

Just what is science?



UNIT A9

This unit consists of a series of activities all related to the nature of science and the work of scientists. Most of them can be used on their own.

Using this unit

The sections of this unit do not need to be used one after another.

The activities could be used at different points in the teaching programme. They could serve to introduce science at KS3 or possibly after SATs as an introduction to science in general before starting GCSE work. They may provide short activities to use at the end of an introductory talk or to fill those 15-minute gaps that sometimes appear in lessons!

This unit is intended to provide not an exhaustive study but rather an opportunity for pupils to reflect a little on the nature of science and some of its limitations.

Useful resources

J. A. D. Mathew, 'Cartoons in science' in *Physics Education* 26 (1991) pp. 110-114.

J. E. McAdam, 'The persistent stereotype: children's image of scientists' in *Physics Education* 25 (1990) pp. 102-105.

M. W. Poole, *God and the Scientists: 10 International scientists speak about their faith within the world of science*, (Worthing: CPO, 1997).

Links with KS3 programme of study

- ◆ Using a wide range of sources of information including ICT (breadth of study).
- ◆ The ways in which scientists work today and examples of how they worked in the past, including the role of experimentation, creative thought and values in changing scientific ideas (Sc1 ideas and evidence).

Moral and spiritual aims

- ◆ To examine the strengths and imitations of science.
- ◆ To show that science is not a neutral, value-free activity.

Notes on the activities

Activity 1: Identifying what you think of as science

A high score (16 to 20) indicates strong agreement with the statements and a strong belief in the power of science and its ideals. This is arguably a traditional view of science. A low score (4 to 8) shows more scepticism about the power of science and possibly a stronger belief in values of other kinds, and these may include religious values. This is arguably a more contemporary view.

Activity 2: Our views of scientists

This is a standard test and the results are consistent: people tend to draw a white, middle-aged, bespectacled, white-coated man in a laboratory usually doing chemistry or experimenting on animals. The Royal Society of Chemistry has a series of posters 'Scientists don't just wear a white coat'. See also the web site entitled: 'Great chemists who aren't dead white guys' at

<http://oak.cc.conncoll.edu/~mzim/dead.html>

This is a chance to examine where our ideas of scientists come from. Do they come from TV caricatures or from real life?

Activity 3: A database of scientists

This is an ICT activity designed to introduce pupils to a range of scientists. It may show that, contrary to popular belief, many scientists have religious beliefs.

Biographies of many women scientists are listed at: <http://www.astr.ua.edu/4000WS/4000WS.html>

Another good source of biographies can be found at: <http://www.pbs.org/wgbh/aso/databank/index.html>

The discussions might help to show that issues are less clear cut. For example, scientists born in one country do their work in another, some chemists make discoveries in physics and some have a faith that helped their work.

Activity 4: What is science?

This activity is designed to elucidate pupils' ideas about science. It will provide opportunity for discussion and debate.

Activity 5: Religion and science

It is a commonly held view that science is religiously neutral. This activity aims to help pupils to question that view by showing them that there is a range of views on this issue.

(b) 2 with A, 3 with B, 1 with C. These are examples of how religious belief affects theory choice in science.

Activity 6: Scientific methods

Many school science textbooks have an opening section explaining the way scientists work. You may find it helpful to draw your pupils' attention to one of these. Section (a) looks at the skills we use in science and section (b) looks in more detail at what may be involved in using our skills of observation.

(a) How do scientists work?

The purpose of this activity is to show that the boundary between science and non-science may be fuzzy.

(b) Seeing and believing

This activity is based on the famous duck/rabbit diagram but here it is a duck/antelope.

Split the class into several groups.

Show some of the groups picture 1: the ducks. Show the others picture 2: the antelopes. (See following page.)

Ask each of the groups to answer the questions on the activity sheet without letting other groups know their answers.

Show the whole class picture 3 on an OHT. Begin by asking the groups to confirm that this is the thing they have been discussing. Then ask the same questions as on the activity sheet. Watch the confusion!

Show all three pictures to the class.

Discuss the problem of observation. How do we know that what we see is what other people are seeing? This exercise illustrates how observation, like any activity, is context-based. We cannot be certain our view is correct, or the only view and we need to proceed with caution.

(c) Looking for patterns

This is a provocative activity to examine whether science is about discovery or invention.

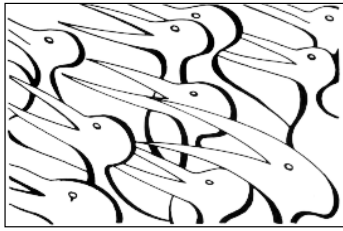
Use the picture of the dots on the following page to make an OHT.

Show the OHT and ask the class to see if they can spot any patterns in the picture.

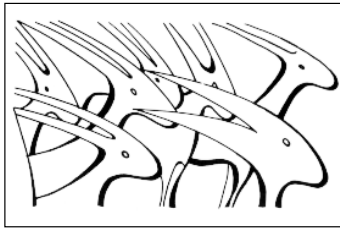
Get several members of the class to show where they can see patterns. Try to identify as many different patterns as possible. Make sure most of the class can see the pattern each time.

Then discuss whether the patterns are really there and being discovered by us, or are we making up patterns out of what exists? This can then lead into discussion of the status of the patterns which science seeks.

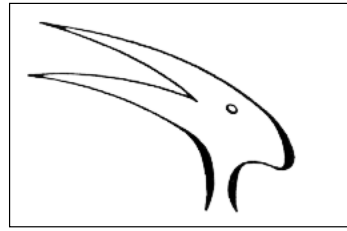
Duck/antelope



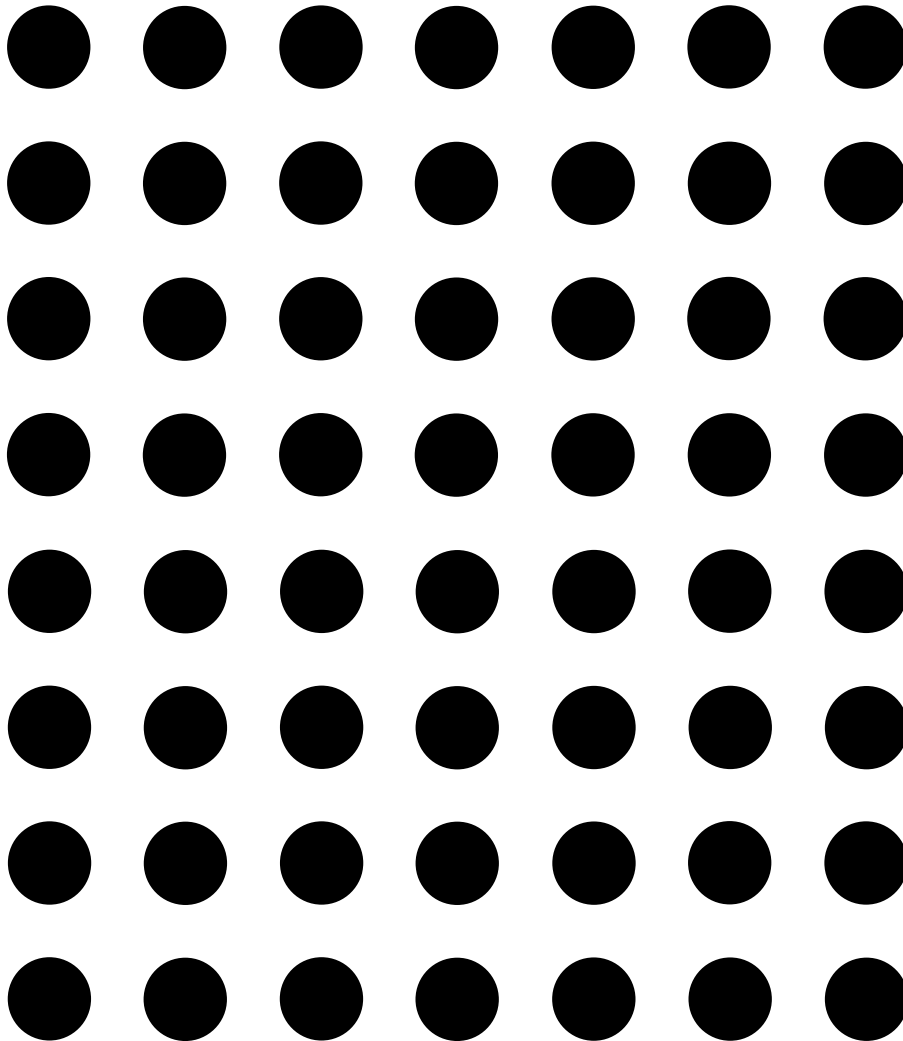
Picture 1



Picture 2



Picture 3



Just what is science?



UNIT A9

Have you ever stopped to think just what science really is? Is doing an experiment doing science? Is crossing the road doing science?

1 Identifying what you think of as science

Below are five statements. Read each of the statements. For each statement, write down a number from the left-hand column, depending on how much you agree or disagree with the statement.

5: STRONGLY AGREE; 4: AGREE; 3: UNSURE; 2: DISAGREE; 1: STRONGLY DISAGREE

- | | | | | | |
|---|---|---|---|---|---|
| 5 | 4 | 3 | 2 | 1 | 1. Science will eventually give us complete control over the world. |
| 5 | 4 | 3 | 2 | 1 | 2. Theories in science can be proved to be definitely true. |
| 5 | 4 | 3 | 2 | 1 | 3. The laws and rules of science will never be changed. |
| 5 | 4 | 3 | 2 | 1 | 4. Nothing should be believed unless it can be proved scientifically. |



Add up your scores and discuss with your teacher what they might mean.

2 Our views of scientists

(a) A typical scientist?

Take a piece of plain paper and on it draw a picture of a typical scientist at work. When you have completed your picture, get into small groups of about 4-6. Look at each other's pictures. In your groups, discuss the questions below. (In a few minutes, you will be asked to give feedback to the whole class, so you will need to make notes and, unless someone else desperately wants to, the person with the shortest surname will be the spokesperson for the group.)

- Why have you drawn the picture that you have?
- What have the pictures got in common?
- In what ways are they different?



(b) Scientists in the media

Either

Collect pictures from magazines or comics that depict scientists. Make them into a collage or poster.

or

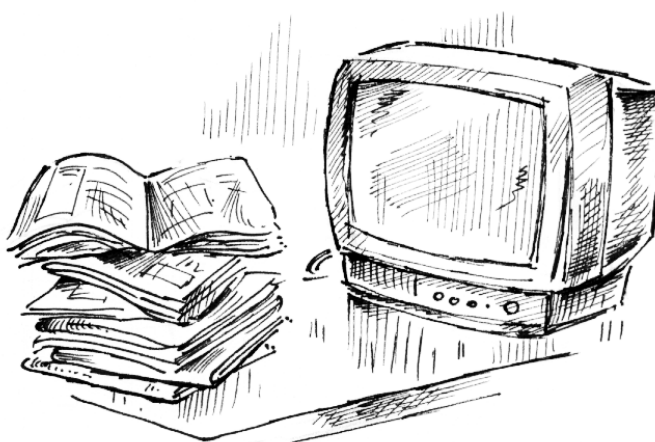
Choose a book or TV programme that features a scientist. How is that scientist depicted?

Is the scientist you drew in your picture of a typical scientist similar to or different from the scientists depicted in magazines, comics, books and films?

Many people, when they think of scientists, think of white, absent-minded, balding, short-sighted males who work in a laboratory.

- Is this true of your drawing of a scientist?
- Is it true of the scientists in books, comics and TV programmes? If so, why do you think this might be?

Scientists are of many different types, e.g. nuclear physicists, hospital biochemists, geologists. Can you think of more?



3 A database of scientists

Using either a computer database or a card system, construct a database for up to **five** of the following scientists. Find out: when they lived; their nationality; their religious beliefs; and what they were famous for.

With the rest of the class, discuss the following:

- How many of the scientists you have researched came from families that were scientific?
- What proportion of the scientists had a religious faith?
- How many different countries were represented in the list?
- How many can you say were chemists or biologists or physicists?

Andre Ampere

James Dewar

Edward Jenner

Archimedes

Charles Drew

Johannes Kepler

Aristotle

Thomas Edison

Guglielmo Marconi

Henri Becquerel

Albert Einstein

Leise Meitner

Jocelyn Bell

Michael Faraday

Isaac Newton

Anders Celsius

Rosalind Franklin

Georg Ohm

*Subrahmanyan
Chandrasekhar*

Galileo

Blaise Pascal

William Gilbert

Joseph Priestley

*Nicolaus
Copernicus*

Janet Goodall

Wilhelm Röntgen

Francis Crick

Stephen Hawking

Ernest Rutherford

Marie Curie

Caroline Herschel

Joseph J Thompson

John Dalton

Robert Hooke

James Watt

Charles Darwin

Fred Hoyle

4 What is science?

Working in small groups,

either

Write the word 'science' on a sheet of blank A3 paper. In turn each person should write down phrases describing what the word means to them.

or

Each person in the group should write down five sentences that describe what they mean by science. Then, in the small group, discuss the sentences that you have written. Try to indicate by each sentence whether the members of the group agreed (write A), disagreed (write D) or were unsure (write U).



Finally, as a whole class with your teacher, find out some things about science that the groups agree on and, if there is time, some that they disagree about. Give some examples to show what you mean. (If pupils agree that science includes research, examples could be research into new medicines or new polymers.)

5 Religion and science

(a) Do religious beliefs have anything to do with science?

A group of scientists were asked 'What do you think should be the relationship between religion and science?'. Some possible answers are given below. For each statement, note down whether you agree (A), disagree (D) or are unsure (U).

1. Science can prove or disprove all religious belief.
2. Religion and science are two approaches to understanding our existence.
3. There is no conflict between faith in God and being a scientist.
4. Science has shown that we no longer need religion.



It might surprise you to know that the scientists held a range of different views about religion and science, including all the four given above.

(b) How do religious beliefs affect what we think about a scientific theory?

One way to see how religious beliefs may affect science is to look at how scientists have responded to the big bang theory (the idea that the world might have started with a very big explosion).

Here are three people who voiced different opinions about the big bang:

1. A British scientist who believes there is no god.
2. A Hungarian scientist who is also a Catholic priest.
3. An American scientist who is a Christian.

Here are the three different opinions:

- A. The big bang supports the Christian idea of a creation.
- B. The big bang theory is wrong because it contradicts the Bible.
- C. The big bang theory is wrong because it supports the idea that the world was made by God.

Can you identify who said what? Match the numbers with the right letters. How did you arrive at your conclusion? Do you think religious beliefs can affect how we view scientific theories?

6 Scientific methods

(a) How do scientists work?

When you do science in school, which of the following activities do you think you actually do most or least? For each activity, say whether you do it always (A), usually (U), sometimes (S) or never (N).

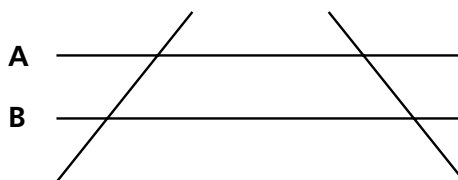
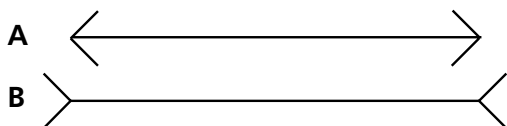
- (i) Observing (looking carefully)
- (ii) Making hypotheses (making good guesses as a basis for finding out)
- (iii) Dreaming (seeing pictures in our sleep or in our imagination)
- (iv) Predicting (deciding what is likely to happen)
- (v) Pattern spotting (spotting trends in data)
- (vi) Inferring (coming to a conclusion from the evidence)
- (vii) Classifying (arranging into categories or groups)
- (viii) Interpreting (explaining or giving a meaning)

It could be argued that you are 'doing science' even when you cross the road! Think carefully about all that is involved in successfully crossing a busy road. Check the list above to see how many of the activities may be involved in crossing a road.

(b) Seeing and believing

Many scientists claim that science is based on observations. But is seeing always believing? Can we trust what we see?

- (i) Look at the lines marked A and B in each of the following pictures. Which is longer in each case?



- (ii) Look at the two squares. Which covers the largest area, the light or the darker?



- (iii) Working in small groups, your teacher will show you a picture of a group of things. Study the picture carefully. (Be careful not to let any other group see your picture.)

6 Scientific methods continued

In your small group, answer the following questions about the thing you saw in the picture:

- How would you describe what you saw?
- What might the thing in the picture be?
- What might it eat and what environment might it prefer?

When your teacher shows you another picture of the thing, be prepared to give your answers to the questions above.

Scientists do not see everything they may believe in. Sometimes we cannot believe what we see and sometimes it depends upon the context as to what we see.

(c) Looking for patterns

Your teacher will show you a picture made up of dots. See if you can spot any patterns in the picture.

Are the patterns really there? Or are we making up patterns out of what exists?

The constellations of stars in the night sky have been given names according to the patterns that people have seen in them in the past. One of the best known of them is the Plough but it is also called the Big Dipper and it, together with adjacent bright stars, is generally called Ursa Major (the Great Bear). The people of Lapland imagined this constellation to be a reindeer and it was called Arthur's Chariot in ancient England.

What about science? If the dots are like the world and the way it is, is science discovering the patterns that are there already or is it inventing the patterns? Are we being discoverers or inventors when we do science?