How fast does sound travel?

Material	Speed of Sound (m/s)
Air at 0°C	330
Air at 20°C	334
Seawater	1, 540
Freshwater	1,410
Rock	2, 500
Steel	5, 000
Aluminium	5,100

In track events, the starter usually fires a gun that produces both a sound and a puff of smoke. The timers and spectators see the smoke of the gun first and hear the sound of the gun a short while later. This happens because light travels much faster than the sound from the gun. Light travels at 300, 000, 000 m/s, reaching the spectators with no noticeable delay. Sound travels through air at a little over 330 m/s. It takes a third of a second or more to reach the spectators, depending on how far they are from the starter. Sound travels quite a bit faster in solids and liquids than it does in air. The speed of sound in some materials is shown in the table.

Sound transmission in solids and liquids

Think about the way that the particles are arranged in solids, liquids and gases. Why is the speed of sound greater in solids and liquids than in air?

Some consequences of the speed of sound

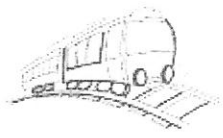
Answer the following questions.

1. Why might the speed of sound be faster in saltwater than in freshwater?

2. In a mining operation, the sound from an underground explosion travels through the air and through the ground to a recording station 5 km away. Which sound arrives first and by how much?

3. Though lightning and thunder occur together, we always see the lightning first and hear the thunder later. If a storm is 1 km away, how long does it take for the sound to reach you?

4. In the old days a cowboy would listen for a train by putting his ear to the steel train tracks. If the train was 2 km away, how long would the sound take to reach him through the train tracks? How long would it take the sound to travel through the air?



5. After the sinking of the *Titanic* in 1912, many efforts were made to find ways of detecting icebergs in the dark or in fogs. By the 1950's, echo sounders for this purpose had become very reliable. Suppose a sound signal is sent from a ship, and reflects from an iceberg 1 km away. How long will this take if the sound travels through the water? How long would it take if the sound travels through the air?

Sounding the depths

Knowing how fast sound travels in water can also be useful in developing a profile of the sea floor. **Sonar** was invented during the Second World War to detect submarines. It is currently used for the same purpose, but it can also be used to find the depth of the ocean and locate shoals of fish.

A ship on the surface emits a sound which bounces on the bottom and is reflected back to the boat where it is picked up by a receiver. Ultrasound is used because there is less confusion with surrounding sounds.

sonar is an acronym for sound navigation and ranging

A9.9 Checking the ocean floor

A survey ship moved away from shore taking sonar readings every hundred metres. The results appear in Table 9.2. The speed of sound in water is 1450 metres per second and the depth of the water can be calculated using the formula

depth = speed of sound x time ÷ 2

1 look at table 9.2. Use the formula to calculate the depth of the sea for each distance from shore.
2 Why does the formula divide the time by 2?
3 Draw a graph to illustrate your results. If you set the axes as shown in Figure 9.15, the finished graph will give a profile of the sea floor.

Table 9.2

Distance from shore (m)	*Time for echo to return (s)*	*Depth (m*
0	0	
100	0.3	
200	0.4	
300	0.5	
400	5.0	
500	6.0	
600	9.0	
700	4.0	
800	2.0	
900	3.5	
1000	2.5	

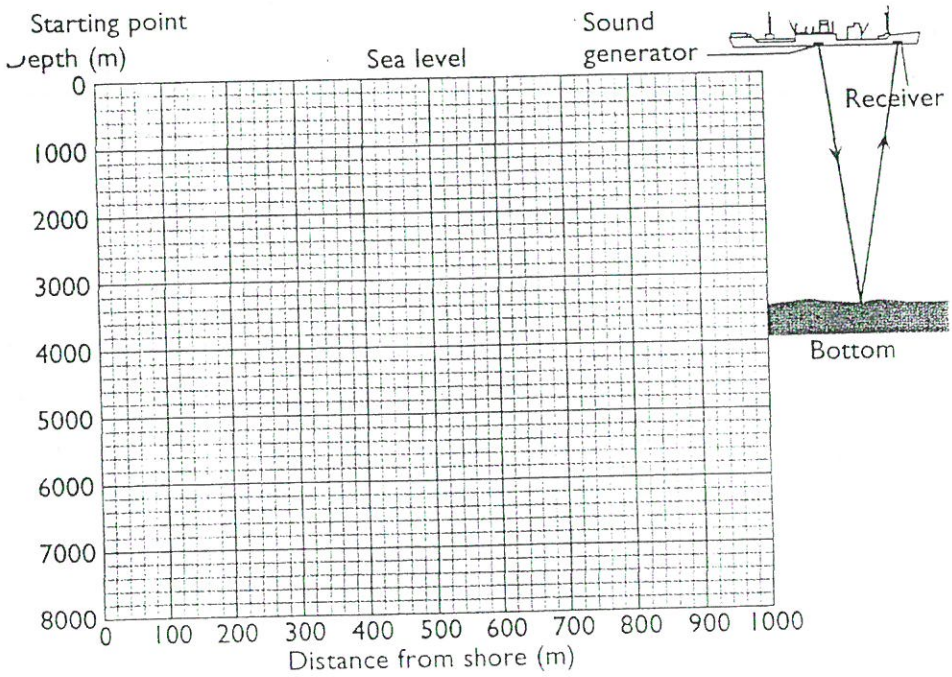


Figure 9.15 Sample graph showing axes