Spectacles and Contact Lenses

Contents: Reading, questions, practical work and survey concerning spectacles and contact lenses.

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

Intended use: GCSE Physics, Biology and Integrated Science. Links with work on the eye, defects of vision and lenses.

Aims:

- To complement and revise prior work on the eye, defects of vision and lenses
- To show some of the background to the development of spectacles and contact lenses
- To develop awareness of the scale and pattern of visual defects in the community
- To provide opportunities to practise certain skills, including observation and interpretation, and to develop the ability to carry out and interpret a survey.

Requirements: Students' worksheets No. 209. For Part 2, a variety of old spectacles of different types will be needed.

This unit comprises reading and activities designed to complement standard work on the eye and defects of vision. There are three parts, and these can be used separately or in conjunction with one another.

Part 1 Gives background information on spectacles and contact lenses. It is a short piece of reading with questions.

Part 2 A short exercise involving the examination of spectacles. It will be necessary to provide a range of spectacles: students could be asked to bring old ones from home. It would be a good idea to go through them before the exercise to check they are a representative selection.

Part 3 A survey, followed by questions. The survey could be carried out in the school, in the street or from home. The main problem is likely to be getting an adequate spread across the age ranges. It might be helpful to pool results.

Notes on some of the questions

Q.2 British people enjoy a high quality of eye care, but this is not the case in many developing countries. Students may be interested to hear of the systems that operate elsewhere. In many countries spectacles are bought at an ordinary shop, without any specialist help with fitting. (This is possible in Britain too, though because of free eye-testing the majority of people get prescription lenses.) Schemes exist for collecting old spectacles in Britain and other developed countries and distributing them in developing countries.

Q.6 Most laboratory lenses are biconcave or biconvex, or possibly plano-concave or plano-convex. Spectacle lenses are generally concave on the side nearer the eye, to give clearance between lens and eye and to correspond to the curvature of the retina, thus minimizing distortion. The other side is generally convex, its curvature deciding the overall nature of the lens.

Q. 9 a needs 2; b needs 4; c needs 3; d needs 1.

Qs 15, 16 Students should be aware of the problem of drawing conclusions from a survey based on small numbers or on an uneven sample. Even with a large sample spread across the age-range, distortions may occur — for example, people may be reluctant to admit their true age or sight condition.

Other resources

1 *The Eye.* A computer software package published by Longman.

2 Two booklets published by the Optical Information Council (Temple Chambers, Temple Avenue, London EC4Y 0DT): *Insight — a look at Human Vision* and *The Sense of Sight.*

Acknowledgements Figures 1 and 4 supplied by the Optical Information Council.

SPECTACLES AND CONTACT LENSES

There are 55 million women, men and children in Britain. 24 million of them need spectacles or contact lenses to help them see clearly.

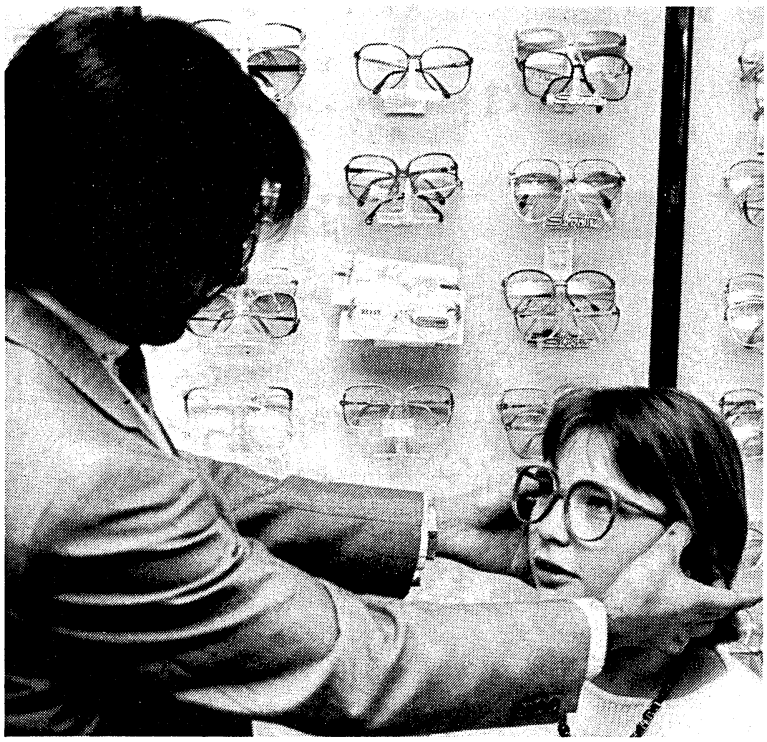


Figure 1 Fitting new spectacles

In your science lessons you will probably have learned about the eye and why it sometimes does not work properly. Table 1 is a brief summary of the main defects of vision.

Table 1 The main defects of vision

Name of defect	*Nature of defect*	*Why it happens*	*How it is corrected*
Short sight	Cannot see distant objects clearly	Eyeball too long, or lens too strong	With concave lenses
Long sight	Cannot see close objects clearly	Eyeball too short, or lens too weak	With convex lenses
Poor accommodation	Difficult to focus on things close up, and far away	Lens hardens, making it difficult to change its shape. Usually starts to happen in middle age	With bifocal spectacles, containing two lenses, one for close up, one for far away
Astigmatism	Cannot see as well in one plane as in others	Lens or cornea is slightly barrel-shaped instead of spherical	With lenses which are slightly barrel-shaped to compensate

This unit is in three parts:

Part 1 Background to spectacles and contact lenses
Part 2 Looking at spectacles
Part 3 A sight survey.

Part 1 Background to spectacles and contact lenses

Who invented spectacles?

The Romans and ancient Chinese knew that a piece of glass of a particular shape would magnify objects seen through it. We do not know who first invented spectacles but by the fourteenth century they were quite common in Europe. Figure 2 shows a monk wearing spectacles, and dates from 1352.

In England in the early thirteenth century Bishop Robert Grosseteste suggested that specially shaped pieces of glass could be used to magnify small objects. He called these pieces of glass lenses, because they were shaped like lentils. This idea was used by his pupil, Roger Bacon, who made some of the earliest spectacles. At first only convex lenses were produced, to help long-sighted people. After the invention of printing many more people needed spectacles and by the fifteenth century they were used quite a lot.

It is now possible to have spectacles that help long sight, short sight, or both (bifocal lenses).

In Britain today, everyone can have their eyes tested free under the National Health Service. If the tests show they need spectacles, young people under 19 or in full-time education get them free under the NHS. So do some people on low incomes. Other people have to pay for their spectacles.

Figure 2 A monk wearing spectacles — date 1352

Questions

1 *Why did more people need spectacles after the invention of printing?*

2 *In Britain, practically everyone can get spectacles if they need them. How would people manage in a developing country where there are few opticians?*

What about contact lenses?

Contact lenses float on the front of the eye, actually touching it. Leonardo da Vinci first suggested the idea, in the fifteenth century. But it was not until 1887 that the first glass contact lenses were fitted. Glass lenses could only be worn for a short time because oxygen could not get through the glass and reach the eye.

By 1935 the growth of the plastics industry meant that contact lenses could be made from plastic. The lenses float over the cornea and are shaped to fit the wearer exactly (Figure 3 on next page).

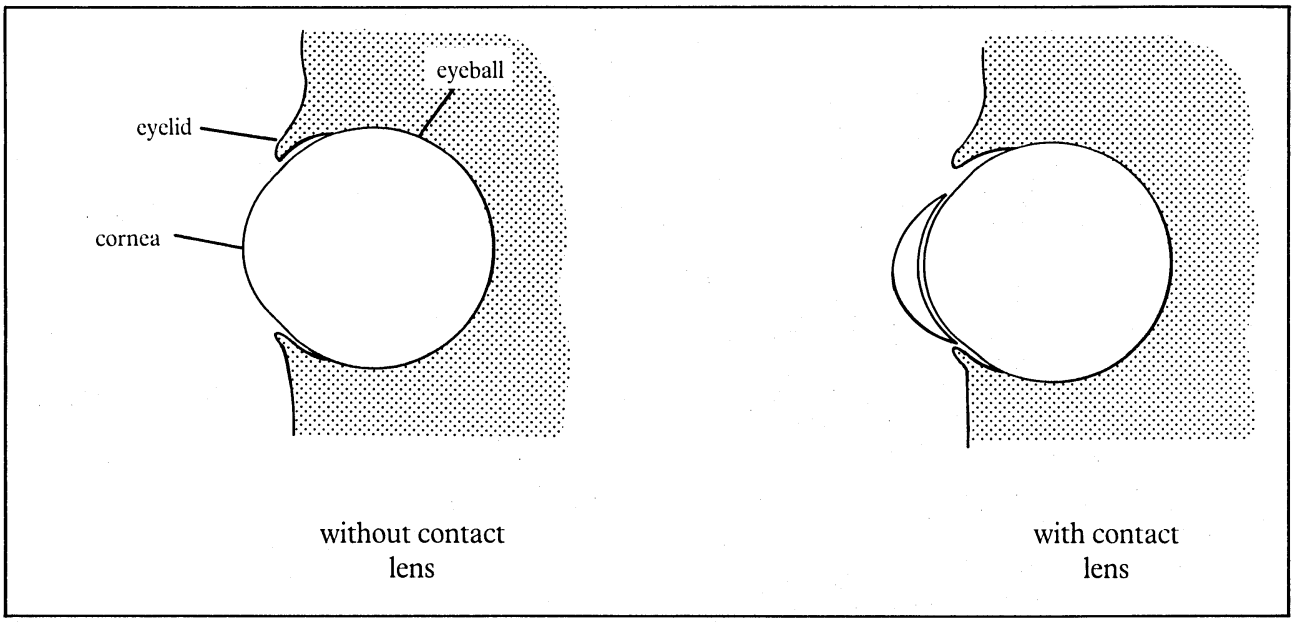


Figure 3 How a contact lens is worn

Modern contact lenses are classified as hard, soft and gas-permeable.

Hard lenses are very small (approximately 9 mm across) and are made from rigid plastic material. They float on the surface of the eye, and are small enough to allow oxygen to reach the eye.

Soft or **hydrophilic lenses** were developed in the 1970s and can be worn for long periods without discomfort. They are made from a plastic that is hard when dry, so that shaping and polishing can be carried out. But the plastic absorbs up to 80 per cent of its own weight of water. This gives a soft, permeable, jelly-like material which is comfortable to the eye.

Gas-permeable lenses are made from recently developed plastics. They are thin and flexible with similar properties to hard lenses, but they allow more oxygen to pass through to the eye.

Questions

3 *Why did the development of the plastics industry lead to many more people wearing contact lenses?*

4 *What are the advantages of (a) hydrophilic lenses, and (b) gas-permeable lenses, over hard contact lenses?*

5 *What do you think are the advantages of wearing contact lenses rather than spectacles? What are the disadvantages?*

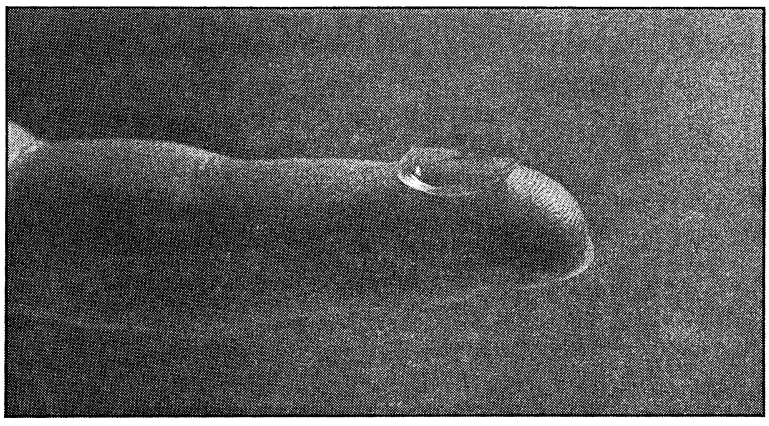


Figure 4 The size of a contact lens

Part 2 Looking at spectacles

For this part of the unit, you will need a collection of spectacles to examine. Use the following method to decide what defect of vision each pair of spectacles is for:

A Look closely at the spectacles. Are there two (or three) different parts to the lens? If so, they are bifocals (or trifocals), for poor accommodation.

B If they are not bifocals or trifocals, hold the spectacles at arm's length. Do they make things look smaller? If so, they have convex lenses for long sight.

C Hold the spectacles at arm's length. Look through one lens at an object, then rotate the lens, still looking through it. Does the shape of the object change as the lens rotates? If so, the lens is designed for astigmatism.

Questions

6 *In what way do spectacle lenses differ from the lenses you use in the laboratory? Why do you think this is?*

7 *Examine a pair of bifocal lenses. Which part is for looking at close objects, and which is for looking at distant objects?*

8 *Why are bifocals usually worn by middle-aged and old people, but hardly ever by young people?*

9 *Bifocal lenses can be made in different arrangements to suit people with different needs. Figure 5 shows four different bifocal lenses.*

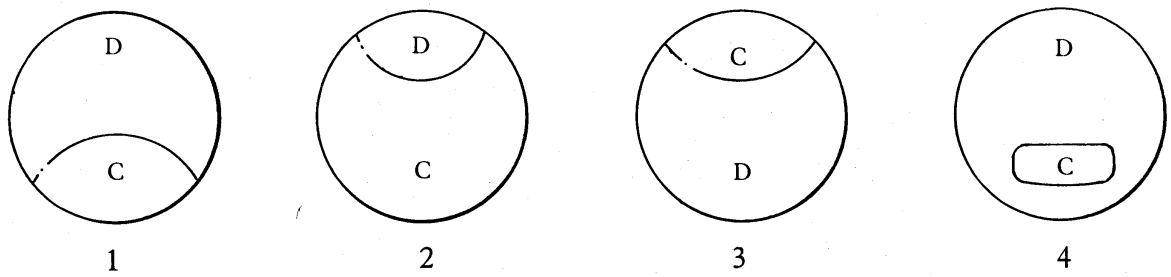


Figure 5 Different bifocal lenses. The part marked C is for close work, the part marked D is for distance.

Which bifocal lens would be most suitable for each of the following?

a A musician who needs to be able to look at wide sheets of music, and occasionally look at the conductor.

b A painter and decorator who needs to be able to look at the walls being painted, to go up and down ladders and occasionally do close reading.

c An airline pilot, who needs to read overhead instruments in the cockpit, and also look ahead out of the cockpit window.

d A shop assistant, who needs to keep looking up at the customer and down at the till.

10 *Are both lenses of a pair of spectacles always the same? If not, why not?*

11 *What is a monocle? What sort of sight defects are monocles worn for? Why are they hardly ever worn nowadays?*

Part 3 A sight survey

In this survey you are going to try and find out if there is a pattern to the type of sight defects from which people suffer.

To help you spot any patterns you must include as many people as possible in your survey. They should be spread as much as possible across the age ranges.

Perhaps you could pool your results with other members of the class to increase the sample. (Make sure you have not asked the same people!)

Copy Table 2 and complete it by putting a tick in each of the boxes which apply to the person you are interviewing. Include people who only wear glasses some of the time.

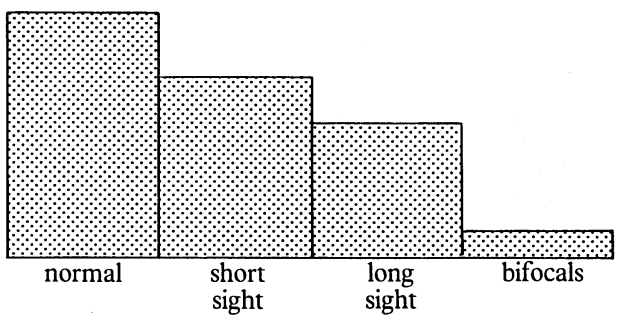
Table 2 A sight survey

Normal-sighted	*Wear glasses or contact lenses for short sight*	*Wear glasses or contact lenses for long sight*	*Wear bifocals*
Male			
Female			
Age 11—21			
Age 21—40			
Age 40—70			
Age over 70			

Questions and activities

12 For each of the four age groups, draw bar charts to compare the numbers of people with different sight conditions. For example, your bar chart for the 21—40 age group might look like Figure 6.

Figure 6
Example of barchart for age group 21—40



13 Is there a noticeable relationship between age and type of sight condition? If so, what is it?

14 Is there a noticeable relationship between sex and type of sight condition? If so, what is it?

15 Are there enough people in your survey to make your conclusions reliable? How could you improve your survey?

16 Even if your survey did include large numbers of people, the results might still be unreliable. Suggest some reasons why.