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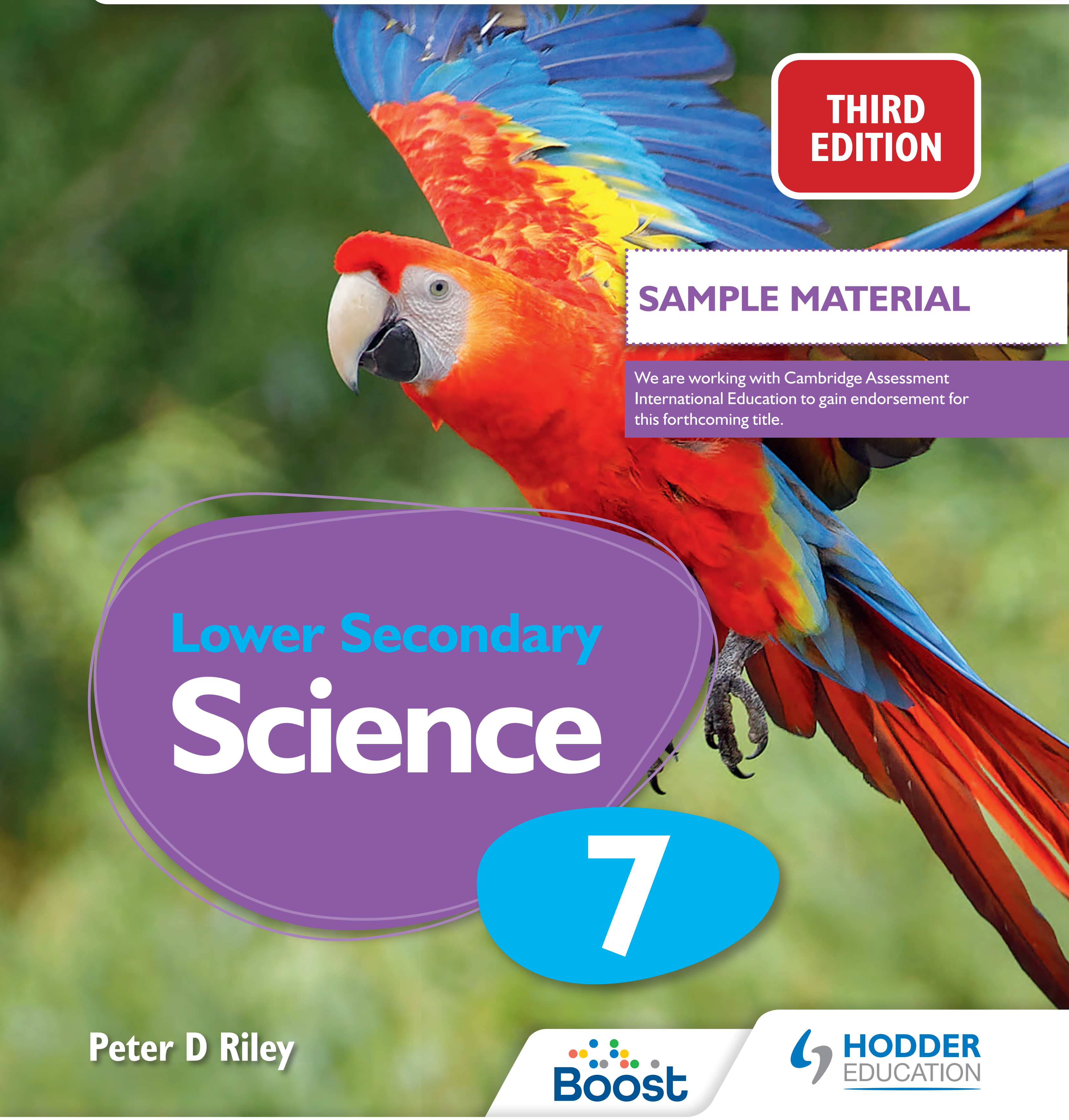

THIRD EDITION

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We are working with Cambridge Assessment International Education to gain endorsement for this forthcoming title.

Lower Secondary Science 7

Peter D Riley

Boost

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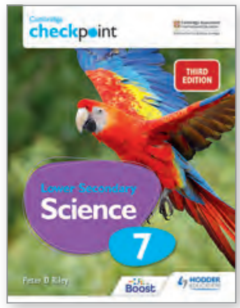

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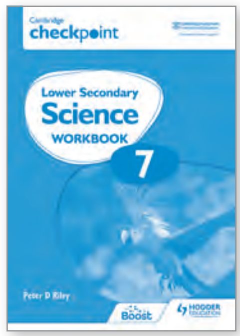

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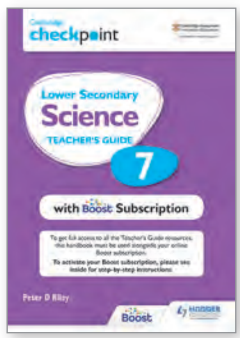

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THIRD EDITION

Lower Secondary Science 7

Peter D Riley

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To Anita, Sally-Anne and Emma-Louise

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Contents

13 Sound

- From vibration to sound-wave
- Describing a sound-wave
- Reflection of sound
- Reverberations
- Echoes

Do you remember?

- Make a sound with a soft volume. Give two examples of sounds with a soft volume.
- Make a sound with a loud volume. Give two examples of sounds with a loud volume.
- Make a sound with a low pitch. Give two examples of sounds with a low pitch.
- Make a sound with a high pitch. Give two examples of sounds with a high pitch.

Figure 13.1

- Using the photo, describe how the sounds are made by the different instruments.

Using a guitar to explain sounds

You will need:

a guitar.

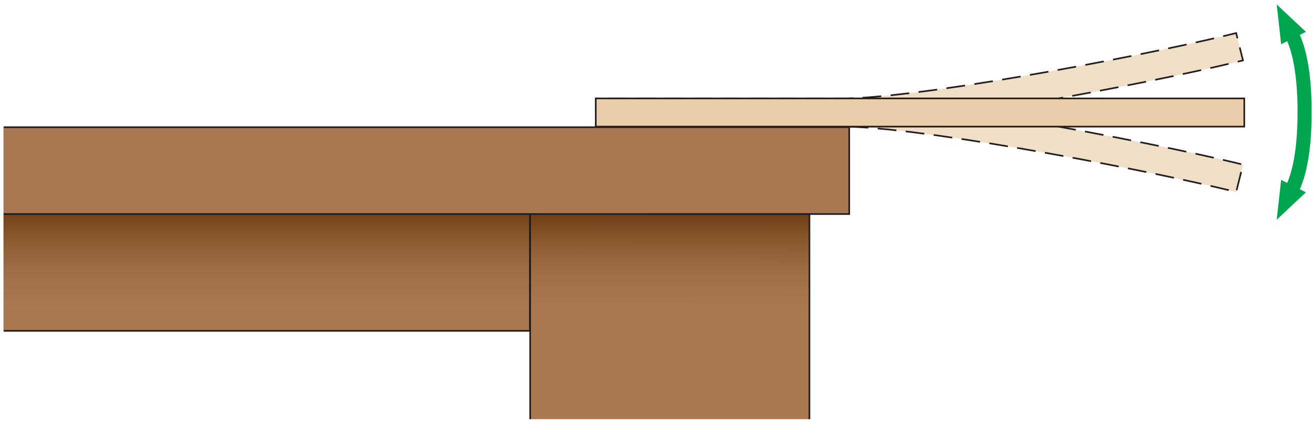
1 Demonstrate how you can make a sound with a soft volume and then change it to a sound with a loud volume.
2 Demonstrate how you can change the pitch of the sound by using different strings.
3 Demonstrate how you can change the pitch of the sound made by one of the strings.

▲ **Figure 13.2** Making a ruler vibrate

You have probably performed some experiments on sound without knowing it. At some time, most people have made a ruler vibrate by holding one end over the edge of a desk and 'twanging' it. The end of the ruler moves up and down rapidly and a low whirring sound is heard which becomes higher as you pull the ruler in from the edge of the desk.

From vibration to sound-wave

Any object can make a **sound-wave** when it vibrates. In practical work on sound, you might use an elastic band, a guitar string or a tuning fork, because they all vibrate easily. A **vibration** is a movement about a fixed point. This movement may be described as a to-and-fro movement or a backwards-and-forwards movement (see Figure 13.3).



▲ **Figure 13.3** Vibration is a to-and-fro movement

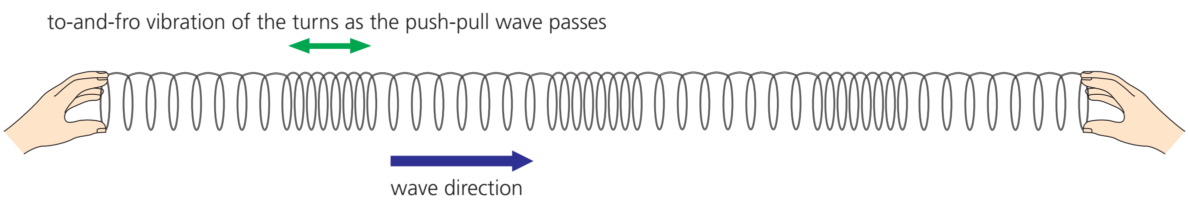
▲ **Figure 13.4** Producing sound by vibration

Sound-waves can travel in a gas, a liquid or a solid, because they all contain particles. When an object vibrates, it makes the particles next to it in the gas, liquid or solid vibrate too. For example, when an object vibrates in air, it pushes on the air particles around it.

As the vibrating object moves towards the air particles it squashes them together. The particles themselves are not compressed, they just come closer together.

As the object moves away from the air particles next to it, it gives the particles more space, so they spread out. This movement of air particles from a vibrating object can be modelled by using a slinky, as shown in figure 13.5.

One end is held firmly by the hand on the right and the other end is pushed and pulled by the hand on the left.



▲ **Figure 13.5**

1 When using the slinky, which coils represent the air particles a) being close together, b) spreading out?

2 What are the strengths and limitations of using the slinky as a model to show how air particles pass a sound wave through the air?

Figure 13.6 These whales communicate by sound-waves

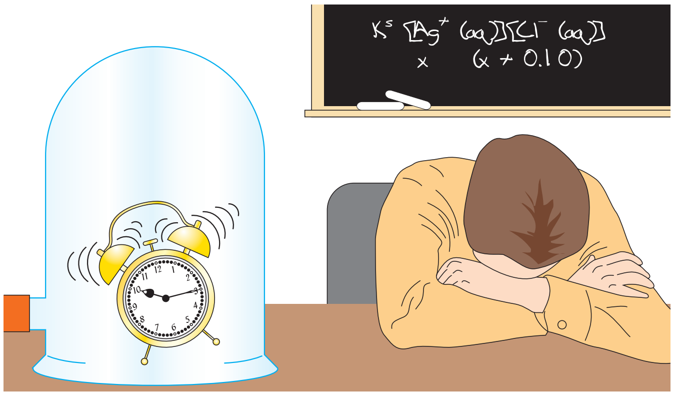
Sound-waves are generated and travel in liquids and solids in the same way as they do in gases. The particles in liquids and solids are held close together by forces of attraction. In a liquid, however, the particles are further apart than in a solid and can move around one another.

Sound travels very well through a liquid. It moves faster and further than it does in a gas. The humpback whale emits a series of sounds, called songs, which travel thousands of kilometres through the ocean. It uses its songs to communicate with other whales.

When sound travels through a solid, it moves even faster than through a liquid because of the close interaction of the particles. However, the sound does not travel as far. A snake detects vibrations in the ground with its lower jaw-bone. The bone transmits the vibrations to the snake's ears and allows the snake to detect the footsteps of its prey.

Figure 13.7 This snake is listening for vibrations in the ground

3 Why is it that a bell in a sealed bell-jar:
  a can be heard when the jar is full of air?
  b cannot be heard when a vacuum is created in the jar?



▲ **Figure 13.8** Sound cannot be heard through a vacuum

Sound-waves cannot pass through a vacuum because it does not contain any particles. Figure 13.8 shows an experiment that demonstrates this. As air is drawn out of the bell-jar with a pump, the sound of the bell becomes quieter. When a vacuum is established in the bell-jar, the bell cannot be heard, although the hammer can still be seen striking it.

Reflection of sound

When light strikes a shiny surface, it is reflected. You may even see an image of yourself reflected in a surface. You can find out what happens when sound strikes a surface through the following simple experiment.

Are sound-waves reflected?

You will need:

this textbook and a ruler.

Hypothesis

Light-waves can be reflected so sound-waves should be reflected too.

Prediction

If a sound is reflected from a surface, you should be able to hear it.

Investigation

1 Close your book and hold it out about 20 cm in front of you, below the level of your mouth.
2 Keep the book below your head and say ‘ahhh’ for as long as you can.
3 Listen to the sound, then raise the book so that it is about 20 cm in front of your mouth.

Analysis and evaluation

Compare the sounds you hear when the book is below your mouth and in front of your mouth.

Conclusion

Compare your evaluation with your prediction and draw a conclusion.

Scientists like to check their discoveries by performing different investigations. The simple investigation using the ears to detect the reflection of sound can be developed into a second investigation using a sound detection meter which measures the energy in a sound-wave. A cell phone can be converted into a sound meter by downloading a decibel meter app. A decibel is a measure of sound energy and its symbol is dB.

CHALLENGE YOURSELF

Plan a modified investigation with the book, voice and ears to include a mobile phone with a decibel meter app. If your teacher approves your plan, try it. How will it confirm or contradict the evidence of the first investigation?

Modelling sound reflection

You will need:

a slinky held firmly at one end by a friend. A second friend with a cell phone camera (optional).

1. Stretch out the slinky between you and your friend.
2. Ask your friend to hold their end firmly, then push and pull the end you are holding so that you set up waves as shown in Figure 13.5.
3. Look for waves reaching the end held firmly and setting up waves back towards you.
4. If you find evidence that the model shows the reflection of sound, ask another friend to film it.

Sometimes scientists make a model before they try an experiment. Here is an example.

Modelling surfaces and sound reflection

The movement of sound energy can be modelled by using a tennis ball (to represent an air particle). The surfaces can be provided by using a metal tray and a cushion.

You will need:

a tennis ball, a metal tray and a cushion.

1. Ask a friend to stand about two metres away and hold up the tray.
2. Throw the ball at the tray and observe what happens to it.
3. Repeat steps 1 and 2 with the cushion instead of the tray.

What conclusion do you draw from using this model?

The conclusion drawn from the model can now be used in an experiment.

Can sound reflections from different surfaces be tested?

You will need:

a metal tray, a cushion, and a mobile phone with a decibel meter app.

Hypothesis
The sound reflected from different types of surface differs in some way.

Prediction
Make a prediction based on the hypothesis about what will happen when the sound from a hard and a soft surface are compared.

Plan and investigation
1. Look back at the first experiment in this chapter and the modelling activities and think about how you can use what you discovered to plan an experiment.
2. Make a plan to test the question in the title of this experiment. In your plan think about:
   - what you will use to make the sound – your voice, a buzzer or something else.
   - how far your sound source will be from the surface.
   - how far the mobile phone will be from the surface.
   - how many times you will test each surface.
   - how you will record your data.
3. Show your teacher your plan, and if it is approved, try it.

Analysis and evaluation
Compare the sets of data you have collected and describe any differences.

Conclusion
1. Compare your evaluation with your prediction and draw a conclusion.
2. What are the limitations of your conclusion?
3. How could the investigation be improved?

4. Why is your shout louder when you cup your hands around your mouth?
5. Why do you cup your hand to your ear to hear a whisper?

If you want to catch someone's attention in the distance, you may shout at them. If they do not hear, you might cup your hands and shout again. This time they may hear you. If someone whispers to you in class, you might cup your hand around your ear to hear better.

Science extra: Reverberations

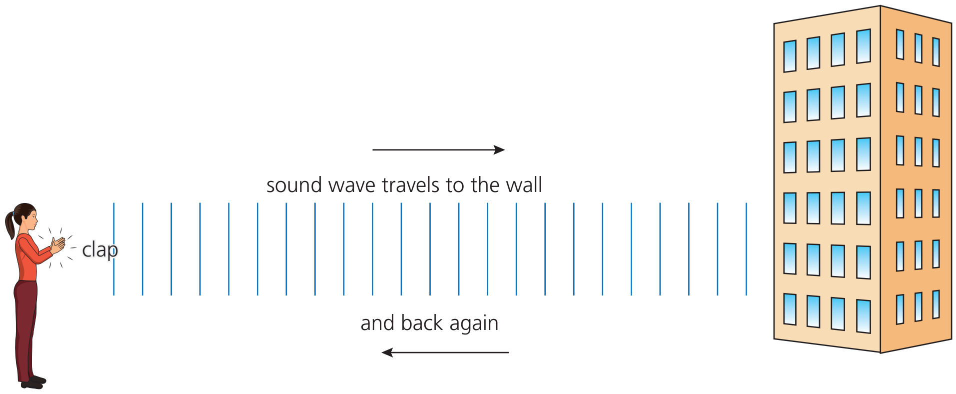
A living room in a home usually has soft furnishings in it such as chairs, a sofa and curtains. Their surfaces absorb sound and make the room quiet. If the room is being decorated, the furniture is taken out and the curtains are taken down, leaving the hard surfaces of the walls, ceiling and windows behind. When a sound is made in such a room, it sounds louder and seems to have a slight echo. This is called a reverberation and is made by many reflected sounds reaching the ear very close together.

Echoes

The human ear can only hear two sounds separately if they reach the ear more than one-tenth of a second apart. If they arrive in a shorter time than this you may hear a reverberation but, in certain circumstances, if they arrive more than one-tenth of a second apart you may hear an echo.

Sound travels at about 340 metres per second, or 34 metres in one-tenth of a second. To make a sound which produces an echo, you need it to travel at least 34 metres from you and back again.

6 What is an echo?



CHALLENGE YOURSELF

Make an echo by standing just over 17 metres from a high wall and clapping your hands repeatedly.

A crash of thunder, called a thunderclap, is made when a streak of lighting flashes through the air. The heat of the lightning makes the air expand so fast that it makes the noise. During a thunderstorm, you sometimes hear a few claps of thunder close together. This is called a roll of thunder and is caused by the sound of one thunderclap being reflected off the clouds, making a multiple echo.

Science in context

Ultrasounds

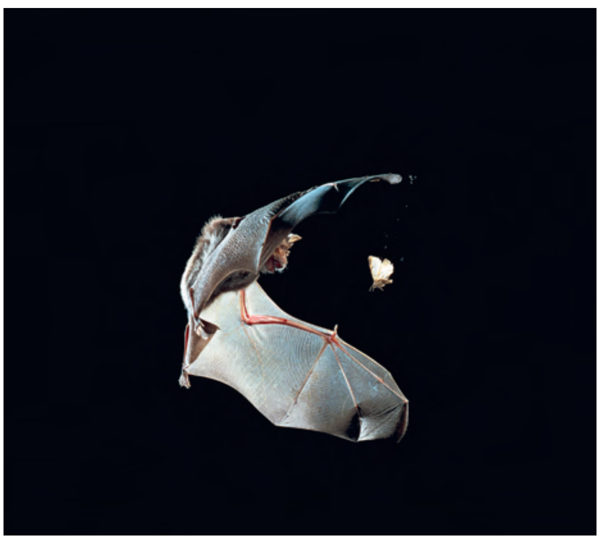
We do not make use of the echoes we can hear in our lives, apart from having fun, but we do use the echoes of sounds beyond our hearing, called ultrasounds. A familiar use of collecting the echoes of ultrasound is in checking that a fetus (an unborn baby) is developing healthily in the womb.

The word ‘sonar’ is used to describe equipment that helps ships navigate in shallow water and submarines navigate underwater. The name stands for ‘sound navigation ranging’ and produces ultrasounds which pass through the water, strike the sea bed and are reflected back to the vessel to help to steer it safely on its journey.

▲ **Figure 13.9** An ultrasound scan of a fetus

▲ **Figure 13.10** Operating sonar

Bats and dolphins also use echolocation to find their prey. Both types of animals send out ultrasounds which reflect off their prey and return to the animals’ ears. In a bat, the brain compares the ultrasounds released with those that return (the echo) and use them to swoop down on an insect such as a moth. A dolphin compares the ultrasounds released and echoed back to find shoals of fish.



▲ **Figure 13.11** A bat catching a moth

▲ **Figure 13.12** A dolphin feeding on fish

Summary

- ✔ Sounds are made by vibrating objects.
- ✔ Two features of a sound-wave are its wavelength and amplitude.
- ✔ Sound-waves can be reflected.
- ✔ Echoes occur when there is a time interval between the transmitted and received sounds of over one-tenth of a second.
- ✔ Sound-waves can be modelled with string, but all models have strengths and weaknesses that need to be identified.
- ✔ When planning an investigation, such as how sound is reflected from different surfaces, it is important to make a prediction about what will happen and to identify the variables.
- ✔ To draw a conclusion from an investigation you need to collect enough evidence and data.
- ✔ Ultrasounds are echoes we cannot hear that are used in society to help ships navigate and in medicine.

End of chapter questions

1. Write down a word that completes the following sentence:
   When the end of a ruler goes up and down it is said to ______________.
2. Why can sound travel in gases, liquids and solids?
3. What is a vacuum?
4. Does sound travel through a vacuum? Explain your answer.
5. What happens when a sound wave is reflected?
6. When you clap your hands 18 metres from a wall
   a. what happens when the sound waves reach the wall?
   b. what do you hear shortly after?
7. Describe how a sound wave moves through the air. You may use some diagrams in your answer.

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Lower Secondary

Science

7

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