Are you made of stardust?

Science content

Chemical elements, stars, nuclear fusion, gravity, the collapse of stars.

Science curriculum links
AT16 The Earth in space

Syllabus links
- GCSE Science, Chemistry, Physics,

Lesson time
1 hour
or homework

Links with other SATIS materials
808 Nuclear Fusion
1207 Radio Telescopes
1208 Are there Fairies at the Bottom of the Garden?

NERIS
Search on
STARS and UPPER SECONDARY

SUMMARY

Clouds of gas and dust condense into stars. Stars evolve. Giant stars become supernovas to throw off layers of gas and dust for the cycle to begin again.

STUDENT ACTIVITIES

- ☐ Making a glossary (may be done by small group discussion).
- ☐ Reading and answering questions.

AIMS

- ☐ To link with work on the Earth in space, the origin of the universe and the solar system
- ☐ To introduce the cosmic cycle of the elements
- ☐ To provide opportunities for independent study

USING AND ADAPTING THE UNIT

- ☐ Students require prior knowledge of the structure of the atom in terms of electrons, protons and neutrons. They should be familiar with terms such as nucleus, atomic number, fusion, universe, constellation of stars, electromagnetic radiation and gravity.
- ☐ This is a challenging topic, suitable for able students towards the end of their GCSE courses.
- ☐ The unit is free-standing and may used for self-study.

Authors **Derek Raine**
Dave Pierson

First published 1991

Glossary activity

Element A simple substance from which other substances are made by chemical combination. All atoms of an element have the same number of protons in the nucleus.

Nebula Seen as a fuzzy patch of light, a gas cloud in which stars are forming.

Gravity The effect of the force between two masses.

Nucleus (plural – nuclei) The small dense central part of an atom where protons and neutrons are located.

Nuclear fusion Involves collisions between two atomic nuclei to produce a heavier nucleus with the release of energy. The nuclei must have sufficient kinetic energy to overcome the repulsion of their positive charges (the coulomb barrier).

Electromagnetic radiation Waves of energy which require no medium for propagation. Electromagnetic waves travel at 3×10^8 m/s through space. Their characteristics depend upon their frequency.

Neutrino Neutral atomic particle (the analogue of the electron and positron). It is believed to be almost massless. Neutrinos interact weakly with matter and are very difficult to detect (see SATIS 1208, *Are there Fairies at the Bottom of the Garden?*). Neutrinos have been detected from the Sun and from the supernova seen in 1987.

Black hole Matter collapsed together, a region where gravity is so strong that light cannot escape.

Supernova A sudden explosion of a giant star when its core collapses inwards.

Red giant Medium-sized stars evolve into red giants when their hydrogen is used up. The core, now composed of helium, shrinks and becomes hotter while the outer layers swell. The helium fuses into carbon.

Cosmic Relating to outer space.

Acknowledgements

Leicester Space Centre assisted with the development of this unit.

Figures 5, 6 and 7 have been adapted from illustrations which first appeared in *New Scientist* magazine, London (3 February 1990, Inside Science No. 29) the weekly review of science and technology.

Further information

Helium, carbon and oxygen have particularly stable nuclides. Fusion reactions stop at iron which has the most stable nuclide of all. (For further information see 'binding energy' in an advanced physics textbook.)

The universe is believed to have started from a state of almost infinite density with an explosion, the 'Big Bang', ten to fifteen thousand million years ago. Before the evolution of stars, gas clouds in space contained only hydrogen with a little helium.

Answers to the questions

Q1 *Carbon, hydrogen and oxygen.*

Q2 *Betelgeuse and Rigel have disappeared. New stars have formed in the region of the nebula below Orion's belt.*

Q3 *(a) A star is a hot cloud of gas that radiates energy.*

(b) Stars 'shine' because they radiate energy in the visible part of the spectrum due to nuclear fusion reactions in their cores.

(c) No stars exist less than one tenth of a solar mass, presumably because such gas clouds do not reach a temperature high enough to initiate nuclear fusion.

Q4 *Ultra violet, visible light, infrared.*

Q5 *The debris from supernovas is thrown out into space and becomes incorporated into gas and dust clouds, eventually condensing into new stars.*

Q6 *As supergiants, Betelgeuse and Rigel will have relatively short lives before they become supernovas and disappear. New stars are forming in the area of the nebula.*

Q7 *H, He, C, N, O, Ne, Mg, Si, S and Fe.*

Q8 *Human beings are largely composed of the most abundant elements, H, C and O. However, the most abundant elements not included in humans are helium (He) and neon (Ne) which, being noble gases, do not readily form compounds.*

Q9 *ME → FOOD → ELEMENTS OF THE EARTH → DUST IN SPACE → SUPERNOVA → GIANT STAR.*

Are you made of stardust?

You are what you eat!

It is sometimes said that 'you are what you eat'. Every atom of your body was once part of something else. There are about 90 types of atom in nature – the **chemical elements.**

- Constructing a glossary – an activity involving reference books for individuals, pairs or groups.
- Information and questions.

Table 1 The types of atom in your body

Element	Percentage of atoms
hydrogen	59.0
oxygen	25.9
carbon	11.0
nitrogen	2.39
sodium	0.70
calcium	0.22
sulphur	0.13
phosphorus	0.13
potassium	0.04
chlorine	0.03
magnesium	0.01
iron	0.0004
Traces of iodine, fluorine, silicon, boron, cobalt, copper, manganese, molybdenum, vanadium and zinc.	

All these elements were made in the stars. They were built up from the simplest elements, **hydrogen** and **helium**. This unit explains how.

Q1 *Carbohydrates are the commonest foods you eat. What elements are carbohydrates made of?*

Glossary activity

The following terms are used in the text. Read through the unit and decide what they mean. Add more words to the list if you wish to.

It may help you to discuss the words with a partner or look them up in reference books.

element
nebula
gravity
nucleus/nuclei
nuclear fusion
electromagnetic radiation
neutrino
black hole
supernova
red giant
cosmic

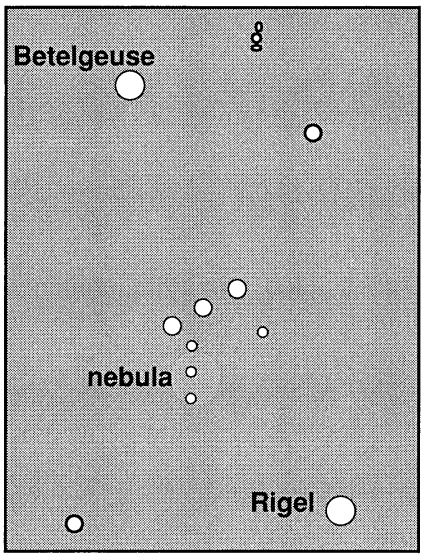


Figure 1 The stars in the constellation of Orion today

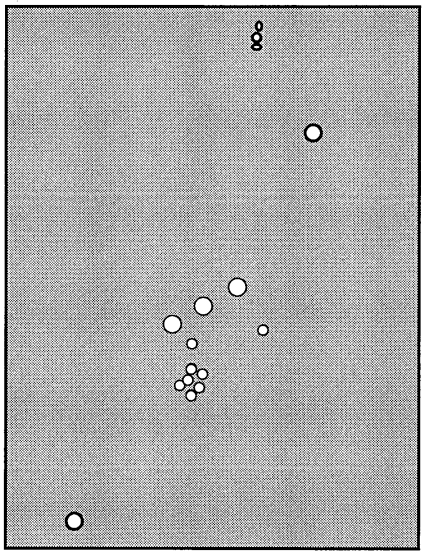


Figure 2 Orion as it might look in ten million years time

What is happening in the stars?

Orion is a **constellation** or group of stars which you can see clearly in the sky at night. Figure 1 shows the stars in Orion in the winter sky. The brightest stars are the supergiants, Betelgeuse and Rigel. These are young stars. Below 'Orion's belt' is a fuzzy patch of light, a **nebula**. It is a huge cloud of gas and dust where stars are forming, 100 000 times the mass of the Sun.

Figure 2 shows how Orion might look in ten million years time.

*Q2 Describe **two** differences between the pictures.*

How do stars begin?

Let's look at where stars come from in the first place. Space is not completely empty. Between the stars there are clouds of molecules, mainly hydrogen. Other elements and compounds are present as well.

The largest clouds shrink under their own **gravity**. As they do so, the work done by gravity makes them hotter. Dense clouds of hot gas form.

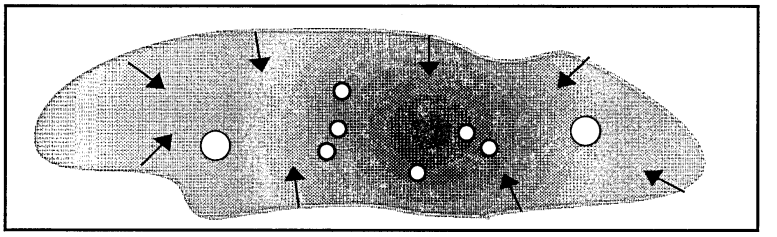
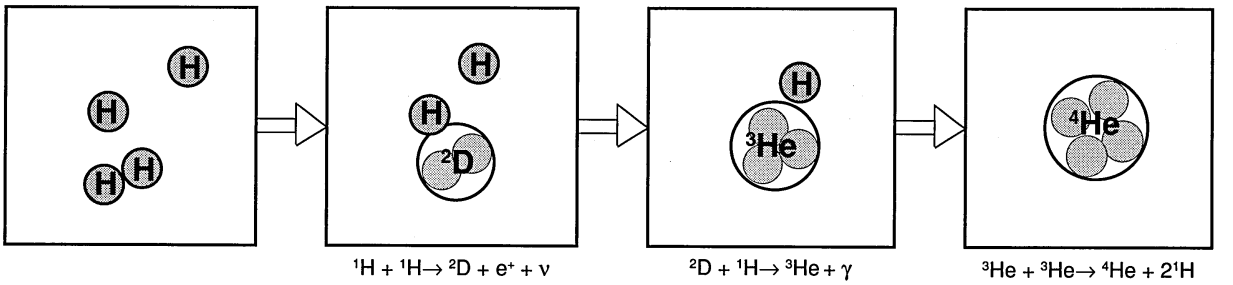


Figure 3 The birth of stars in a cloud of gas shrinking under its own gravity

Stars start to shine when the temperature reaches 10 million °C and **nuclear fusion** begins. Hydrogen nuclei bump into each other with enough energy to combine. They join or **fuse** forming first deuterium and then helium, giving out huge quantities of energy.



e$^+$ is a positron
ν is a neutrino
γ is a photon of electromagnetic energy

Figure 4 Four hydrogen nuclei fusing to form a helium nucleus

Energy from the fusion reaction keeps the stars hot and prevents them collapsing further. Some energy is given out as **electromagnetic radiation** and as **neutrinos** – small particles with no charge and probably no mass.

Hydrogen fusion continues until most of the hydrogen is converted into helium. Small stars can shine for thousands of millions of years while the largest stars may last for only a million.

What happens when the hydrogen runs out?

What happens depends on the mass of the star.

The smallest stars (about one tenth of the mass of the Sun) stop producing energy, cool, and cease to give out light.

Bigger stars (0.4 to 8 times the mass of the Sun) go on to make heavier elements, up to carbon and oxygen, becoming **red giants** as they do so. When nuclear fusion reactions stop, they cool and fade from sight.

The largest stars (8 to 60 times the mass of the Sun) make the elements up to iron in their cores. Fusion reactions stop. A dying giant star will suddenly beome very bright. Astronomers call it a **supernova**. In a spectacular explosion, the core collapses inward under gravity. The outer layers fall in and 'bounce back', more elements being made in the shock waves. The outer layers of the supernova are flung far into space.

The collapsed core becomes a dense mass of **neutrons** or even a **black hole** where gravity is so strong that light cannot escape.

The elements made in supernovas spread out as dust in space. They mix with clouds of gas. The clouds shrink. New stars form and the **cosmic** cycle of the elements is repeated.

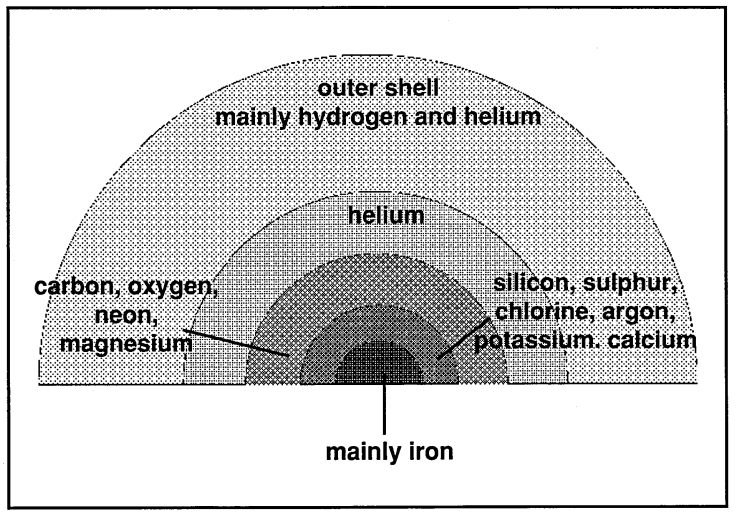


Figure 5 The layers of a giant star just before it explodes as a supernova

Table 2 The elements up to iron. All these are 'cooked' in the cores of stars. Heavier elements are made in the outer layers and in supernovas

Atomic number	Element	Symbol
1	hydrogen	H
2	helium	He
3	lithium	Li
4	beryllium	Be
5	boron	B
6	carbon	C
7	nitrogen	N
8	oxygen	O
9	fluorine	F
10	neon	Ne
11	sodium	Na
12	magnesium	Mg
13	aluminium	Al
14	silicon	Si
15	phosphorus	P
16	sulphur	S
17	chlorine	Cl
18	argon	Ar
19	potassium	K
20	calcium	C
21	scandium	Sc
22	titanium	Ti
23	vanadium	V
24	chromium	Cr
25	manganese	Mn
26	iron	Fe

What will happen to the Sun?

The Sun is thought to be about halfway through its life of 10 billion years. When the hydrogen in its core has been used up, helium fusion will begin and the outside layers will swell. The Sun will turn into a **red giant**. The fusion reactions will stop when the Sun's core has turned to carbon. The outer layers will drift away leaving a cooling white dwarf. Being composed of carbon, it will become a 'diamond in the sky'.

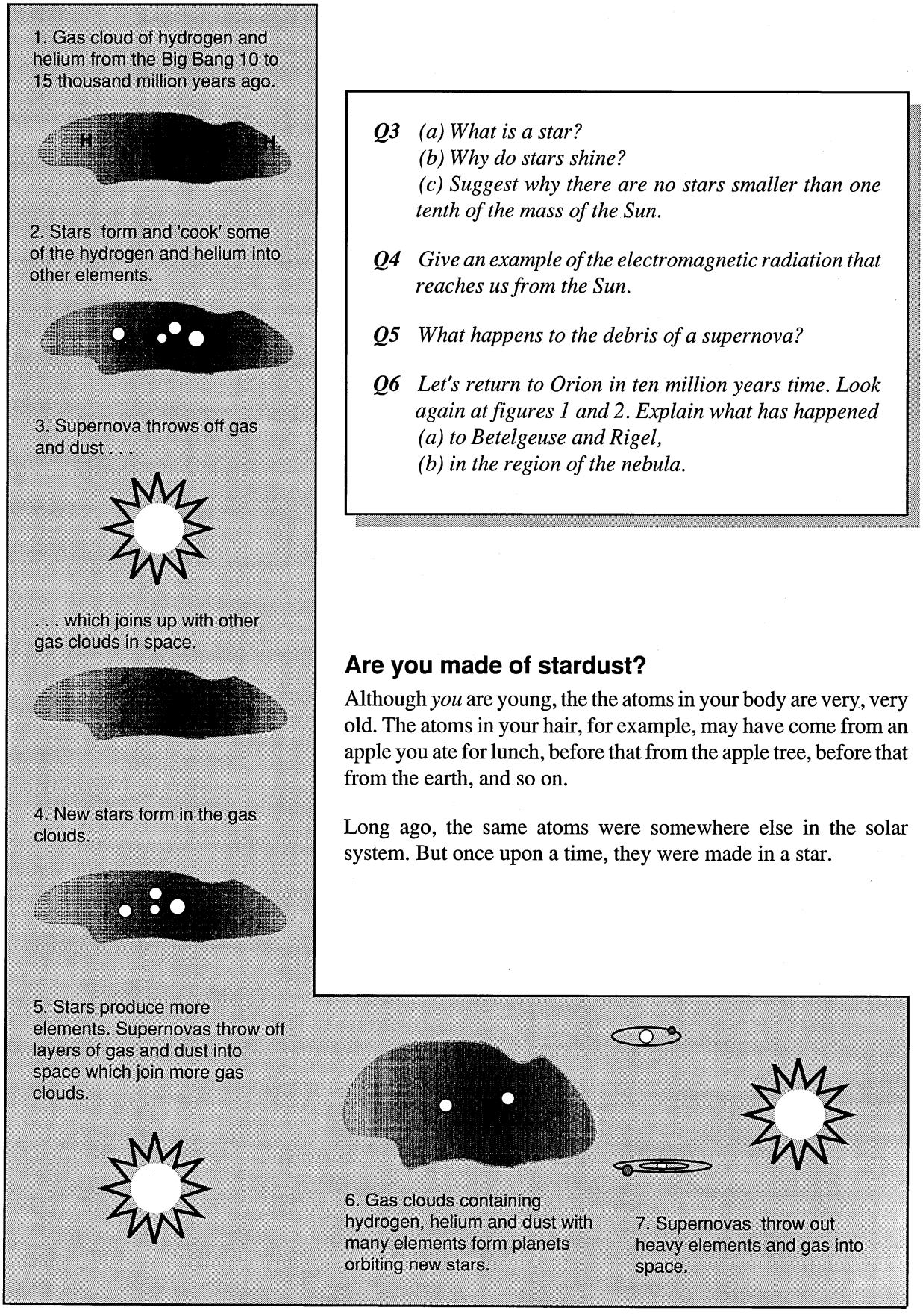


Figure 6 The cosmic cycle of matter through generations of stars

Q3 *(a) What is a star?*
(b) Why do stars shine?
(c) Suggest why there are no stars smaller than one tenth of the mass of the Sun.

Q4 *Give an example of the electromagnetic radiation that reaches us from the Sun.*

Q5 *What happens to the debris of a supernova?*

Q6 *Let's return to Orion in ten million years time. Look again at figures 1 and 2. Explain what has happened*
(a) to Betelgeuse and Rigel,
(b) in the region of the nebula.

Are you made of stardust?

Although *you* are young, the the atoms in your body are very, very old. The atoms in your hair, for example, may have come from an apple you ate for lunch, before that from the apple tree, before that from the earth, and so on.

Long ago, the same atoms were somewhere else in the solar system. But once upon a time, they were made in a star.

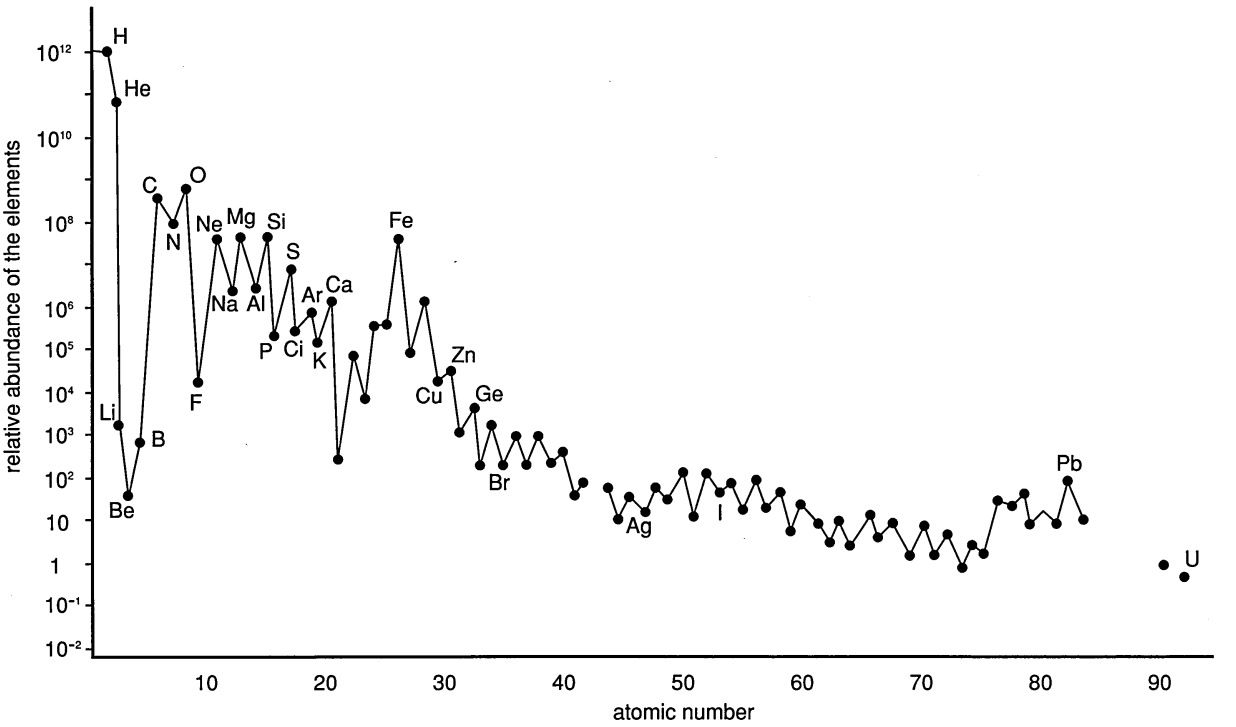


Figure 7 The relative abundance of elements in the solar system. Notice that the vertical scale increases in powers of 10. Each division is ten times greater than the last

Q7 *Look at figure 7. Which are the 10 most abundant elements in our solar system?*

Q8 *Compare the elements you gave in answer to question 7 with the elements in table 1. Comment on the similarities and differences between these lists.*

Q9 *Are you made of stardust? Draw a flow chart tracing the origin of the elements from which you are made back to a star. The flow chart has been started for you.*

ME → FOOD →

The source of energy of the stars, nuclear fusion, is the same source of energy as in the hydrogen bomb.

Fusion reactions give out huge quantities of energy. But can they be harnessed for peaceful use?

SATIS No. 808 considers the possibility of using nuclear fusion for generating electricity.

Answers to the questions are given in the *Teachers' Notes.*

Bottled Water

Science content

Minerals, health, water purity, pollutants, ions, pH.

Science curriculum links
AT 3 Processes of life
AT 5 Human influences on the Earth

Syllabus links
- GCSE Science, Biology, Chemistry
- Technology

Cross-curricular themes
- Health Education
- Environment
- Economic Awareness

Lesson time
2 hours or more

Links with other SATIS materials
410 Fluoridation of Water Supplies

BBC Radio SATIS Topics 14–16
The Water Pollution Mystery

SUMMARY

Groups of students in the class form advertising agencies competing for an account to design a promotional campaign for a new brand of bottled water. The 'technical reports' and related questions may also be used separately.

STUDENT ACTIVITIES

Part A Reading introductory information, group work and presentation: planning an advertising pitch for a new brand of bottled water.

Part B Reading in French; questions about scientific vocabulary.

Part C Questions for answer or discussion on the technical reports.

Part D Research and discussion: hydrotherapy.

AIMS

- ☐ To complement and extend work on minerals in the diet by considering minerals dissolved in water
- ☐ To provide opportunities for collaborative work, analysing information and using it creatively
- ☐ To create awareness of scientific vocabulary in French
- ☐ To link modern understanding with historical views on hydrotherapy and health

USING AND ADAPTING THE UNIT

- ☐ Parts of this unit may be selected according to the ability of the students. Reading the technical reports may be set for homework along with the questions in part C.
- ☐ Work may be extended into a tasting session, testing the pH of bottled water samples, visits to shops and interviewing consumers.
- ☐ The BBC radio programme for SATIS No. 810, 'The Water Pollution Mystery', is about the purification of drinking water and provides useful information to support the technical report on 'Tap water' in this unit.

Author **Jane Vellacott**

First published 1991

Teaching notes

The material may be used in a variety of ways and is also suitable for cross-curricular work, linking economic understanding with health, science and creative studies. If time permits, aspects like packaging could be considered in greater detail, for example, the use of glass, plastic or carton containers.

Allow the class to divide into small groups (two to five students). The groups will become advertising agencies competing for the Park Springs' account. At the end, invite the best agencies to present their ideas to the rest of the class – as a simulation of the presentation to the directors of Park Springs.

Marketing strategies not suggested in the text could include an introductory offer, collecting labels to qualify for free gifts, marketing the water in earthenware containers based on an original, special displays, using other types of retail outlets such as newsagents.

Video, if available, provides a good medium for presenting a pitch.

Part B A medicinal mineral water? The passage and questions (a) to (f) require no prior knowledge of French. The aim is to show the similarities between scientific vocabulary in French and English and to illustrate some of the wider medicinal claims which have been made for mineral waters.

Part C Questions These questions are provided to support the technical information sheets if they are used for homework or independent classwork.

Part D This section could be used as a stimulus for class discussion, community studies and library research. If there is a spa nearby, the topic could be extended to link with local history.

Jane Austen's novel *Northanger Abbey* starts by describing the life style of eighteenth century gentry who went to Bath to take the waters.

Acknowledgements

The trial version of this unit was checked by Don Gerrard of Lloyd Le Carma Advertising Agency.

Figure 3 is reproduced by permission of Thames Water.

Figure 4 is reproduced by permission of Mary Evans Picture Library.

Answers to the questions

Part B A medicinal mineral water?

(a)

gazeuse	*gaseous*
bicarbonatée	*bicarbonate*
sodique	*soda (or of sodium)*
radioactive	*radioactive*
carbonate	*carbonate*
calcium	*calcium*
magnésium	*magnesium*
intestinales	*intestinal*
hépatique	*hepatic*
anémie	*anaemia*
arthritisme	*arthritis*
regazéifiée	*'re-gasified'*
gaz	*gas*

(b) *Bicarbonate of soda (i.e. sodium hydrogencarbonate), carbonate of calcium and magnesium (these must refer to calcium hydrogencarbonate and magnesium carbonate or magnesium hydrogencarbonate as calcium carbonate is very insoluble).*

(c) *Intestinal and liver complaints, anaemia, arthritis. No – medical recommendations such as these for advertising are not allowed by law in the UK.*

(d) *No. Radioactive emissions are now known to cause cancers. (See SATIS No. 803,* Radiation – how much do you get?*) Like other phenomena not properly understood, general medical efficacy was claimed for radioactivity. Although Source de l'Afrique is fictitious, such claims are made in certain countries.*

(e) *Yes. The level would depend on the local geology. Granites provide a high level of background radiation.*

(f) *Spring water is under pressure in the rocks and has gases dissolved in it. They escape as the pressure is released (like opening a bottle of fizzy drink). More gas (by implication carbon dioxide) must be dissolved under pressure to make the water effervescent again.*

(g) *Water from the spring gushes up at 42°C naturally effervescent with bicarbonate of soda, radioactive and rich in carbonates of calcium and magnesium. Recommended treatment for: intestinal and liver complaints, anaemia and arthritis. Drawn off and re-gasified with natural* gas.*

** implying re-carbonated with naturally-made carbon dioxide*

Part C

Q1 *Evian, Chiltern Hills, Park Springs and Perrier.*

Q2 *The brands in the list which are low in nitrates and low in other minerals are Evian, Scottish Spring Water, Park Springs.*

Q3 *No. A balanced diet provides plenty of minerals.*

Q4 *Lead, aluminium. (Copper is mentioned under acidity and is also toxic.)*

Q5 *Do not use bare aluminium cooking utensils, e.g. saucepans, teapots. (However, aluminium is an excellent material for cooking pots if coated with enamel or a non-stick surface because it has a low density, high thermal conductivity and relatively high specific heat capacity.)*

Do not poach foods wrapped in aluminium cooking foil. Check the contents of indigestion treatments and if they are high in aluminium, do not take them regularly. In the unlikely event that tap water is high in aluminium, use a water filter that removes aluminium ions. If the taste of filtered water is unpleasant, drink bottled water.

Q6 *As a short-term remedy, Mr and Mrs Jones could buy a water filter (on sale in chemists shops) which will remove lead ions (or persuade the water company to supply one). They are cheaper to use than buying bottled water, but levels of bacteria can increase while the water stands. Nevertheless it is an expense that Mr and Mrs Jones can ill afford. Mr and Mrs Jones could participate in community action to demand safer water supplies. It might be possible for the community to turn to law and force the water company to provide a safer supply.*

Part D

1 *For treatment of chronic ailments like gout, arthritis, rheumatism; hydrotherapy (in Germany you can have spa treatments on your health insurance, while in the USSR unions run health hydrotherapy centres), for therapeutic holidays or as part of the social season.*

2 *Spa in Liège province was a favourite watering place of royalty. Spa mineral water is now bottled and on sale in supermarkets in the UK.*

3 *Modern medical treatments are more effective. Hydrotreatments are very time-consuming.*

Bottled Water

Part A – The bottled water boom

More and more supermarkets are selling bottled water. It is a product which is simple to produce and there are large profits to be made. Bottled water costs 600 times more than tap water. The boom in sales is due to clever advertising and marketing.

This unit is about the work of advertising agencies. Your task will be to devise a marketing campaign for a new brand of bottled water.

But first, here's a little background information. It looks at why people are prepared to go out and *buy* something they can get by turning on the kitchen tap.

If you can, why not gather information of your own – go to shops, talk to people who buy bottled water or arrange a tasting session?

Part A Information: the boom in sales of bottled water.

Groupwork: planning a marketing campaign for a new brand of bottled water.

Technical reports are provided on chemical analysis, mineral waters and health, tap water.

Part B Questions to answer about a bottled water labelled in French.

Part C Questions based on information in the technical reports.

Part D Spas: find out about and discuss.

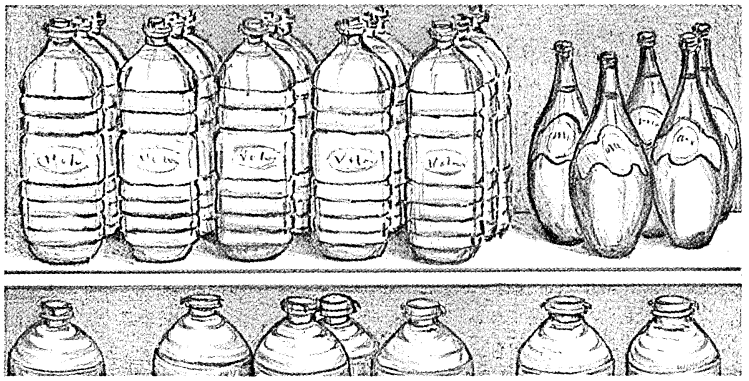


Figure 1 Supermarket shelves filled with bottled waters

The bottled water market

The first bottled water to go on sale in supermarkets in Britain was the French brand, Perrier, in 1974. Since then, sales have risen steadily. They reached a retail value of £150 million by 1989. The rise seems likely to continue. Figures for the amount drunk per person in Britain lag well behind the rest of Europe.

Most of the 200 brands sold in the UK are British. More people buy sparkling water than still.

The reasons which consumers give for buying bottled water fall into three categories: taste, medical advice and concerns about pollution of tap water.

Table 1 The number of litres of bottled water bought per person per year in European countries (1988)

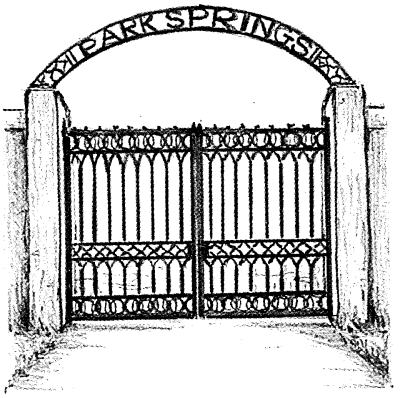
Belgium	60
Britain	4
France	70
Germany	60
Italy	60

Park Springs – a new brand of bottled water

This is the situation. You belong to a new advertising agency.

You receive a letter from the marketing director of Park Springs Estate Ltd., a firm that runs a local health centre.

The firm wishes to sell bottled water from the spring on its estate. It is asking advertising agencies if they are interested in promoting this new brand of bottled water nationally.



A firm that wants to employ an advertising agency will usually invite several agencies to compete for the job.

In the advertising world this is called 'pitching for the account'. Each agency draws up a marketing plan and presents it to the directors of the firm.

The account is normally awarded to the agency that comes up with the best ideas within a reasonable budget.

Park Springs Estate Ltd.
Wood Lane
Beechfield
Homeshire

Dear

As you may know, the water from the spring on our Estate has been famous for its purity and health giving properties since Victorian times. With the growing sales of bottled waters in supermarkets, we believe the time is right for us to enter this profitable market.

Your agency is invited to pitch for the account to market Park Springs Mineral Water nationally.

We expect that the successful agency will provide a complete marketing plan – from the design and labelling of the bottle, to information leaflets for shoppers as well as a national advertising campaign.

Agencies pitching for this account are asked to submit their proposals by the end of the month.

Yours sincerely,

Rita H Lomas

Rita H Lomas

Marketing Director

Your agency will pitch for the Park Springs account. Success is important to establish its reputation as a new agency.

Plan your advertising pitch

☐ Work in a small group. Your group will act as an advertising agency.

☐ Decide on a name for your advertising agency.

Figure 2 Some brands with which Park Springs will compete

☐ Plan a marketing campaign for Park Springs water. Here are some points to help you.

1 *Why do people buy bottled water?*
Think up some ideas.

2 *What technical information will help you with your marketing campaign?*
You have three technical reports on water:
- chemical analysis,
- mineral waters and health,
- tap water.

Decide how you are going to share out the work of reading this information.

3 *What sort of image of Park Springs mineral water (e.g. pure, fresh, healthy etc.) should you promote?*
Consider competitors' packaging and labels. Decide on some key words to describe your product.

4 *What sort of publicity material is needed?*
Think about what sort of people will be buying Park Springs water. Devise a scheme. Share out the work between you.

5 When you have finished, collect your publicity material together and send it to the Directors of Park Springs Estate Ltd.

6 Your advertising agency may be asked to make a personal presentation of your scheme. People in agencies often share such presentations between two or three people, each covering one special aspect.

Your pitch for the account should include some of the following:

- An outline report on how you plan to promote Park Springs water nationally. It must include a background to the agency, the personnel, their credentials etc.
- A design for the bottle (should it be returnable or recyclable?) and for the label – what information should go onto it?
- A leaflet for shoppers.
- An advertisement suitable for a food magazine.
- A letter to shop managers persuading them to stock Park Springs mineral water. You must assure the retailer that the line will be profitable. You may suggest a trade competition as an incentive to staff to 'sell' the product.
- An article on bottled water for a free magazine which uses the opportunity to promote Park Springs mineral water.

Chemical analysis report

Water from springs and wells contains minerals dissolved as ions. Ions are charged atoms or groups of atoms.

The directors of Park Springs Estate asked chemists working in an analytical laboratory to test popular brands of mineral waters.

The concentrations of mineral ions they found are given in table 2.

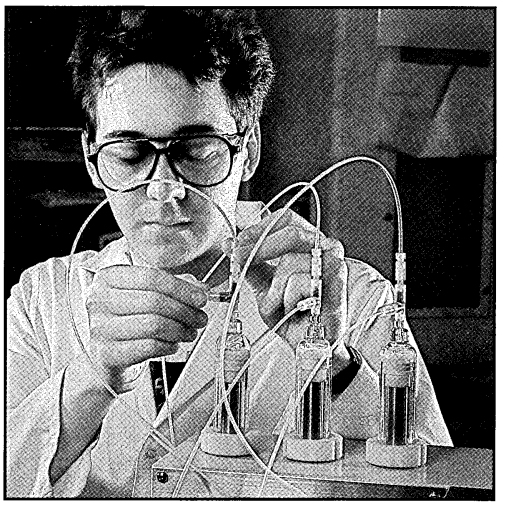


Figure 3 Apparatus for analysing water samples

Table 2 The concentration of mineral ions in bottled waters in milligrams per litre

	Water					
	SSW	**CH**	**Per**	**Ev**	**SPel**	**PkSp**
Sodium	45	8	14	7	45	9
Calcium	50	104	147	78	207	170
Magnesium	13	1	3	24	58	11
Sulphate	14	12	61	10	540	27
Chloride	74	15	28	2	71	35
Nitrate	2	5	22	4	1	7
pH	7.6	5.0	5.4	7.5	5.1	6.2

Key

SSW	=	Scottish Spring Water
CH	=	Chiltern Hills
Per	=	Perrier
Ev	=	Evian
SPel	=	San Pellegrino
PkSp	=	Park Springs (the product you are to promote)

Report on mineral waters and health

For many centuries people have believed that water from special sources had medicinal properties. Even today bottled waters in some countries are claimed to treat ailments like rheumatism and gout.

Bottled waters are low in **minerals**. A good balanced diet will provide all the minerals, like calcium, a person needs. Bottled waters will not therefore promote good health by supplying extra minerals. However, their low mineral content may benefit people with medical conditions like high blood pressure and heart disease. If they are advised to go on a strict low sodium diet a bottled water with a low sodium content may help.

People who are concerned about the levels of lead, nitrates and aluminium in tap water and their long-term effect on health may feel safer buying bottled water.

Children especially are at risk of **lead** poisoning. Lead affects the brain and nervous system, it can cause anaemia and affect muscles.

Nitrates pose a risk of blue baby syndrome, a rare blood disease in small babies. In areas where the tap water is high in nitrates, parents are advised to use bottled water for making up babies' formula. Nitrates occur naturally in foods that adults eat. Although there have been concerns that nitrates may be linked with human cancer, no definite link has been established.

Aluminium may cause loss of memory in the elderly with a form of senile dementia called Alzheimer's Disease. Most people's intake of aluminium comes from food or other sources such as food packaging, additives or cooking utensils. Even 'health salts', used as indigestion treatments, may contain aluminium compounds and should not be taken regularly.

The balance of medical evidence suggests that by drinking bottled water rather than tap water you may be doing yourself less harm rather than more good. British law on advertising forbids any special claims that bottled waters are good for health.

Report on tap water

It seems that Britain's tap water is no worse than that in the rest of northern Europe. However, levels of pollutants do vary across the country and in some areas tap water has failed to meet European Community (EC) standards.

Bacteria Tap water supplies are carefully treated to kill bacteria which may cause diseases like typhoid and cholera. Natural mineral waters are not treated to kill bacteria and levels in them are generally higher than in tap water. The use of water filters with tap water often allows bacteria to multiply.

Nitrates Tap water from intensive farming areas may contain higher levels of nitrates than EC safety limits. Water companies dilute water supplies with a high nitrate content with water from other sources before piping it to the consumer.

Lead Lead levels in several regions are above EC safety limits. Homes built before 1976 may have lead pipes carrying their water supplies. People in soft water areas are at greater risk of lead poisoning from water supplies. (See also **acidity**.)

Aluminium Some natural water supplies contain aluminium. Aluminium may be added to water during treatment. Levels are monitored and controlled.

Iron and manganese These elements discolour water but are not thought harmful to health in small amounts.

Organic compounds Chemicals from the pitch on roads, sealings around old water mains, agricultural insecticides and industrial degreasing and dry cleaning fluids have been discovered in water supplies. They are known to cause cancer in animals but it is not known if they cause cancer at the levels found in tap water.

The acidity (pH) Tap water which is slightly acid will attack lead and copper plumbing putting people at risk of poisoning by lead and copper compounds.

Radon A radioactive gas, radon, dissolves in water underground but escapes when water is left standing in reservoirs. It may be present in water drawn directly from springs and wells.

Table 3 Analyses of typical water supplies

	Cambridgeshire	London	Manchester	Scotland
sodium	120	30	15	20
calcium	420	270	35	25
chloride	100	20	20	20
sulphate/nitrate	180	30	15	5
pH	7.1	7.6	8.2	6.7

Part B – A medicinal mineral water?

Source de l'Afrique is a bottled water which has won the highest awards for its quality.

The label provides the following information.

(a) *Make a list of the all the scientific words you recognise with their English equivalents.*

Even if you cannot read French you can see that scientific words in French are very similar to their equivalents in English.

(b) *What chemical substances are dissolved in the water?*

(c) *For which medical problems is it recommended? Have you found similar recommendations on labels in the UK?*

(d) *Source de L'Afrique water is radioactive. Do you think this property will help to treat the medical problems mentioned?*

(e) *Would you expect British mineral waters to be radioactive too?*

(f) *Why is the water 'regassed' for bottling? Which 'natural gas' is used?*

(g) *If you can read French, translate the information on the label.*

Part C – Questions

For answer or discussion

Q1 *Which of the bottled waters in the chemical analysis report would you choose for a person who has been recommended a low sodium diet by a doctor?*

Q2 *In areas where nitrate levels in tap water are high, formula for babies' bottles should be made with bottled water. The lower its mineral content the better. Which brands would you suggest are most suitable?*

Q3 *Do you think that children should be encouraged to drink mineral water in order to have enough calcium in their diet?*

Q4 *Which metal ions sometimes found in water supplies may be damaging to health?*

Q5 *Some people have high levels of aluminium in their bodies. Suggest how they might reduce their intake of this element.*

Q6 *Mr and Mrs Jones have two small children and only just enough money to live on. They discover in the local newspaper that levels of lead in their tap water are above the European Community recommended level. The local water company sends out letters to say that the problem is temporary and that levels are well below those known to damage health. What do you think Mr and Mrs Jones should do about drinking water for their family?*

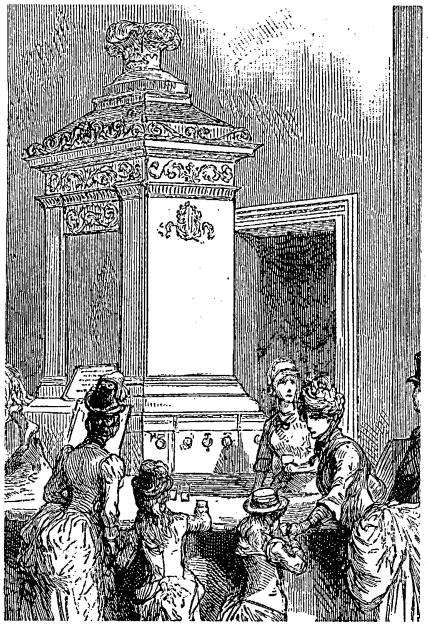


Figure 4 Cheltenham Spa in its heyday

Part D – Spas

For centuries people have gone to spas to 'take the waters'. The hot springs at Bath used by the Romans were a fashiohable meeting place in Jane Austen's day. These practices, now known as hydrotherapy, still flourish in many parts of Europe.

Find out about and discuss

1 For what sort of ailments did people go to take the waters?

2 Spa is a resort town in Belgium. How did it become famous? (Try looking up 'spa' in an encyclopaedia.)

3 Most British spas have closed. What changes in science and society may have brought this about?

Answers to the questions are given in the *Teachers' Notes.*

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