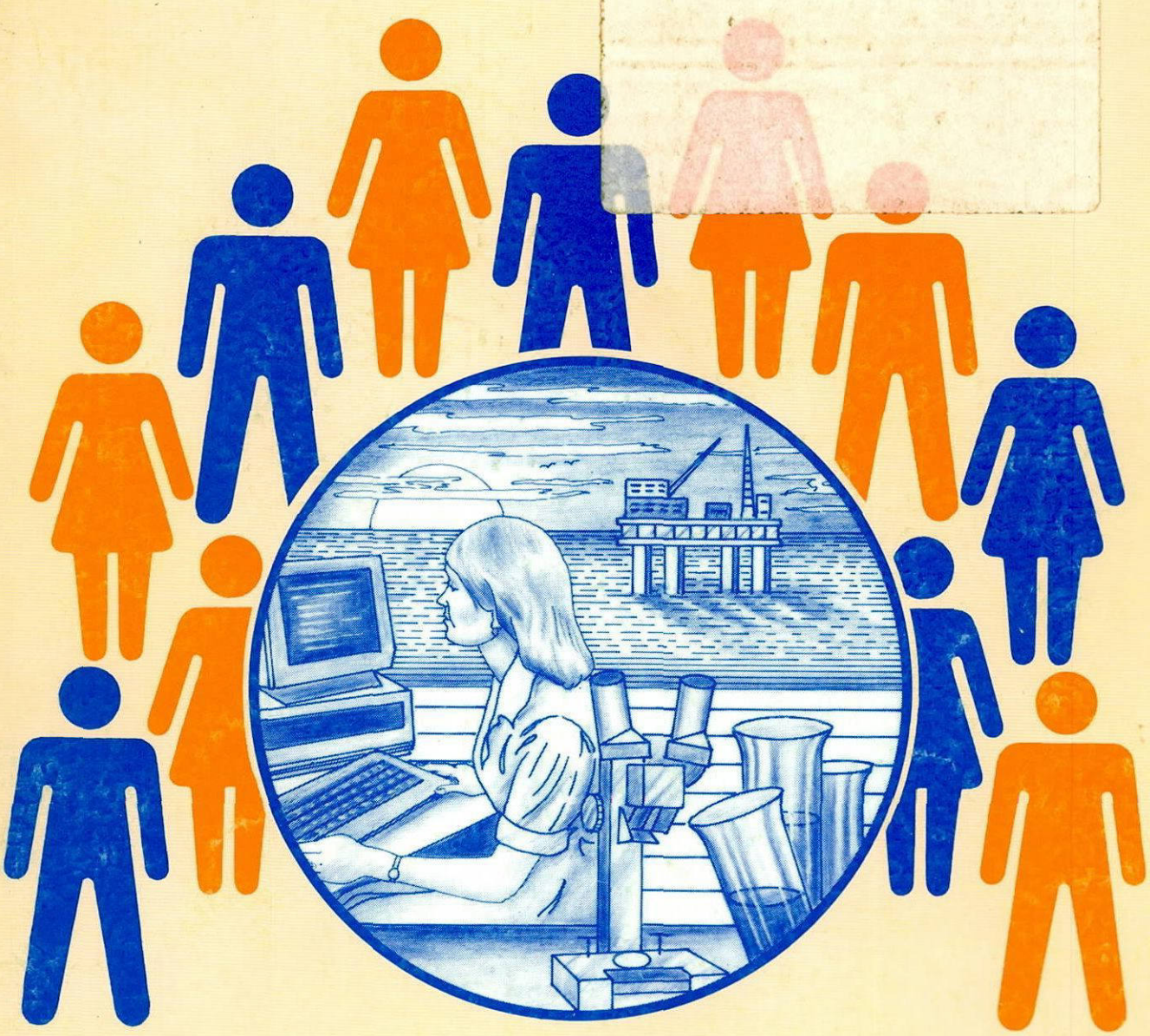
SCIENCE & TECHNOLOGY IN SOCIETY

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.

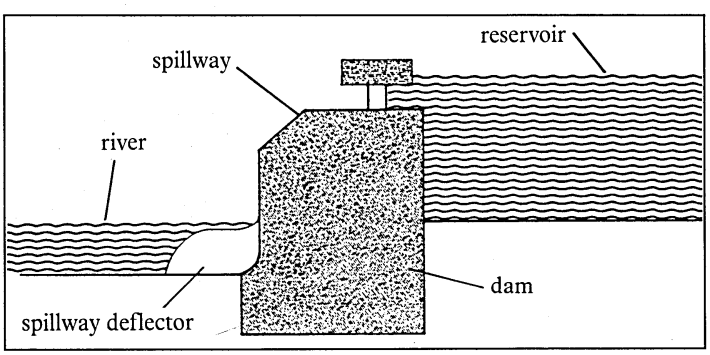
Suggested use of the unit

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.

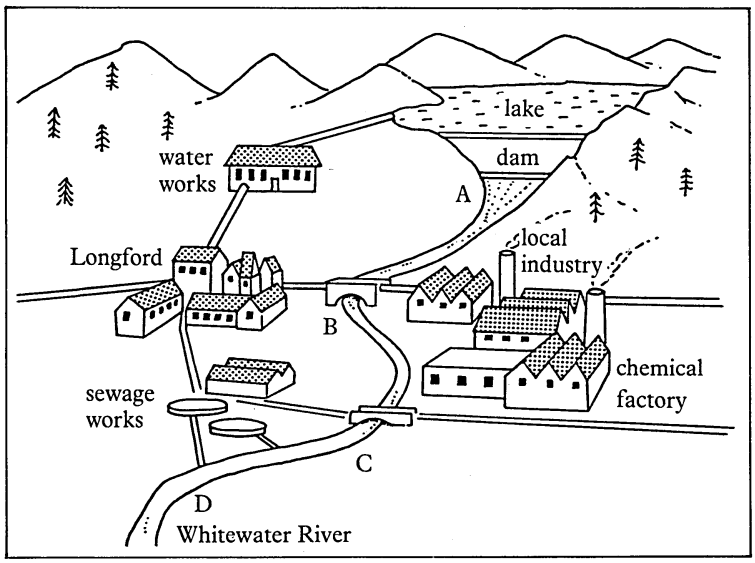


Figure 1 The Whitewater River

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.

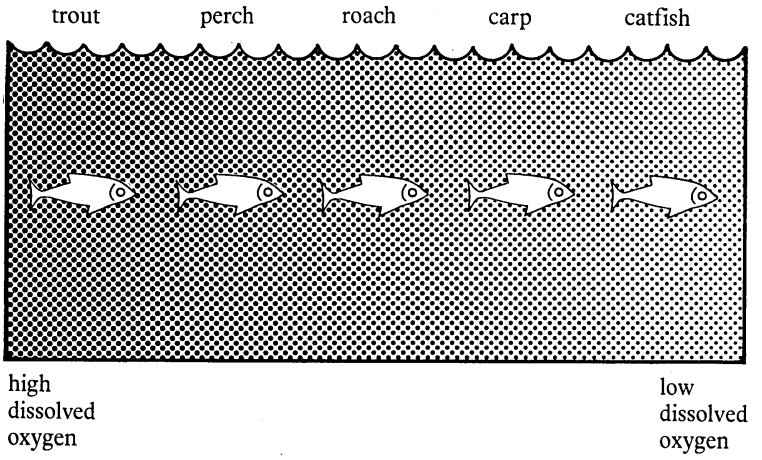


Figure 3 Dissolved oxygen required for various fish

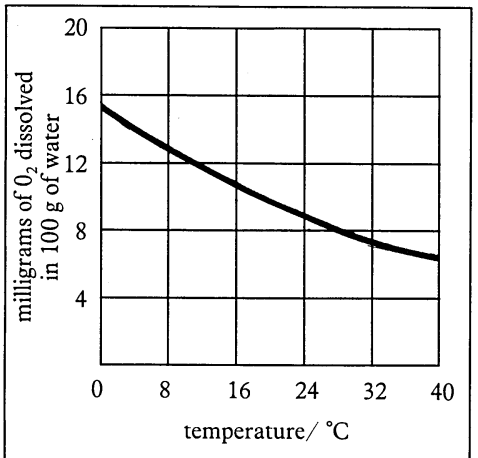


Figure 2 Solubility curve for oxygen gas in water in contact with air

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.

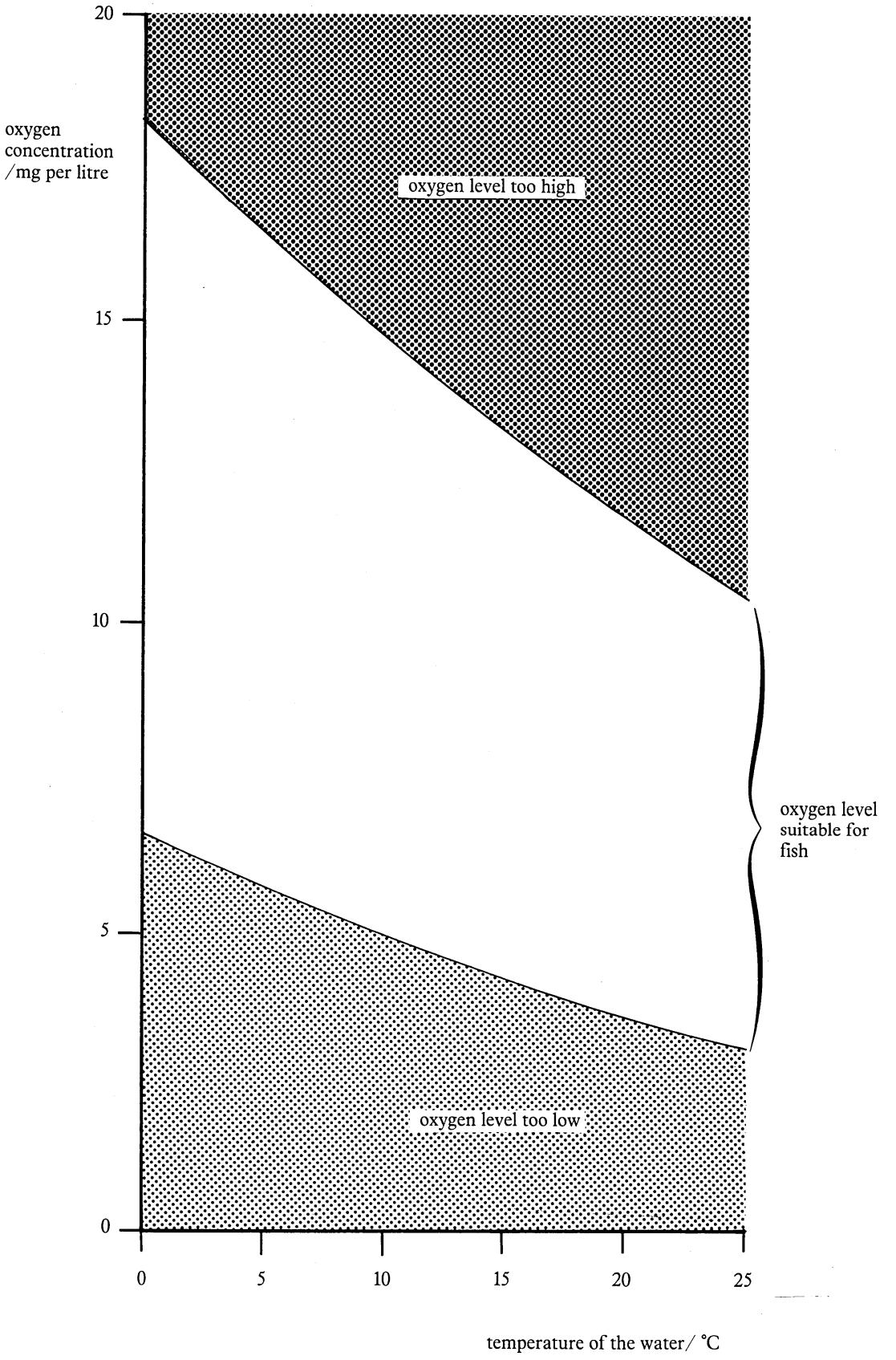


Figure 4 Graph showing the conditions of oxygen concentration and temperature which are suitable for fish

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'.