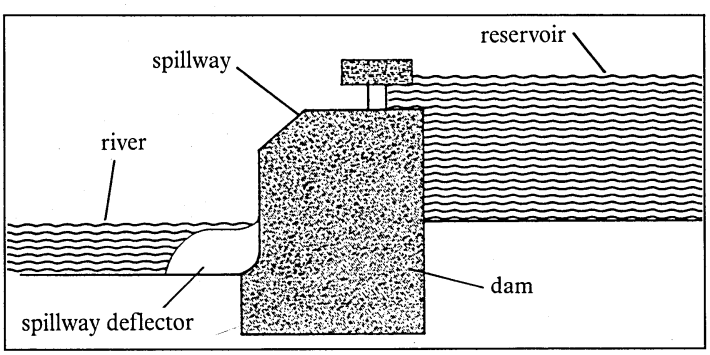
Suggested use of the unit

Part 1 can be used on its own as a data-analysis exercise. The results are inconclusive. The Lab. Reports show that none of the suggested causes can account for the death of the fish.

Once the students have worked through Part 1 and found that they have no answer to the problem, they can be given Part 2 and asked to write the article for the local newspaper as suggested.

However, many students will need help with the ideas in Part 2 and the journalism exercise is demanding. Some teachers may prefer not to issue Part 2 to the students but tell the class about the explanation given.

An alternative problem for the pupils to think about is the way in which water is released from the dam. One method of reducing the problem would be to release the water more slowly. Another possibility is to install deflectors on the downstream side of the dam to prevent water plunging to great depths.



Further resources

Further resource material is available from local Water Authorities, and from the Research and Information Officer, Water Authorities Association, 1 Queen Anne's Gate, London SW1H 9BT.

THE WATER POLLUTION MYSTERY Part 1

What you have to do

As a local scientist you have been asked to join a team of scientists led by Dr Marjorie Element. You have been called in at short notice to help investigate the sudden death of the fish in the Whitewater River. You have read newspaper reports such as the one on this page.

There is an urgent need to solve the problem. The water company is having to spend thousands of pounds bringing in drinking water. The tourism trade is threatened. Local industrialists need to know if they can continue to use river water in their processes.

You have already acted quickly by arranging to have water samples collected and analysed. The water does not look unusual and it does not smell. Nothing unexpected was found when samples of the water were filtered. There is no oil floating on the surface. So you think that the problem may have been caused by something dissolved in the water.

You have now decided to investigate the following possible causes of the sudden death of the fish:

- Was the water polluted by poisonous metals?
- Was it pollution by acids or alkali?
- Was it the temperature of the water?
- Was there too little, or too much, oxygen in the water?

The first results of the analyses have just arrived and the team are now meeting to discuss the findings. You have to advise the water company what they should do next.

Your job will be to study the results, with the help of the questions and then draw up a short report to the water company.

LONGFORD OBSERVER, FRIDAY, AUGUST 28TH

WHITEWATER RIVER POISONED?

There is fear in the minds of those who live along the Whitewater River. Who has poisoned our river?

Thousands of dead fish have been found floating in the river. The dead include roach, perch and carp.

The pumping station at the waterworks has been closed down until scientists can find what has polluted the water. Essential drinking water is being brought in by tanker from other areas at great expense.

Local shopkeepers are very worried by the loss of trade. The nearby hills are popular with weekend walkers. Already some people have cancelled their late summer holidays.

Some officials think that poison must have been poured into the reservoir upstream.

Local fishing folk are very upset. The weekend competition has been cancelled.

One man interviewed said: 'This has ruined our future. The fish have died in a terrible way with bleeding and bubbles under the skin. I dread to think what's in the water.'

The fish died in a very short time so experts believe the problem is due to some kind of pollution of the water. It seems unlikely that a disease could develop so quickly.

Water samples are being analysed in an attempt to find the cause of the disaster.

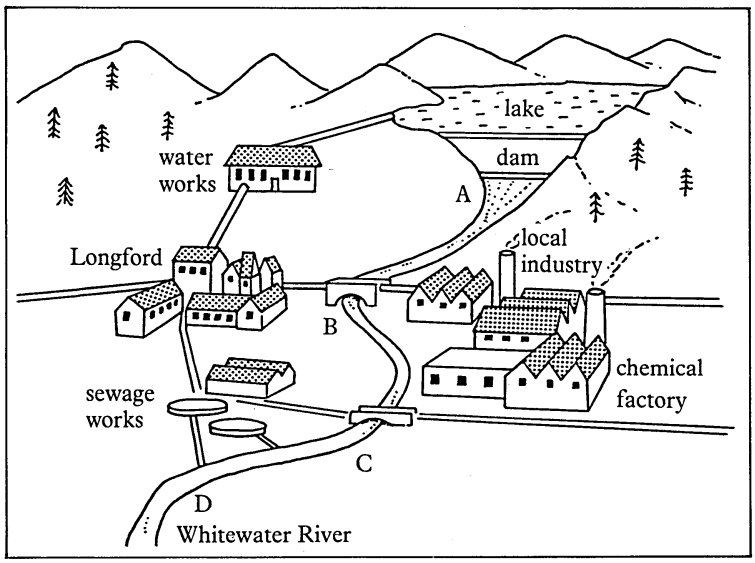


Figure 1 The Whitewater River

Reports from the analytical laboratories

1 Was the water polluted by poisonous metals?

BACKGROUND INFORMATION

Compounds of the heavy metals lead, mercury and cadmium are serious pollutants. They are very harmful to animals, including human beings. They are particularly hazardous because they are widely used. They can build up in food chains.

Compounds of arsenic and selenium may be present in water. They are also poisonous.

These poisonous elements dissolve in water as their ions, particularly if the water is acidic.

Read Lab. Report 1, then answer questions 1 to 4.

LAB. REPORT 1

Water samples were taken for analysis at point D (see the map in Figure 1). Table 1 shows the concentrations of a number of ions which might have caused pollution. The results are compared with values obtained for the same ions six months ago.

Table 1 Ion concentrations in the Whitewater River

Ion	*Concentration six months ago/ 10^{-2} mg per litre*	*Concentration now/ 10^{-2} mg per litre*	*Limit for freshwater life/ 10^{-2} mg per litre*	*Limit for humans/ 10^{-2} mg per litre*
Arsenic	0.02	0.02	44	5
Cadmium	0.01	0.01	0.15	1
Lead	1	2	7.4	5
Mercury	0.04	0.01	0.41	5
Selenium	0.4	0.8	26	1
Chloride	5240	5160	No limit	No limit
Sulphate	3400	3510	No limit	No limit
Nitrate	210	190	No limit	5000

Questions

1 *Which ions have decreased in concentration in the Whitewater River during the last six months?*

2 *Which ions have increased in concentration during the last six months?*

3 *Do you think that the water company needs to be concerned by the concentrations of any of the ions in Table 1?*

4 *Was the concentration of any of the ions responsible for killing the fish?*

2 Was it pollution by acids or alkali?

BACKGROUND INFORMATION

Rainwater is naturally slightly acidic. This is because it dissolves some of the carbon dioxide in the air. However, it can become even more acidic if the air is polluted by sulphur dioxide or nitrogen oxides. These oxides are formed when fossil fuels are burned in power stations and cars.

Rivers can be polluted by accidental spills of acids or alkalis from factories. Sewage works can release outflows which affect the pH of a river. Pure, neutral water has a pH of 7. The pH of acidic water is below 7. Alkaline water has a pH above 7.

Most fish can survive in river water with a pH range from 5 to 9. Fishing is generally only worthwhile in rivers with a pH between 6.5 and 8.2.

Read Lab. Report 2, then answer question 5.

LAB. REPORT 2

The river was sampled at four places (A, B, C and D, as shown on Figure 1). The pH measurements are given in Table 2.

Table 2

Sample point	*pH of the water*
A	6.5
B	6.6
C	7.4
D	7.7

Question

5 *Did acid or alkali pollution kill the fish? (Give your reasons briefly.)*

3 Was it the temperature of the water?

BACKGROUND INFORMATION

Figure 2 shows how the solubility of oxygen in water varies with temperature.

Different fish require different amounts of oxygen to live in a river as shown in Figure 3 and Table 3.

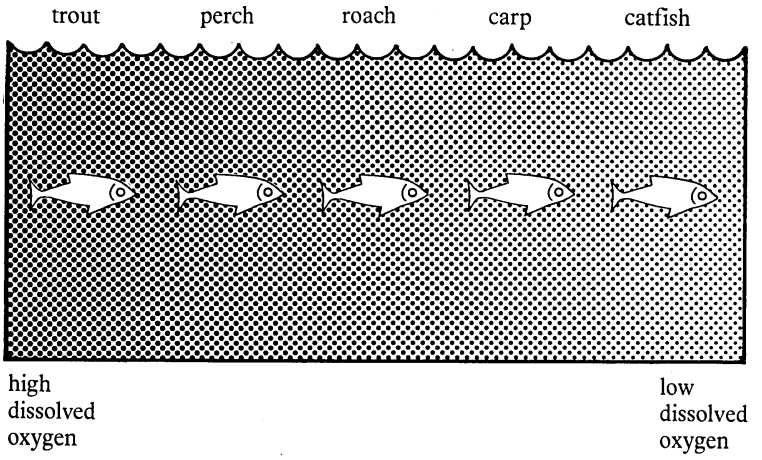


Figure 3 Dissolved oxygen required for various fish

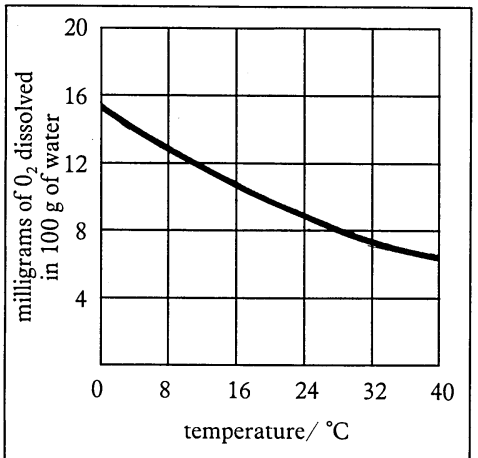


Figure 2 Solubility curve for oxygen gas in water in contact with air

The water temperature also affects the rate at which fish use oxygen. Fish are 'cold blooded' which means that their body temperature is the same as the water temperature. Fish are more active, eat more and swim faster when the water is warmer. So they use more oxygen.

Read Lab. Report 3, then answer questions 6 to 10.

LAB. REPORT 3

Table 4 shows the maximum water temperature recorded each month over the past year. Fish have thrived in the river until the sudden deaths during August this year.

Table 4 Monthly maximum temperatures and monthly dissolved oxygen levels in the Whitewater River

Month	*Maximum water temperature /°C*	*Dissolved oxygen / mg per litre*
August (last year)	22	9.2
September	19	9.2
October	11	10.6
November	8	11.0
December	7	11.0
January	2	12.7
February	3	12.5
March	7	11.0
April	8	10.6
May	10	10.4
June	16	10.2
July	18	9.6
August (month of fish deaths)	23	9.9

Table 3 Maximum water temperature at which fish can survive

Fish	*Temperature °C*
Trout	15
Perch and pike	24
Carp	32
Catfish	34

Questions

6 *How many milligrams of oxygen will dissolve in 100 g river water*
(a) at 8°C
(b) at 20°C?
(Figure 2)

7 *Why was the level of dissolved oxygen higher in January than in August? (Table 4)*

8 *Why is there a danger of fish suffocating for lack of oxygen during hot summer weather?*

9 *Explain, with the help of Figures 3 and Table 3, why carp can survive in water at a higher temperature than trout.*

10 *Was the temperature of the water responsible for the death of the fish? (Remember that the dead fish included roach, perch and carp.)*

4 Was there too little, or too much, oxygen in the water?

BACKGROUND INFORMATION

High temperatures are not the only factor which can lower the amount of dissolved oxygen in river water. Sewage waste can have the same effect. So too can organic waste materials from farms.

Sometimes the level of dissolved oxygen can be too *high*. This is unusual but it can be serious for fish.

Study Lab. Report 4, then answer questions 11 to 13.

LAB. REPORT 4

The lab. has sent a graph (Figure 4) to help you to study the information about the oxygen levels in the water. Plot the results from Table 4 as points on the graph.

Fish are in danger if the points lie in either of the shaded areas.

Questions

11 Do any of the points you have plotted on the graph suggest that the fish might be expected to die?

12 Is there anything significant about the position of the point for the month when the fish died?

13 Write a short report to the water company, explaining what you have found out about the water pollution mystery.

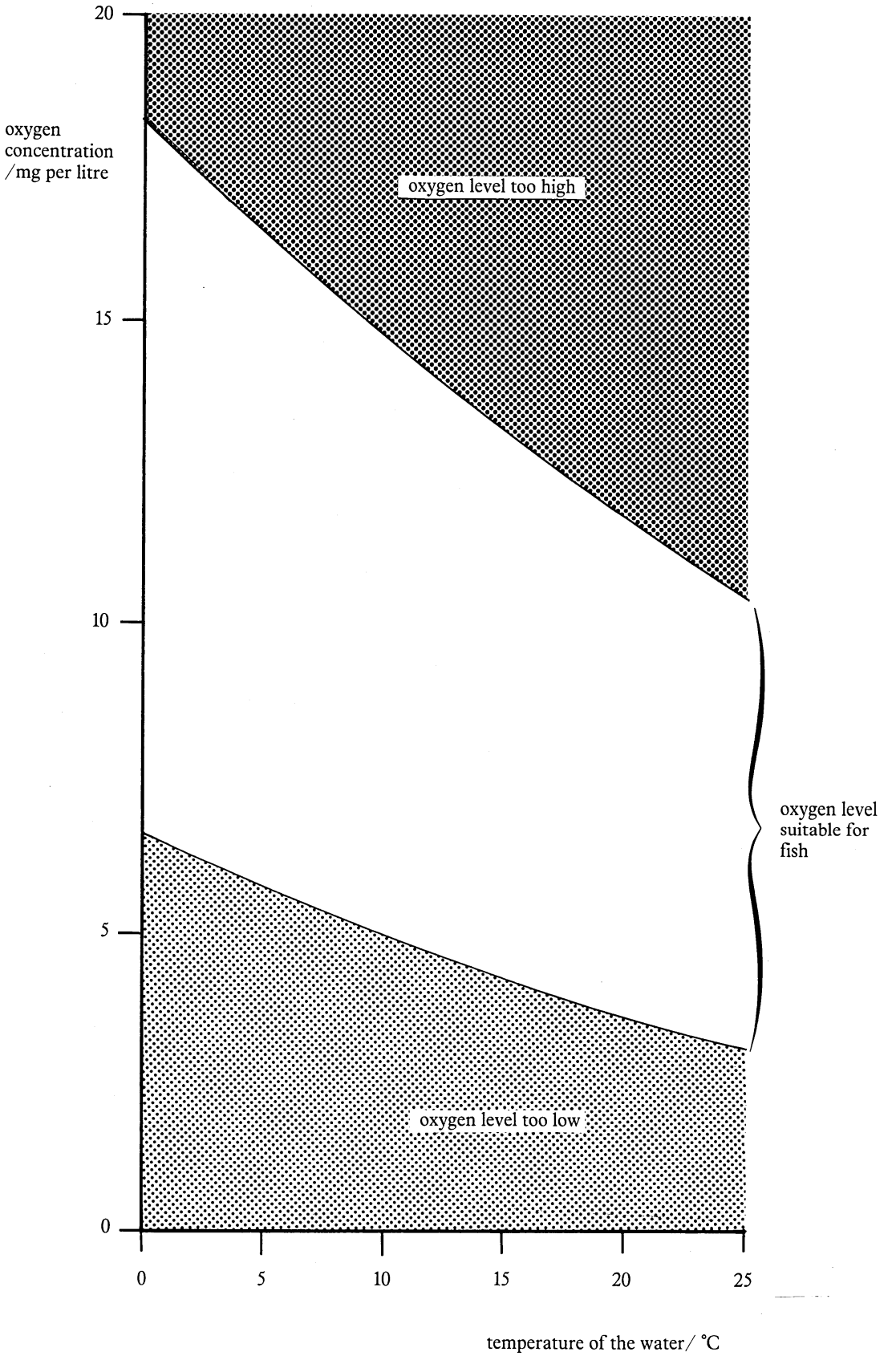


Figure 4 Graph showing the conditions of oxygen concentration and temperature which are suitable for fish

Part 2 — A new theory

The fish mystery was solved after a long meeting at which no one could think of any answer to the problem. A group of scientists were sitting round a table having drinks and watching the bubbles rising round the edge of the glasses.

Suddenly Dr Element rushed from the room and came back with her papers and the original newspaper article. She was full of excitement about gases and bubbles. Someone else remembered reading a report about fish suffering from a condition rather like the 'bends'. Divers suffer from the 'bends' if they come to the surface too fast.

At last it was beginning to make sense. Suddenly everyone was very excited. Everybody seemed to be talking at once, but eventually you agreed to summarize the new theory:

- The Whitewater River contained more air than can normally dissolve at the temperature of the water.
- The excess air passed into the blood of the fish through the gills.
- The extra air came out of solution to form bubbles in the gills and heart of the fish.
- The bubbles blocked the blood vessels and stopped the blood circulating, so the fish died.

Fizzy drinks provided the clue. More gas can dissolve in water if the pressure is raised. Some of the gas comes out of solution again forming bubbles when the pressure is released. But it you have ever taken the top off a fizzy drink bottle you will know that the gas does not all come out at once. More gas bubbles form if the drink is shaken or stirred.

Too much air can dissolve in river water near dams and hydroelectric schemes. This happens when a big rush of water is released forming a froth. The water and air plunge down below the surface of the river. The pressure is greater the deeper the water. The increased pressure forces more air into solution.

What you have to do

As the local scientist in the investigating team you have been asked to write an article for the *Longford Observer.* The editor wants you to explain why the fish died. Many people still do not really understand why so many fish were killed even though the water was not harmful to people.

The editor has asked you to describe the findings of your research group to help reassure the public. She has also asked you to give an explanation of the 'gas bubble' condition.

You have a word limit of 300—500 words. You are allowed space for two diagrams, or pictures.

LONGFORD OBSERVER

Fish deaths mystery solved

Life has returned to normal along the Whitewater River. The pumping station at the waterworks has reopened. There was never any risk to human health.

A press conference was held this morning at the offices of the water company. The team of scientists who have been investigating the death of fish in the Whitewater River last August presented their findings. The team was led by Dr Marjorie Element who announced that the fish died because of a rare condition called 'gas bubble disease'.

Dr Element explained that there was an excess of air dissolved in the river water. 'The excess air forms gas bubbles in the gills and heart of the fish. This stops the blood circulating and the fish die.'

Dr Element was not willing to comment on the reasons for there being so much air dissolved in the river. However, informed sources say that the records of the hydroelectric scheme higher up the valley are being investigated.

On the next page one of the investigating team has written an article explaining 'gas bubble disease'.

Hypothermia

Contents: Reading and questions about hypothermia including a case study to show how it can affect young people in severe weather conditions.

Time: 2 periods, or more, depending on the number of parts attempted.

Intended use: GCSE Biology, Human Biology and Science. In Physics courses there are possible links with work on energy transfer by convection, conduction, and radiation as well as with the energy changes which accompany phase changes.

Aims:

- To complement work on the regulation of body temperature and work on heat transfer
- To explain the nature and causes of hypothermia and to show how the condition can affect both old and young people
- To provide opportunities to practise skills in reading and comprehension
- To provide an opportunity to practise the evaluation of evidence.

Requirements: Students' worksheets No.802.

Authors: Julian Cohen and Kris Stutchbury

Suggested use

This unit is in three parts:

Part 1 What is hypothermia?
Part 2 Why are old people more likely to suffer from hypothermia?
Part 3 Danger out of doors

Students should start by studying Part 1 but they can then either study Part 2, or Part 3, or both. Part 3 can be shortened by omitting pages 5 and 6.

The unit concentrates on the dangers of hypothermia, but a sub-normal body temperature can be useful too. Surgeons cool the blood and body before doing heart operations. The heart can be stopped for up to 12 minutes if the body is cooled to 30°C. During one operation at the Westminster Hospital in London a patient's heart was stopped for 50 minutes after cooling the body to 15°C.

Notes on some of the questions

Q.6 Suitable answers might be:

(a) 29°C
(b) 1°C
(c) 26°C
(d) 43°C
(e) 60°C
(f) 200°C
(g) 10°C

Q.7 Alcohol gives a feeling of warmth and well-being, but this effect does not last and is dangerous for people who are weak, or suffering from exhaustion. Energy loss from the body may increase rapidly after drinking alcohol, because alcohol causes blood vessels in the skin to dilate. Students might be interested to hear about the danger of taking a cold dip to 'sober up' after excessive drinking.

Q.8 Digesting food releases energy and so a nourishing cold meal can help to warm the body in the same way as a hot meal. A cold meal may not feel as satisfying.

Q.9 Activity and regular eating are the best ways of keeping warm. Extra clothing can help but too much produces little extra benefit and may discourage a person from moving around. It can be dangerous for old people to go to bed during the day, even though they might think it will warm them up, because it stops them moving around.

Q.10 There is no real evidence either way, but some medical experts think that there may be a link between the large incidence of bronchitis in Britain and the tradition of having cold bedrooms.

Q.11 Most at risk are: (b), (d) and (e).

Q.13 About twenty people die each year on the hills and moors of Britain. Under normal conditions about one-third of the energy transferred from the body is lost by the evaporation of perspiration. More is lost in this way after strenuous exercise. The danger of wearing damp clothing is that it can allow rapid loss of energy, through loss of air insulation and the cooling effect of evaporation. When there is a wind blowing, wet walkers are no better off than they would be naked at a lower wind speed.

Qs 14 to 16 'Space blankets' are effective because:

(a) Their shiny inner surface reflects back radiation emitted by the body inside.

(b) Their outer surface is also partly shiny, and this reduces emission of radiant heat.

A matt black surface is a good absorber and emitter of radiant heat, so a black plastic bag would not be very effective at keeping you warm.

Suggested practical activities

It is possible to simulate various aspects of heat loss using thermometers and water-filled beakers. For example:

1. Show the principle of 'space blankets' by comparing the rate of cooling of two beakers, one wrapped in aluminium foil and the other wrapped in black paper.

2. Demonstrate that huddling together prevents heat loss, by surrounding a beaker of hot water with several other beakers and comparing the rate of cooling with an isolated beaker.

Both these exercises would lend themselves well to problem-solving activities. For example, the first exercise could be presented as 'How can you show that a shiny covering keeps in heat better than a black one?'

Acknowledgements Figure 3 supplied by *The Watford Observer;* Figure 4 from photograph by Doug Scott.

HYPOTHERMIA

This unit is in three parts. The first part tells you about hypothermia. The second part explains why old people may be affected by hypothermia in winter. The third part is a case study showing the danger of bad weather conditions on moors and mountains.

Part 1 What is hypothermia?

The blood inside your body is close to 37°C. As you can see from Figure 1, it is very dangerous if your temperature drops.

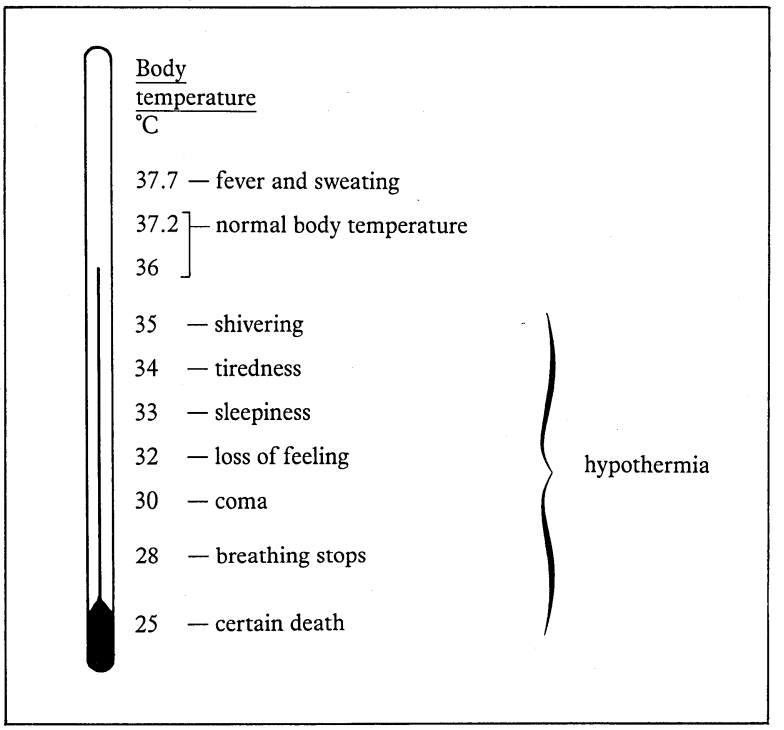


Figure 1

When you begin to get cold you may see goose pimples on your skin, and start to shiver. These are signs that your body is reacting normally to keep your temperature at a safe level.

When you are cold the blood vessels in your skin become narrower so that less blood reaches the surface of your body. This means that less heat is lost. Sometimes this can make your toes and fingers go numb. It may not matter if the blood in your *skin* gets cool as long as the blood circulating *inside* your body through the heart stays close to 37°C.

If you stay cold for a long time and do nothing about it the temperature inside your body may drop to dangerous levels. You begin to suffer the effects of **hypothermia** if your body temperature falls to 35°C, or below. Your heart beats slower and eventually stops if the blood gets too cold.

Now try questions 1 to 5.

Questions

1 *How does your body reduce the blood supply to your skin when you are cold?*

2 *Why may people look pale when they are cold?*

3 *Why is a thermometer placed under your tongue when your temperature is taken? Why not just hold the thermometer in your hand?*

4 *Why do you think goose pimples appear on your skin when you get cold? Do goose pimples help to keep you warm?*

5 *How do you think shivering helps to stop your body getting too cold?*

Here are some of the signs and effects of hypothermia in the order they develop:

- unexpected and unreasonable behaviour
- slow response to questions, lethargy
- blurred vision
- slurred speech
- sudden shivering fits
- sudden outbursts of energy
- falling over
- unconsciousness
- death

Other possible symptoms include: blue lips; pale and puffy face; slow pulse and slow breathing.

How should we treat hypothermia?

If someone is suffering from hypothermia they must be warmed up. This has to be done carefully. If the person is warmed up too quickly from the outside the blood vessels may widen so that there is a rush of blood to the skin. Most of the skin has not warmed up, so that even colder blood is returned to the heart. This can cause sudden death.

The best treatment starts by preventing any more heat being lost. This can be done by wrapping the person up well. (Figure 2)

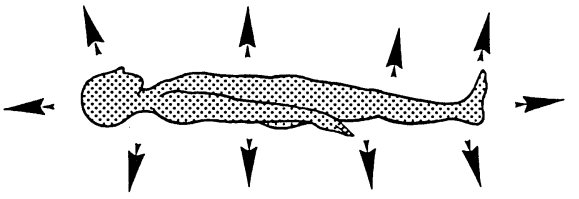
Questions

6 *Make an estimate of the temperature in °C of:*

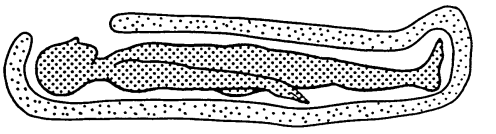
- *(a) the air on a hot day in summer*
- *(b) the air on a cold day in winter*
- *(c) the water in an indoor swimming pool*
- *(d) the water in a hot bath*
- *(e) hot tea when you can just drink it*
- *(f) the air in a hot oven*
- *(g) milk in a refrigerator*

7 *Do you think a drink of rum, whisky or brandy is a good way to warm up a person who is suffering from extreme cold?*

8 *Does eating cold food, such as a sandwich, make you colder? Is it helpful or harmful to give someone cold food if they are suffering from hypothermia?*



The body cools all the time by loss of energy from the surface of the skin



The rate at which the body cools can be slowed down by insulating the person with blankets or a sleeping bag

Figure 2

In a case of hypothermia:

DO

- warm up the room
- give a warm drink
- wrap the person up well
- call a doctor

DON'T

- load heavy blankets onto the person
- apply heat directly to the skin
- use hot baths, hot water bottles or electric blankets
- encourage the person to move
- give alcohol

Now try questions 6 to 10.

Questions

9 *A person has several layers of clothes on and has the room heating turned up as high as it will go. The person still feels cold. Is it best to:*

- *(a) put on more clothes*
- *(b) go to bed*
- *(c) move around and make a hot drink or snack?*

10 *Is it healthier to sleep with the bedrooom window open even on cold nights?*

Part 2 Why are old people more likely to suffer from hypothermia?

When people move around, their bodies are warmed by heat released from active muscles. Old people are less active, so they are likely to get hypothermia when they sit for long periods in cold rooms.

The natural mechanisms which keep the body warm (see Part 1 of this unit) do not always work as well for the elderly.They may not shiver when they are cold. Also it has been shown that it may take longer for the blood vessels in their skin to narrow. This means that more blood goes on circulating through the colder parts of the body. Old people can sometimes get very cold without realising it.

Figure 3 This man in a wheelchair uses his gas fire sparingly because of the cost. He wraps up with extra clothing and blankets.

Elderly people living on small pensions may be worried about heating bills. They may spend the whole day in cold rooms. This is made worse in bad housing which is damp and draughty.

About 40 000 more old people die in winter than in summer. One recent survey suggests that about 300 — 400 of these extra deaths are directly caused by hypothermia. In most cases the people suffering from hypothermia had got cold because they were ill or suffering from some handicap which stopped them moving around.

Most of the extra deaths in winter are caused by heart attacks, strokes or diseases which affect the lungs.

Now try questions 11 and 12.

Questions

11 Which of these old people are likely to be at risk with hypothermia?

(a) Someone living in an old people's residential home
(b) Someone living alone
(c) Someone who goes out a lot even when it is cold
(d) Someone who lives in a damp and draughty house
(e) Someone who is ill and cannot get about easily

12 Design a leaflet or poster for a doctor's surgery advising old people of the dangers of hypothermia and telling them how to avoid getting too cold.

Part 3 Danger out of doors

Fit and active people can die from hypothermia too. Mountaineers, divers and fishermen may suffer from hypothermia if they are out in cold wind and rain without proper protection. This is sometimes called **exposure**. The danger is that their bodies will cool faster than they are being heated by the activity of their muscles.

Figure 4 A mountaineer wearing a one-piece suit filled with down to stop his body cooling too quickly.

Questions

13 Why do you get colder more quickly if your clothes are wet and there is a wind blowing?

14 Why does a space blanket slow down the loss of heat from the body? (Remember that heat can be transferred by conduction, convection and radiation.)

15 Marathon runners are sometimes given a space blanket after they have crossed the finishing line. Why is this a good idea?

16 A large black plastic bin liner is less effective than a space blanket. Why?

17 Suppose you are in charge of a party of young people setting out for a hike in the hills in winter. What advice would you give and what food, clothing and equipment would you require every member of the party to take with them? What would you say to help them to understand the reasons for your advice?

In emergencies **space blankets** can be used. These are made from thin foil which is shiny on one side. The sufferer is surrounded by the blanket with the shiny surface inside. Space blankets are very effective even though they are thin.

Preventing hypothermia is better than treating it. Hypothermia can set in quickly out of doors in winter when it is windy and wet. Warm and waterproof clothing, warm drinks and high-energy foods can all help to prevent hypothermia.

Now try questions 13 to 17.

Exposure on the moors

Here are two accounts of an expedition on Dartmoor. Read them and then try questions 18 to 25.

Newtown High School magazine

Outdoor pursuits group — spring activities
by Sam Jump

Highlight of this term was a weekend snow and ice survival course at Alenmore Lodge in Scotland. Thirty-two members attended. Weather conditions in Scotland were superb, with two days of bright sun but plenty of good firm snow. We were able to practise step-cutting and survival techniques.

The techniques learnt in Scotland stood us in good stead later as Susan Wiseman showed during a training weekend on Dartmoor in April. Susan Wiseman, Peter Furly, Jenny Long and Simon West set out to walk 10 miles across the moor.

They woke up late and missed breakfast which was probably a mistake. They led off in bright sunshine but ran into blizzard conditions at about midday.

Simon, the youngest in the group, began to show signs of exhaustion. Susan organised the others to make a shelter in some rocks. They put all the spare clothing on him, and gave him hot drinks and glucose tablets.

Susan and Peter set off to get help. Simon and Susan had a couple of days in hospital, but all's well that ends well and it just goes to show the value of good training.

In closing I'd like to thank Kris Checkland for all her help in looking after the gear and Mike Thomas for driving the minibus. We'd also like to thank the members of the Police and the Dartmoor mountain rescue team who brought Simon down.

Extract from a local newspaper, April 3rd:

POLICE CHIEF SLAMS CARELESS HIKERS

Chief Inspector Stern of the Devon Constabulary yesterday condemned badly prepared and equipped groups who treat Dartmoor as a playground, without realising that weather conditions can change very quickly.

A party of walkers from Newtown High School in Cheshire left Princetown in bright sunshine on Saturday morning on a training walk for the Duke of Edinburgh Gold Award. Weather conditions deteriorated rapidly and by noon it was snowing heavily. One of the party collapsed, and was suffering from hypothermia. Failure to report at the third checkpoint alerted leaders that all was not well.

A search was quickly mounted, led by the Dartmoor rescue team and helped by police and local residents. During the afternoon, conditions became so bad that Police Constable Paul Rogers, 29-year-old father of two, collapsed and had to be assisted from the moor by the rescue team.

As dusk fell, conditions improved slightly and the rescue team were able to reach the stranded party, led to the spot by plucky 17-year-old Susan Wiseman, who had left her companions to seek help after organising shelter for the exhausted boy and getting him into a sleeping bag.

Today, Susan and 16-year-old Simon West are recovering from their ordeal in an Exeter hospital. A hospital spokesman said that Simon had been suffering from hypothermia, which can occur very quickly in such extreme conditions. Lack of effective waterproof over-trousers had caused Simon's trousers to become soaked and the resultant heat loss had contributed to his collapse.

Alison Rogers, wife of the Police Constable who collapsed, said, 'I blame the school. I don't think these school parties ought to be out on the Moor at this time of year. It's always those of us who live here that have to help when they run into trouble.'

Chief Inspector Stern underlined her statement, reminding all parties venturing on to the Moor at Easter that: 'Full winter gear, emergency rations, and survival kit are essential'.

Questions

18 *How do you think that Susan and the others were able to tell that Simon was beginning to suffer from hypothermia?*

19 *In what ways were the group well prepared for the expedition?*

20 *What two mistakes did Simon make which made it more likely that he would suffer from hypothermia in the cold snowy weather?*

21 *What other equipment might the group have carried to help them to cope with the emergency?*

22 *Do you think that the leaders of the exercise had done everything possible to prevent accidents of this sort? Explain.*

23 *What differences are there between the two accounts of the emergency? Why do you think that the two versions are different? Which story do you think is likely to be more accurate?*

24 *How do you think that Inspector Stern would react if shown Sam Jump's account of the expedition?*

25 *Imagine that you are the headteacher of Newtown High School.*

(a) *How do you react to the newspaper story? Are you going to take any action about it?*

(b) *Will you allow the Outdoor Pursuits Group to organise another expedition to Dartmoor next year? What reasons will you give if you are asked to justify your decision?*

The Technology of Toilets

Contents: Reading, diagrams, pictures and questions about alternative solutions to the design of toilets.

Time: 2 periods, or more, depending on number of parts attempted. Homework time could be used. Part 1 is particularly suitable for homework, so the unit could be started for homework, then completed in class.

Intended use: GCSE Biology, Physics, Technology and Science courses.

Aims:

- To complement work on sanitation, hygiene and the control of disease
- To complement work on control systems, water pressure and domestic water supply
- To develop awareness of the history of the design of a common appliance (the toilet)
- To provide an opportunity to evaluate alternative design solutions to a practical problem
- To provide an opportunity to practise skills in reading and comprehension.

Requirements: Students' worksheets No.803

Author: Anabel Curry

This unit is in three parts which can be used independently if required:

Part 1 History
Part 2 Toilet designs
Part 3 The development of the water closet.

Part 3 is more demanding than the first two parts, particularly the questions on page 6 concerning cistern design.

Notes on some of the questions

Q.5 Problems with soiling the pan and the valve due to the lack of a method for flushing and the shape of the pan. Modern pans are shaped to reduce the possibility of soiling. The valves wore out and let in smells from the drains.

Q.6 The flush water is trapped under the rim and runs around the top of the pan to clean all of the surface. The wash-out pan was only cleaned where the jet of water fell at the front.

Q.7 To provide a water seal to prevent smells rising from the drains.

Q.8 Because of the bend in the trap.

Q.9 Adults could adopt a more natural position for evacuation of the bowel. Small children could use the toilet more easily.

Q.10 The floating ball.

Q.11 The valve opens as the float falls.

Q.12 The rising ball moves the slider which presses the washer against the inlet pipe.

Q.13 As more water enters the cistern the rising float makes the water flow less. Positive feedback would create a flood.

Q.14 Cisterns are fitted with an overflow pipe which empties outside the house or into the toilet pan.

Q.15 The rising piston in the wide cylinder pumps water up to fill the flush pipe. The water then siphons out, because the outlet is at a lower level than the inlet.

Q.16 The high level cistern has a more forceful and effective flush because of the increase of water pressure with depth.

Acknowledgements Figures 1 and 6 based on illustrations in the official guide to the Jorvik Viking Centre, York, by permission of York Archaeological Trust; Figures 2, 3, 4 and 12 cartoons by Laurie Fahy; Figures 5 and 7 supplied by the Wellcome Institute Library, London.

THE TECHNOLOGY OF TOILETS

Imagine what life would be like if no one had invented toilets. Good sanitation is essential for our health. In this unit you are asked to think about the ways technology has been used to solve the problem of getting rid of our everyday waste products.

Part 1 History

Wild animals do not use toilets. There are many small animals which carry away and digest other animals' dung. Bacteria also help break down wild animals' excrement.

Disposing of human excrement is not a difficult problem for small rural communities. The filth and stench of decomposing excreta can become a problem when people live in crowded towns and cities.

The toilet was invented to solve the problem. Archaeologists have found remains of ancient toilets in the Middle East. They were high-seat toilets that were flushed by pouring water into them. All of them were in palaces. No evidence has been found that ordinary people had toilets. The oldest known toilet was discovered in India. It dates back to 3000 BC.

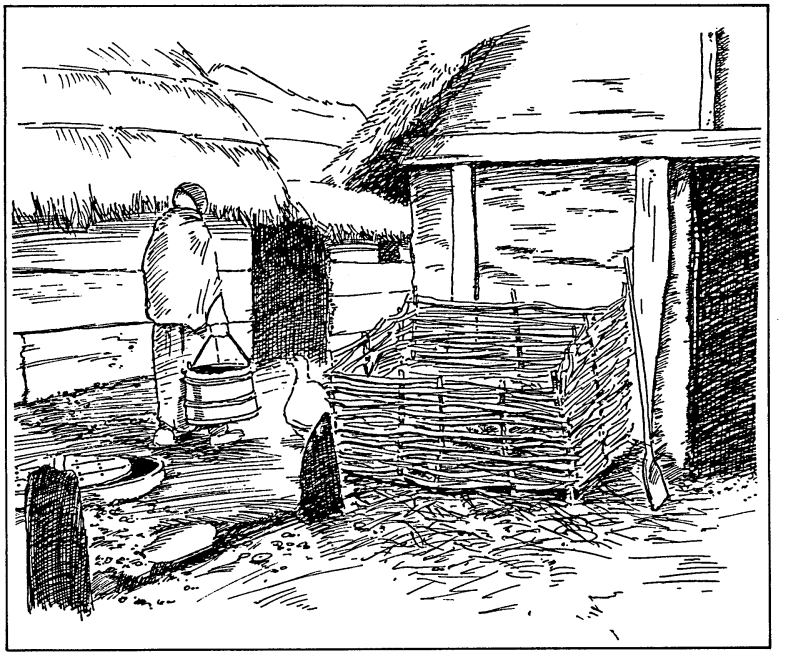


Figure 1 A model of a latrine in Viking times, in the Jorvik museum in York. The latrines were just by the houses. They were holes in the ground near the wells.

The Romans brought toilets and sewers to Britain. Sitting on a toilet could be a sociable activity. A toilet built in Northumberland could seat 20 soldiers together. However, in their private houses the Romans used chamber pots and had slaves to empty them.

Answer questions 1 to 3.

Questions

1 *Use a dictionary to make sure you know the meaning of words used in this unit including: excrete, excrement, cesspit, latrine, closet, cistern, flush.*

2 *Why is it important to keep clean the cages of pets such as hampsters or budgerigars?*

3 *What happens to the excretment of wild animals?*

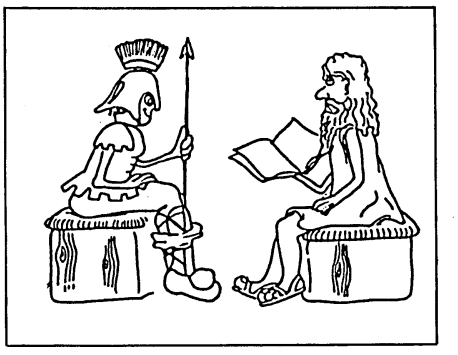


Figure 2

Unfortunately, the technology of toilets vanished along with the Romans. The only sanitary requirement in medieval England was to 'retire a bow's shot away'.

In the Middle Ages, London stank from cesspits and open drains. Rivers were choked with sewage and waste.

Even after the Great Fire of 1666, when London was rebuilt, chamber pots were emptied out of the windows into the streets. Sometimes people gave a warning shout of 'Gardez-loo'. This was meant to be French for 'beware of the water'. That is why the toilet is sometimes called the 'loo'.

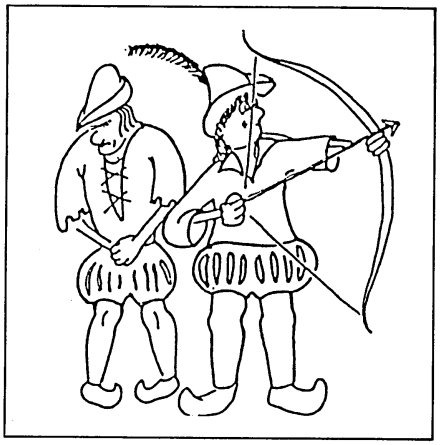


Figure 3

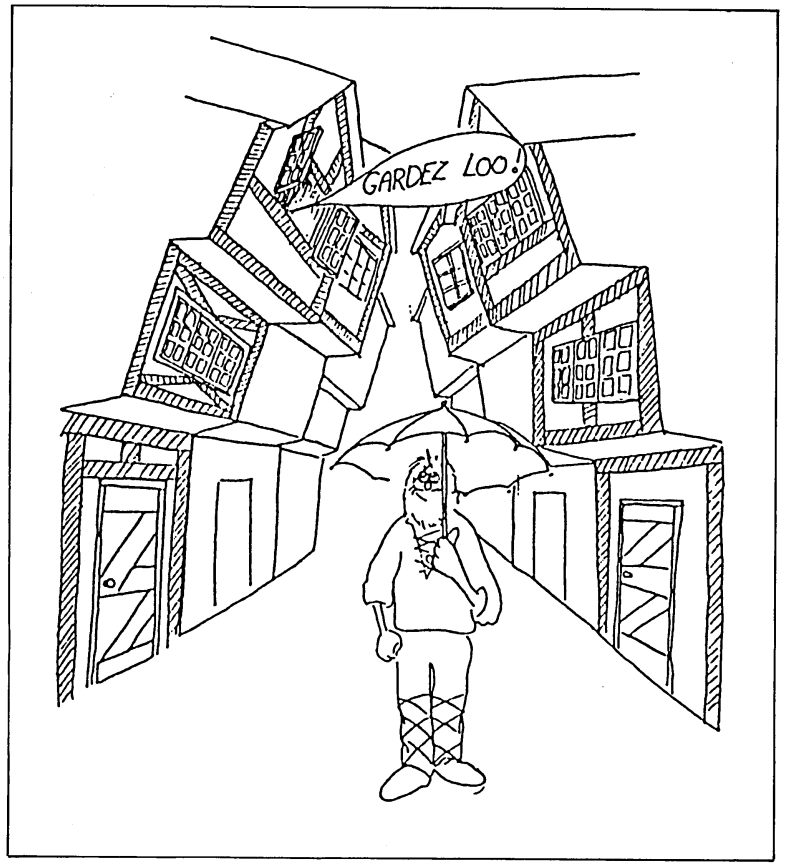


Figure 4

Major outbreaks of diseases such as cholera and typhoid were common in big cities during the nineteenth century. They spread quickly because of poor sanitation. It was a luxury for a family to have a toilet of their own. All the people in a row of houses might have to share one outdoor toilet.

Some landlords provided no sanitation when new houses were built. The families had to use chamber pots. They emptied them on the nearest piece of waste ground, or in the street. Even in homes with their own toilet, it might be in an unventilated cupboard. It would drain into an outdoor cesspit likely to overflow.

Water closets were introduced towards the end of the nineteenth century. But there was still the problem of where the waste would go.

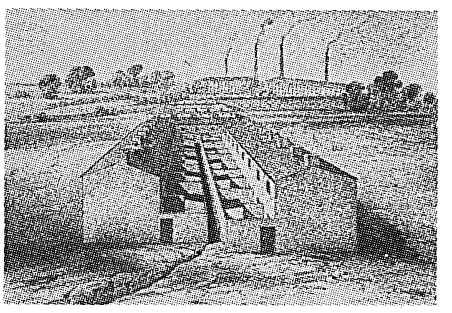


Figure 5 Terrace houses in Preston in 1844. The toilets at the end of the yards emptied into a trench running down the gap between the yards. The waste in the trench was cleaned out once a year and piled nearby.

Part 2 Toilet Designs

What makes a good toilet? A satisfactory toilet should:

- Collect excrement
- Dispose of excrement, to prevent the spread of infectious diseases
- Be comfortable and pleasant to use
- Prevent smells from spreading
- Be easy to clean
- Not become infested with flies and maggots

There is often more than one way of solving a practical problem. On this page and page 4 you can see some designs which have been tried. Look at the pictures and then answer question 4 on page 4.

Figure 6 A pit latrine in Jorvik. (See also Figure1.)

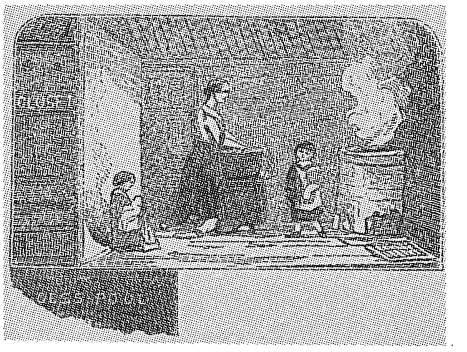


Figure 7 This drawing shows a closet in the washroom of a London house in the nineteenth century. There is a cesspit directly below the closet.

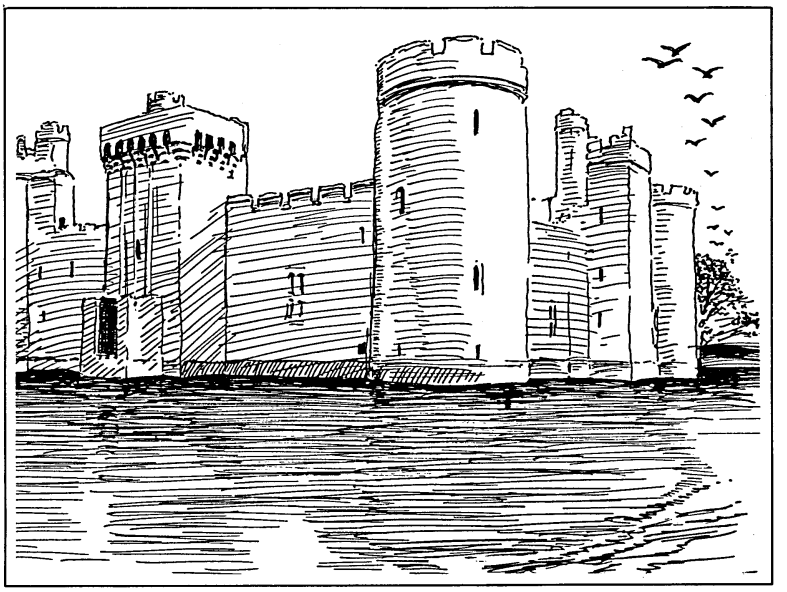


Figure 8 In castles they built small latrines (called garderobes) into the thick outer walls. In some cases the open shafts emptied into the castle moat. Inside the castle they emptied into pits which could be dug out from time to time.

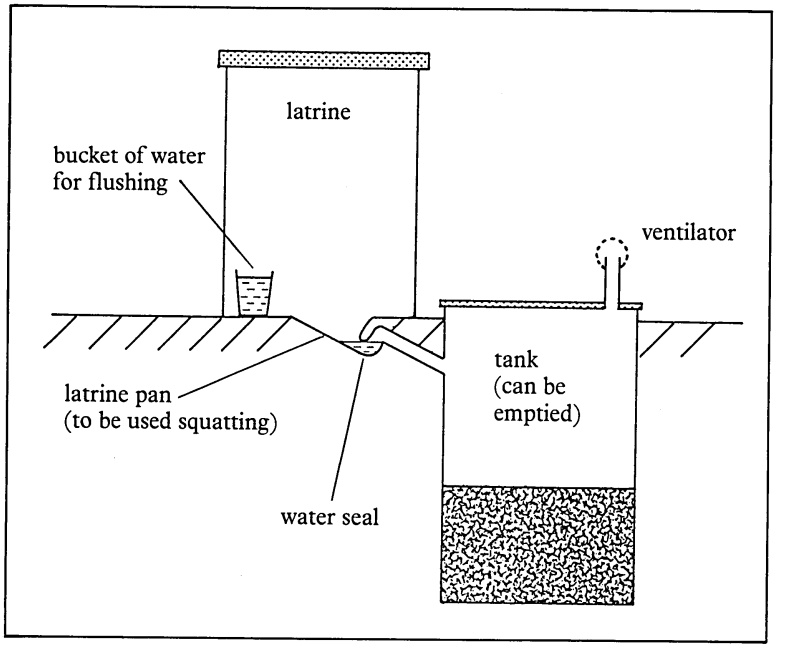


Figure 9 This improved pit latrine is designed for use in parts of the world where rainfall is low and water purification is expensive.

Question

4 Think about the types of toilet described in words and pictures on this page and on page 3. You can also include Figure 5 on page 2. Make a copy of the chart below. For each design, put ticks or crosses in the chart.

	Figure						
	5	6	7	8	9	10	11
• Collects excrement							
• Disposes of excrement to prevent disease							
• Comfortable and pleasant to use							
• Prevents smells							
• Easy to clean							
• Will not become infested with flies and maggots							

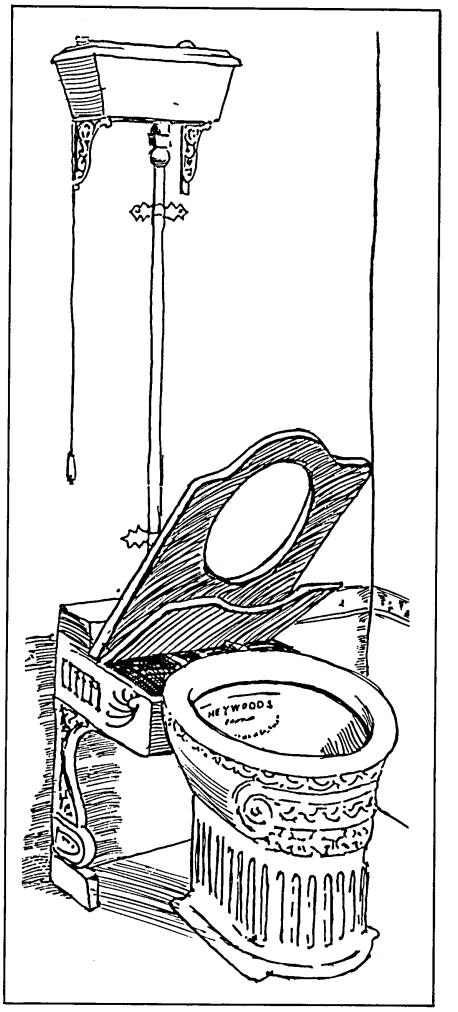


Figure 10 This type of water closet was on sale in 1889. There was still the problem of where to pipe the waste when the toilet was flushed.

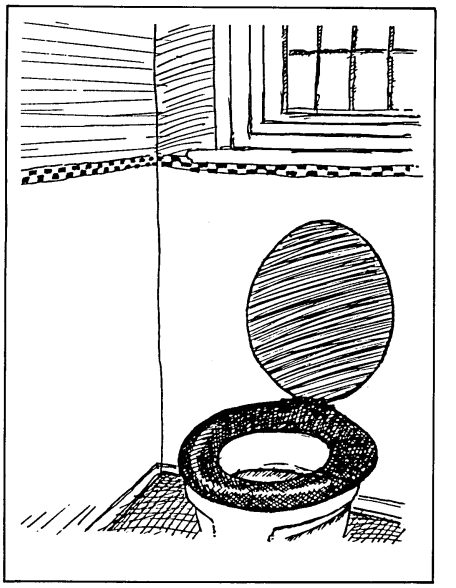


Figure 11 This toilet has a high flush cistern which is not shown. The toilet is in a small room built for the purpose.

Part 3 The development of the water closet

The design of the water closet (WC) has been changed and improved many times. The first Englishman to build a flushing water closet in his home was Sir John Harrington in 1596. His solution to the problem of smells was to use a leather covered valve. The valve had to be opened to empty the contents of the toilet into the sewer. The toilet was cleaned by turning on a tap which flushed water from his fish tank!

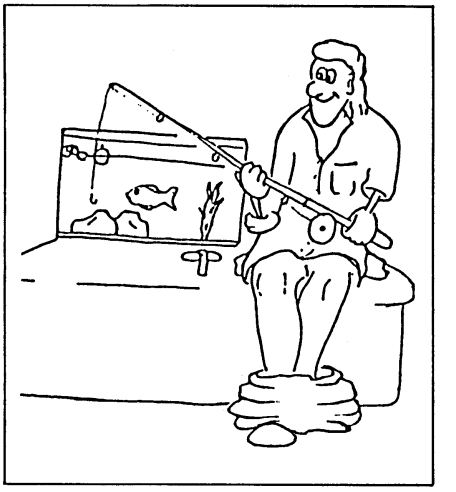


Figure 12

Sir John Harrington's invention did not catch on. Interest in designing water closets did not reappear until the eighteenth and nineteenth centuries. Again, designers used a valve to cut off the toilet from the drains. But there was no satisfactory method of flushing them. This made it difficult to keep the toilets clean. As the valves became worn, water ran away form the pan and smells leaked back from the sewers.

Eventually a Victorian plumber called P.J. Davies designed a water closet without a valve at the bottom. Instead a water seal was left after each flush to stop smells from the drains. This was the forerunner of the modern wash-down water closet.

Answer questions 5 to 9.

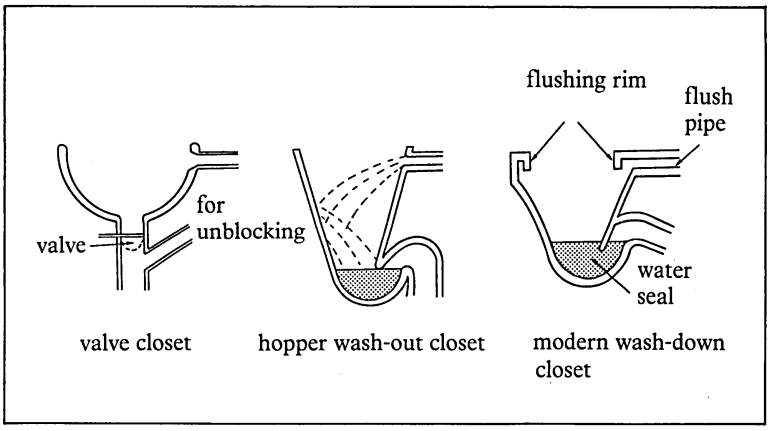


Figure 13 Types of toilet pan

Questions

5 *What were the main problems with valve closets ? Do you think a satisfactory valve closet could be designed today using new materials?*

6 *How is the rim on a modern pan an improvement on the older wash-out design (see Figure 13)?*

7 *What is the purpose of the water seal?*

8 *Why does water remain in the trap after flushing?*

9 *Some doctors suggest that toilets should be made with lower seats. Why do you think that doctors give this advice?*

The water closet could not come into common use until a public water supply was available to flush it. Early designs of flushing cisterns were unreliable and many Victorians still preferred the earth closet.

How does the toilet cistern work?

A cistern has to release its water into the toilet, and refill itself automatically.

Automatic refilling is usually controlled by a ball-valve. This valve is a kind of tap. It is turned on and off by a floating ball on a lever. (See Figures 14 and 15). Flushing is started by a piston which forces water up over the top of a flush pipe. The water then siphons out (see Figure 16).

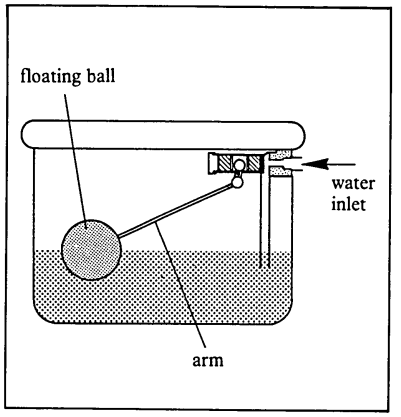


Figure 14 Simplified diagram of a toilet cistern showing just the ball-valve

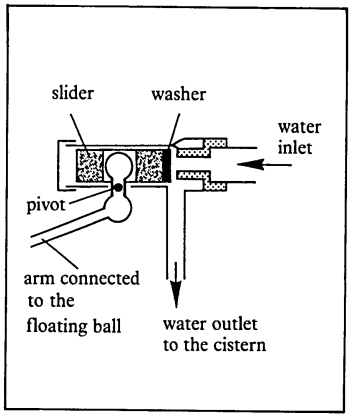


Figure 15 Detail to show how the ball-valve works

The cistern is kept full of water by a system of control which uses *feedback* of information about the water level. Look at figures 14 to 16. Try to work out what happens as the cistern is flushed and then refills. If possible look inside your toilet cistern at home.

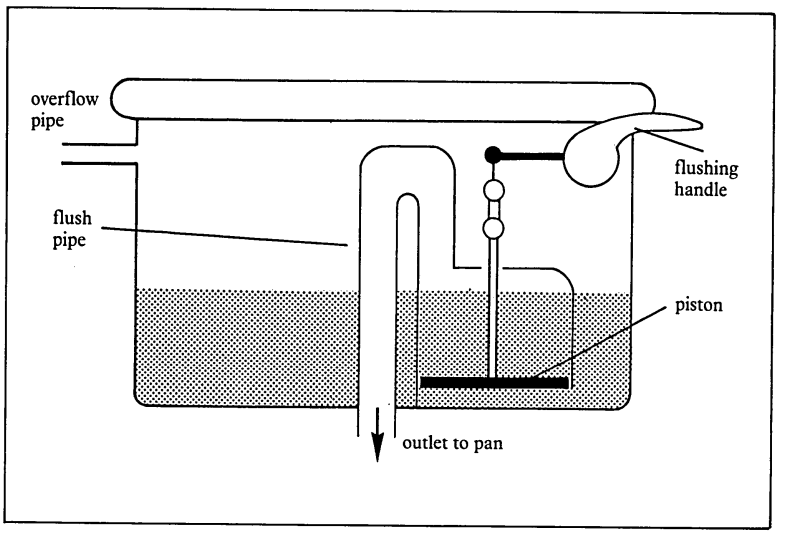


Figure 16 Toilet cistern showing the flushing mechanism

The modern designs of water closet and cistern had been developed by the beginning of this century. The names of the early pioneers are still well known today. They include Twyfords, Doultons and Shanks.

Now answer questions 10 to 16.

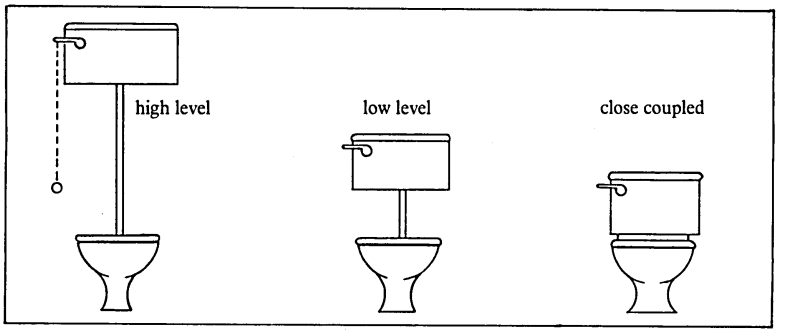


Figure 17 Types of toilet suite

Questions

10 When the toilet is flushed, what acts as the sensor *in the cistern to detect that the water level has dropped?*

11 What happens to put the water back to its original level?

12 How does the sensor detect when to shut off the water supply?

13 The flow of water into the system is controlled by feedback. Information is fed back from the sensor to the valve. This is an example of **negative** *feedback. Why negative? What would be the result of* **positive** *feedback in a toilet cistern?*

14 What happens if the ball-valve goes wrong and does not shut off the water flow? How is the cistern designed to cope with this failure?

15 Explain how water is made to siphon out of a toilet cistern.

16 Public toilets and school toilets usually have high level cisterns. Many modern homes have more expensive low level, or close coupled cisterns. Which type washes out the pan with greater force? Are the more expensive cisterns more effective?