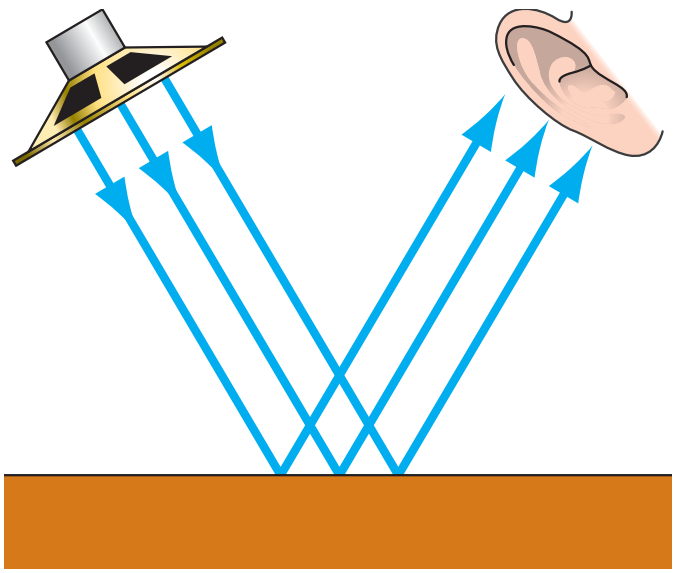
5 Echoes and reflections

Sound will bounce, or REFLECT, from hard surfaces. Delayed sound reflections are called ECHOES.

Sound waves and light waves have many things in common. If you shine a light at a mirror, it will bounce, or be reflected back. If a sound hits a hard, flat surface, it too will bounce from that surface.

Reflected sound

If a sound hits a hard wall at an angle, it will bounce off at the same angle as it arrived (Picture 1) with little loss of loudness.

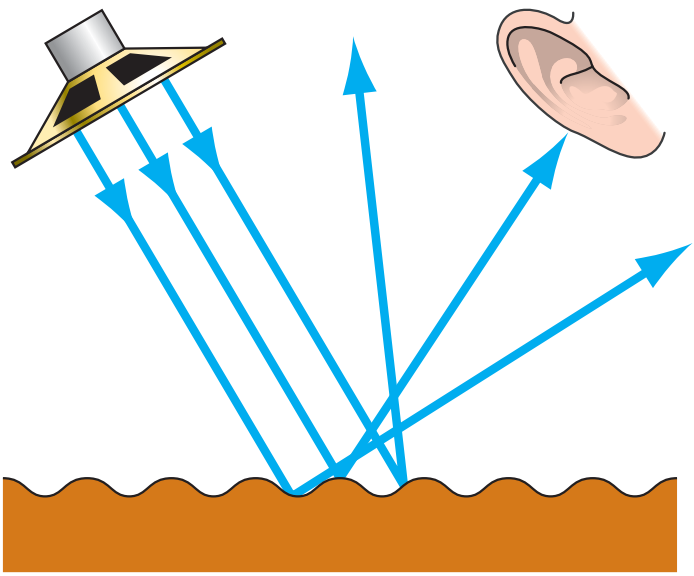


▲ **(Picture 1) When a sound hits a flat, hard surface, it bounces off at the same angle as it arrived. The reflected sound is only slightly quieter.**

If the surface is rough, the sound will bounce off in all directions (Picture 2), and anyone listening to the reflected sounds will hear only a quiet, **MUFFLED** sound. We shall see how important this is later.

Echo

It takes longer for a sound to be heard when it bounces off a hard surface, than when it travels directly in a straight line, because the reflected sound has further to go. In an ordinary living room, this difference is tiny, so direct and reflected sound reach the listener's ear at more or less the same time. But if the room is large, such as a hall bigger than 15m across, then it takes so long for the sound to bounce back that the reflected sound is heard well after the direct sound. As a result, we hear what seems like two separate sounds. The sounds that arrive later are called echoes (Picture 3).



▲ **(Picture 2) When a sound hits a rough surface, the sound is scattered and the reflected sound is much fuzzier and quieter than the arriving sound.**

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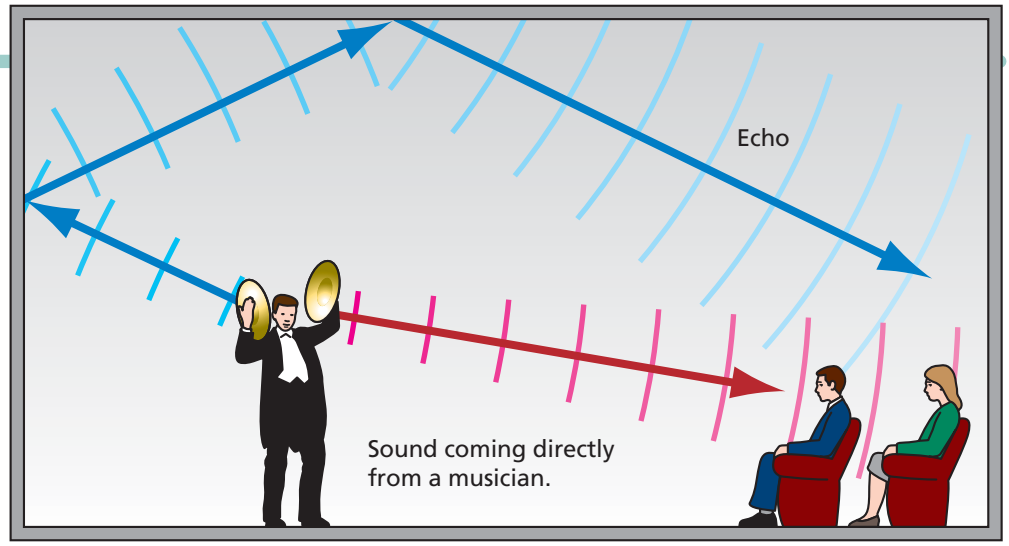
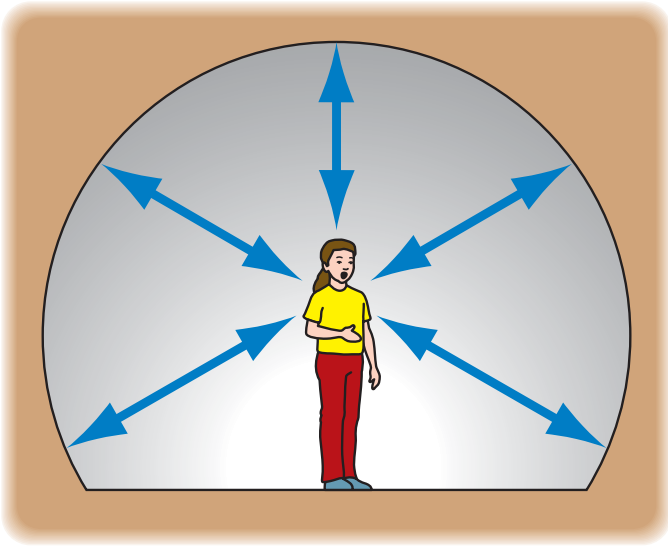


▶ **(Picture 3) In a hall with hard surfaces, sound is bounced from the walls and ceilings and does not arrive directly. The bounced sounds have further to travel, so they arrive later than the direct sound. This produces echoes.**

Spaces that echo

You may have wondered why caves, tunnels and some buildings echo more than other spaces (Picture 4). The answer is in their shape. Sound can be focused just like light. In a space with curved walls, almost all the sound is reflected back down towards the person who made the sound, producing extremely strong echoes (Picture 5).

▼ **(Picture 5) Echoes in a tunnel or cave.**



▼ **(Picture 4) This cathedral is the sort of large building that causes echoes. The many shapes of the walls and roof mean that the sound will bounce back and echo in a very complicated way.**

Summary

- **Sound waves bounce from hard surfaces.**
- **Echoes are formed if sound bounces in large halls.**