CP1b.1 Measuring speeds

Your teacher may watch to see if you can…

- follow instructions
- take careful measurements.

Aim

To measure speeds in different ways.

1: Walking and running

Apparatus

- measuring tape
- chalk or playground cones/markers
- stop clock

Method

A Work with a partner. Measure out a length of 10 m on the playground. Use chalk or playground markers to mark the ends.

B One person walks at a normal pace between the two markers. The other person measures the time it takes.

C Now one person runs between the two markers. The best way to do this is to start running before the first marker so that you are at a normal running speed when you reach it. The other person measures the time.

D Repeat steps B and C with the other person walking and running.

Recording your results

1 Draw a table to record your results.

2 Calculate the walking and running speeds, using the formula in the box.

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

Considering your results

3 A walking speed often used for planning walks is 5 km/h (1.4 m/s). The world record for the 100 m running sprint is just over 10 m/s. How do your walking and running speeds compare with these values?

Evaluation

4 Describe how you could find out how fast you can swim.

5 Measurements of the speed of athletes in major competitions are made using electronic equipment, not stop clocks. Why do you think this is?

6 How accurate do you think the method you used above would be for measuring the speed of a racing car and an aeroplane? Explain your answers.

2: Speed of sound in air

Apparatus

- measuring tape
- stop clock
- clapper
- microphone
- datalogger

Method

A Find an outdoor space with a wall (your teacher will tell you which part of the school grounds to use).

B Measure a distance of 50 m from the wall. This is the place you will stand.

C Clap your hands (or use a clapper) and listen for the echo. Use the stop clock to measure the time it takes for the sound to travel from your hand to the wall and back again.

D Now clap repeatedly, and time your claps so that you clap at the same time as you hear the echo from the previous clap. Once you have practised clapping like this, your partner measures the time for 10 claps.

E Measure the speed of sound again, this time using a microphone and datalogger to measure the time between the clapper and the echo.

Recording your results

1 Record the time for a single clap and the time for 10 claps measured using a stop clock.

2 Record the time for a single clap using the microphone and data logger.

Considering your results

3 How far has the sound travelled between making the single clap and hearing the echo?

4 Calculate the speed of sound using the time for a single clap. The formula you need is in the box.

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

5 Divide the time for 10 claps by 10 to find the time for a single clap. Calculate the speed of sound using this value for time.

6 Calculate the speed of sound from the time measured using the microphone and datalogger.

Evaluation

7 How accurate do you think your measurement of time is for a single clap and echo using the stop clock? Explain your answer.

8 Explain the advantage of measuring the time for 10 claps.

9 How did the speed of sound using the microphone and datalogger measurements compare to the ones using the stop clock measurements? Explain which you think is likely to be the most accurate.

10 The speed of sound depends on air temperature and pressure. An average value for sea level is 330 m/s.

a How does your calculated speed compare to this?

b If you did not obtain this value, suggest as many reasons you can why you got a different value.

3: Speed of sound in a solid

Apparatus

- measuring tape or metre rule
- solid object, such as wooden bench
- small metal block
- 2 'stethoscope' microphones
- datalogger

Method

A Fasten the two microphones to the solid you are going to test. One should be about 5 cm from one end of the object, the other should be right at the opposite end of the object.

B Measure the distance between the microphones and write it down.

C Connect the two microphones to the datalogger so that it can measure the difference in the time at which the sound reaches each microphone.

D Make a sound in the solid by hitting a metal block in the 5 cm gap at one end of the solid object.

Recording your results

1 Write down the times at which the sound reached the two microphones and the distance between them.

Considering your results

2 Calculate the speed of sound using the distance and the time. The formula you need is in the box.

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

Evaluation

3 How does the speed of sound in your solid compare to the speed of sound in air?

4 Explain why you cannot measure the speed of sound in a solid without using microphones and a datalogger.

5 Explain why the two sensors need to be as far apart as possible.

I can…

- use formulae relating distance, speed and time
- recall typical speeds for walking, running
- use different methods for measuring speeds
- measure the speed of sound in air and in a solid.