Noise

Contents: Reading, questions and optional survey on the problem of noise pollution.

Time: 2 periods or more, depending on how many parts are used.

Intended use: GCSE Physics and Integrated Science. Links with work on sound.

Aims:

- To complement work on sound
- To develop awareness of some of the social and medical problems caused by noise
- To show some of the problems involved in reducing noise
- To provide opportunities to practise skills in reading, comprehension and the collection of information.

Requirements: Students' worksheets No. 407.

This unit is in five parts:

Part 1 Noise and hearing
Part 2 Where does noise come from?
Part 3 How can noise affect your health?
Part 4 How can we cut down noise?
Part 5 How noisy is your school?

Part 5, the noise survey, can be omitted if time is short, though it makes an interesting exercise. The survey is best tackled by students working in small groups, or as a whole-class exercise.

Notes on some of the questions

Q.6 Students might be interested to discuss the psychology of noisy machines. Does a noisy vacuum cleaner seem more powerful than a silent one would? Why do some motor cyclists enjoy riding noisy machines?

Q.7 After exposure to a noise level of 100 dB for 10 minutes a person is likely to experience a shift of hearing threshold from 0 to 20 dB. This loss of hearing would wear off after half an hour or so. 100 minutes' exposure to 100 dB might cause a shift of hearing threshold to 30 dB which would take 36 hours to wear off. The loss of sensitivity is most pronounced at a frequency of around 4000 Hz. As a result of such hearing loss, speech sounds muffled and high frequencies sound unnaturally strong.

Q.10 It is interesting to speculate what the British attitude to Concorde would have been had the airplane been developed and built in another country.

Q.12 People with particularly noisy working environments include workers in bottling plants and boiler factories, truck and tractor drivers, printers, swimming bath supervisors, some typists, pop musicians, disc jockeys, and perhaps teachers.

Q.17
(a) Double glazing and possibly cavity wall insulation.
(b) Carpets and soft wall coverings would help. Rubber feet or absorbent mats under the typewriters are also effective.
(c) The best plan would be to have a word with the neighbours, or bang on the wall.

Note on the decibel

No attempt has been made in the students' materials to explain the basis of the decibel unit — it is simply used as a relative scale. For high ability students, the reason for using a logarithmic scale could be explained, and related to the very wide range of sound intensities with which the ear has to cope. (For instance, the sound produced by a jet engine is about 10^{12} times more intense than that of rustling leaves. This is expressed logarithmically by saying that the jet is 12 Bels, or 120 decibels, louder than the rustling leaves.) The figures quoted in the students' materials are actually in dB(A) units. This is a modified dB scale which takes into account the fact that the ear is more sensitive at one frequency (about 4000 Hz) than at lower and higher frequencies.

Further activities: possible experimental work

1 *Noise meters* A great deal of interesting practical work can be done if a noise level meter is available, particularly as part of the school survey.

2 *Why are jet aircraft so noisy?* The following simple demonstrations illustrate why jets produce a variety of noises, from a deafening roar to a high-pitched scream:

(a) Light a bunsen with the air hole open.
(b) Start a fan (for example, a vacuum cleaner).
(c) Hit a sheet of metal. Place a noise-producing device (for example, a ticking clock or a small electric motor) on the metal to show how the noise is amplified.

Discuss, in terms of air vibration, why each of these produces a noise. Then point out that a jet engine combines all three.

Other resources

Materials relating to noise abatement can be obtained free by sending a stamped address envelope to: The Noise Abatement Society, PO Box 8, Bromley, Kent BR2 0UH.

Acknowledgements Figure 1 supplied by Farmers Weekly; Figure 3 supplied by the Noise Abatement Society; the graphs in Figure 4 are adapted from *Physics in Society*, a text produced by the Department of Physics, The Free University of Amsterdam, The Netherlands.

NOISE

Sit still and listen to the sounds around you. Some may be pleasant, but there may be some sounds you would prefer to do without.

Noise is sound we do not want to hear.

Noise can pollute the environment in the same way as smoke and oil can be pollutants.

This unit is in five parts:

Part 1 Noise and hearing

Part 2 Where does noise come from?

Part 3 How can noise affect your health?

Part 4 How can we cut down noise?

Part 5 How noisy is your school?

Questions

1 *List five sources of noise that you often hear.*

2 *Some sounds are pleasant to certain people, but unpleasant noises to other people. Give two examples.*

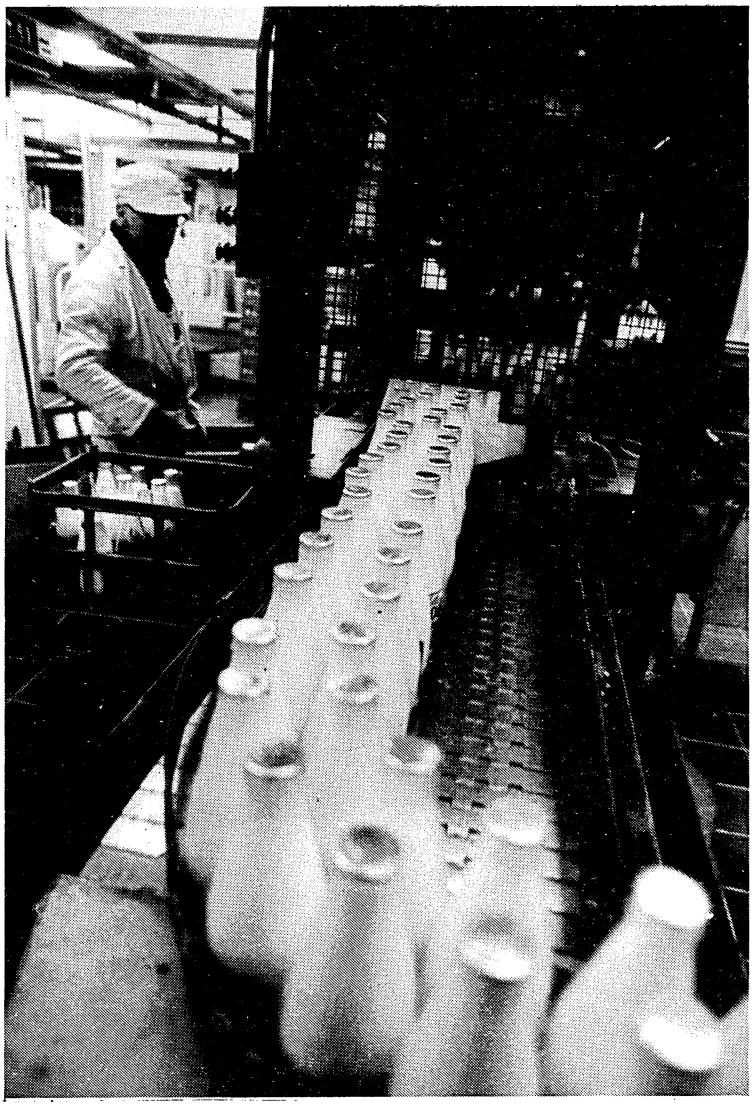

Figure 1 A bottling plant is one of the noisiest working environments

Part 1 Noise and hearing

The **frequency** of a sound vibration decides its pitch. A high frequency gives a high pitch. Frequency is measured in hertz (Hz). The **amplitude** of the vibration decides how loud it is. A high amplitude gives a loud sound. Loudness is measured in **decibels** (dB).

Comparing the loudness of different sounds

Using the decibel scale, we can compare the loudness of different sounds (Figure 2).

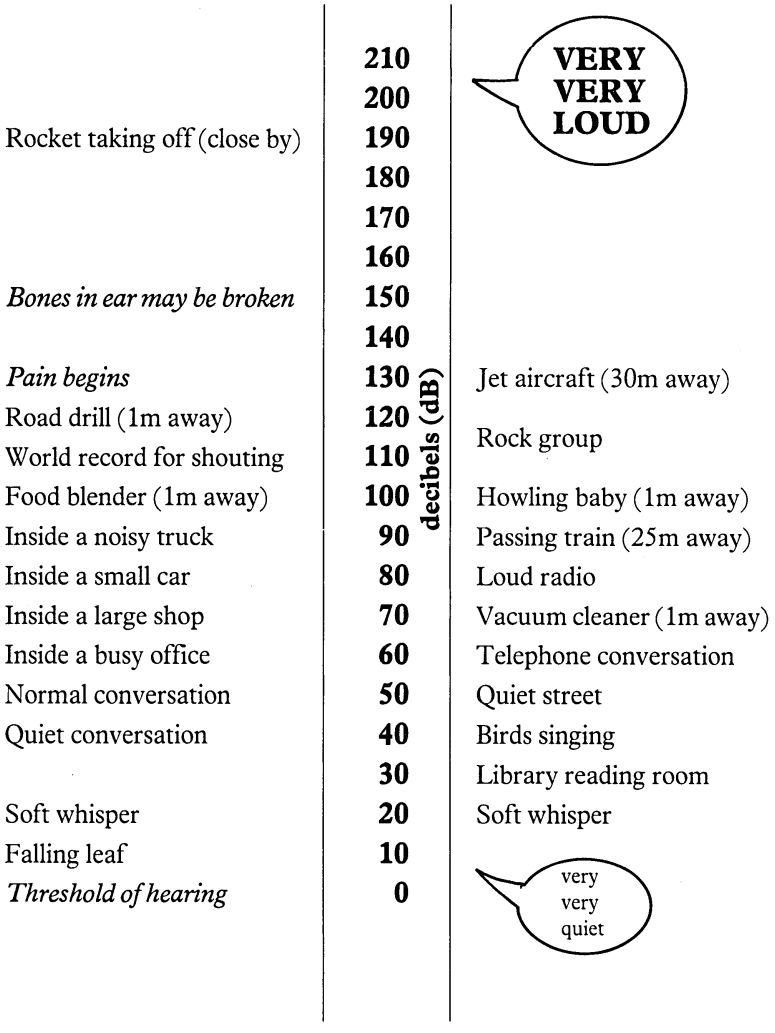

Figure 2 The decibel scale of loudness

Questions

3 *Using the scale, estimate the noise level in decibels inside your classroom at this moment. (If you are doing this at home, try to imagine your classroom noise level on an average day.)*

4 *What is the highest noise level you think you could put up with all day?*

Part 2 Where does noise come from?

At home

Noise can be very irritating at home because it invades people's lives. The commonest culprits are regular party-givers and do-it-yourself enthusiasts. Other people's noise is always worse than your own!

Questions

5 *What are the most annoying noises in your home?*

6 *People sometimes seem to enjoy using noisy machines. Why do you think this is? Give some examples.*

Pop music

The average sound level in a disco is about 103 dB. In a pop concert it can be about 115 dB. Roger Daltry of The Who admits he has a hearing problem because of years spent on stage close to loudspeakers.

Personal stereos can generate over 100 dB at the ear, and some may go as high as 124 dB. A noise level of 124 dB would be illegal in a factory for more than 15 seconds a day.

Question

7 *What do you notice about your hearing after you come out of a loud disco or pop concert, or after you have been listening to loud music on a personal stereo?*

Road traffic

Road traffic noise comes particularly from the tyres and exhaust of vehicles. Faulty silencers are often a serious source of noise.

Question

8 *Which types of road vehicles are noisiest? Why?*

Air traffic

Jet engines are among the noisiest human inventions. The problem is worst for people who live near airports. There are 173 airports in the United Kingdom, and it is estimated that 10 per cent of the population suffers from noise pollution by aircraft. Even the Queen suffers — Windsor Castle is often disturbed by the noise of jets from Heathrow. Prince Philip has his own noise meter to keep a check on noise levels.

Figure 3 Aircraft taking off or landing cause noise pollution for people living nearby

Questions

9 Aircraft are noisiest when taking off. Why?

10 Concorde is the noisiest civil airplane, with a peak noise level of 138 dB. This has led to its being banned in several countries. Why was it never banned in Britain?

Industry

Some factories are very noisy. Inside a boiler factory the noise level can be 120 dB, and a hydraulic press has a level of 130 dB at a distance of 1m. Workers who are constantly exposed to noise risk damaging their hearing. It is recommended that workers should not be continually exposed to noises louder than 90 dB during an 8-hour day. If the noise level is higher, the worker should be exposed to it for a shorter time, as shown in Table 1. Unfortunately, these recommendations are not always followed.

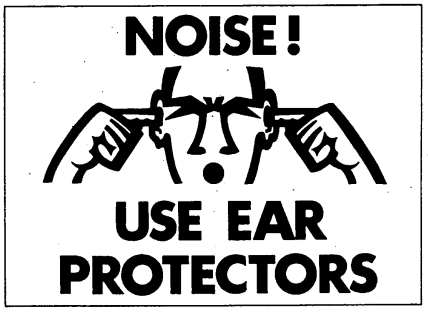

Table 1 Maximum noise exposure times

Sound level/dB	90	93	96	99	102	105
Maximum exposure time (hours per day)	8	4	2	1	0.5	0.25

Questions

11 Suppose you work in a disco where the noise level is 103 dB. According to Table 1, roughly how long should you work in the disco per day? Comment on your answer.

12 List five workers who are particularly at risk from loud noise.

Part 3 How can noise affect your health?

Very loud noises (above 150 dB) can actually break the tiny bones inside the ear. Noises above 130 dB cause ear pain. Below this level, constant exposure to loud noise can cause loss of hearing.

But even if noise is not loud enough to affect hearing, it can cause stress and tension. Look at these facts:

- Secretaries are 20 per cent less efficient when they are surrounded by office noise.
- A survey was recently carried out in a district near Heathrow Airport in London. It showed that eight times as many people were admitted to mental hospitals compared with people living in quieter areas.

- A London man set fire to a record shop below his flat because he could not stand the constant noise.
- A Middlesex man committed suicide after a motorway was built a few metres from his cottage. He left a note saying: 'The noise, the noise, I couldn't stand the noise'.

Evidence from the Netherlands

In the Netherlands the effects of air traffic noise on people's health have been investigated. The surveys compared the number of pills taken per adult per year in two similar areas:

Area A on the flight path near Amsterdam airport
Area B near Amsterdam airport, but away from the flight path.

The airport was opened in 1969, and in late 1973 a restriction on night flights was introduced.

Look at the four graphs in Figure 4, then answer question 16.

Questions

13 Do you ever find noise irritating? If so, when?

14 What signs of stress and tension have you noticed in a teacher in front of a particularly noisy class?

15 Research has shown that the hearing of a 70-year-old person from Sudan in North Africa is as good as that of a 20-year-old American. Suggest a reason for this.

Question

16 Comment as fully as you can on each of the four graphs. What do the graphs suggest about the effect of aircraft noise on health?

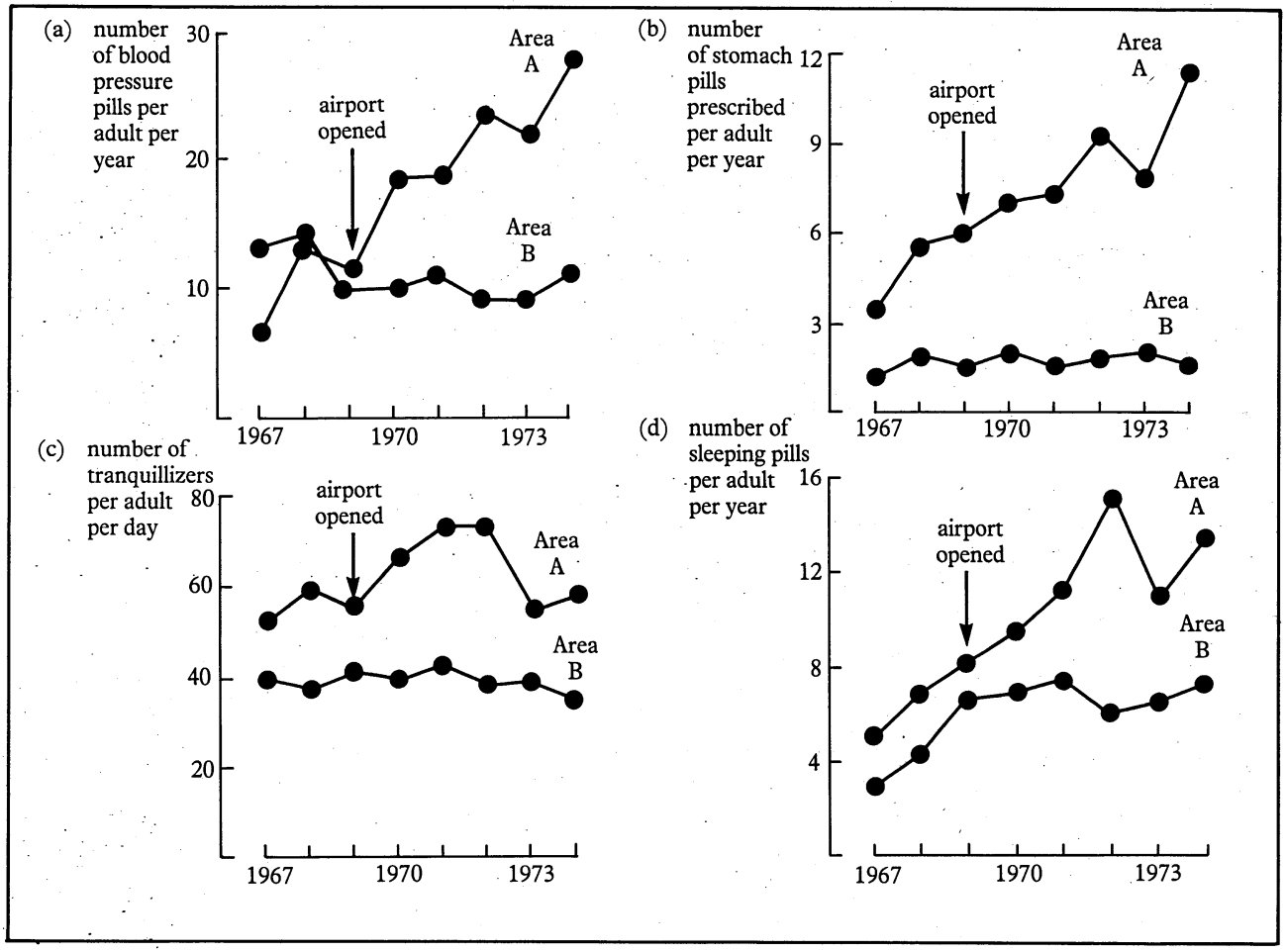

Figure 4

Part 4 How can we cut down noise?

There are three general ways to cut down noise:

- **Stop it at source** — for example, by making quieter machines and passing laws to prevent people making too much noise
- **Stop it travelling** — for example, by sound-proofing
- **Stop it at your ears** — for example, by wearing earmuffs.

Many ordinary things are unnecessarily noisy, and they can be made quieter by changing their design.

For example, in aircraft and cars a serious cause of noise is the release of hot, fast-moving exhaust gases from pipes. This noise is reduced if the gas comes out of a large number of holes. The jet engine exhaust shown in Figure 5 reduced noise by 6 dB.

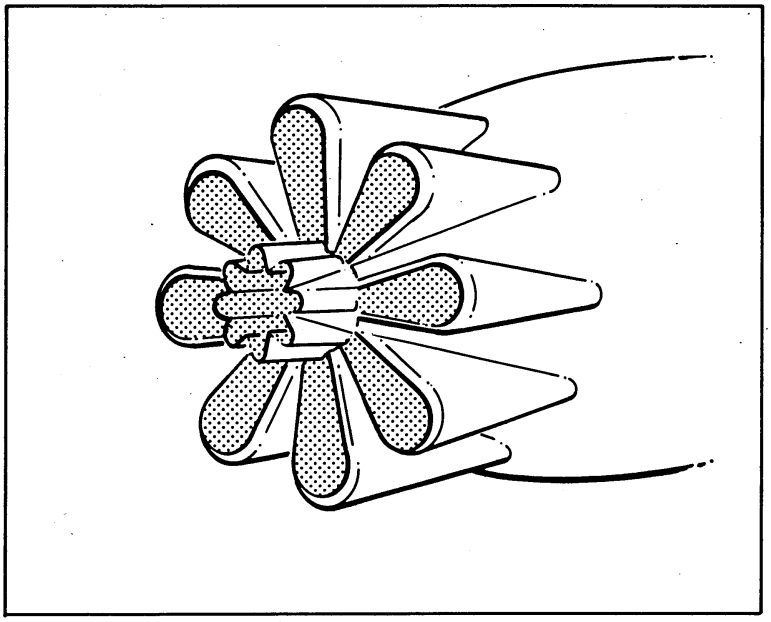

Figure 5 A jet exhaust designed to reduce noise

The amount of noise people are allowed to make in public is controlled by law. But the law is often broken, and it is difficult to catch people and prosecute them.

The general principle of **sound-proofing** is to absorb vibrations. Anything that vibrates will carry sound well. Thus glass, stone and metal carry sound well, but cloth and foam rubber do not — they muffle sound. Double glazing is effective. People living near large airports sometimes get grants to fit their homes with double glazing. Barriers can be used to reduce noise. Walls or screens of trees are often put near busy roads to shield nearby housing.

Noise inside large, echoing buildings can be cut down by choosing the right furnishings. Thick carpets, heavy curtains, soft wall coverings and padded furniture all help cut down unwanted sound.

Question

17 How would you reduce noise nuisance in each of the following cases?

(a) A house built next to a railway line
(b) The inside of a noisy typing room
(c) A semi-detached house in which the neighbours often play loud music.

Part 5 How noisy is your school?

Imagine you are on a committee which is preparing a report on the problems of noise in your school. You can find out the opinions of those who work in the school with this survey.

What are the problems?

First you should decide where noise is a nuisance. Here are some possible problems to consider:

- Noise getting into rooms from outside, for example, traffic or aircraft.
- Noise carrying from room to room.
- Noisy activities, for example, metalwork, games, work in school kitchen, music, etc.
- Difficulties in hearing in a particular room because of the size or shape of the room itself.

Look and listen yourself, and talk to people in the school who will be able to suggest where there are noise problems. You might approach the headteacher, the secretary, the teaching staff (especially in craft, games and music, and those who teach nearby), and the kitchen staff.

Write down between five and ten noise problems which you consider exist in the school.

What do people think about the problems?

With your list of problems, carry out a survey of the opinions of students and teachers. Ask them to judge the nuisance value of each problem, using a table like the one below. (The problems given in this table are examples.)

Problem	*(1) not noticeable*	*(2) noticeable*	*(3) irritating*	*(4) very irritating*
Aircraft noise				
Traffic noise in art room				
Noise in rooms next door to music room				
Echoes in assembly hall				
Noise in canteen				

For each student you ask, put a letter S in the appropriate box according to their opinions. For each teacher, put a letter T. Then add up the total scores for each problem. Do this separately for students and teachers. Write out the list of problems in order of seriousness.

- *What are your recommendations to the committee on noise? You should include suggestions on how the problems might be solved.*
- *Do students and teachers agree about the problems? If not, can you explain why?*