Hint

To measure the time period, measure over as many whole cycles as possible and divide by the number of cycles.

3 We can see from the waveform that one full cycle corresponds to a distance of 3.8 cm across the screen horizontally. As the time base control is set at $2\,\text{ms cm}^{-1}$, the time period T is therefore 7.6 ms (= $2\,\text{ms cm}^{-1} \times 3.8\,\text{cm}$). Therefore, the frequency of the alternating pd is 132 Hz.

Using an oscilloscope as a dc voltmeter

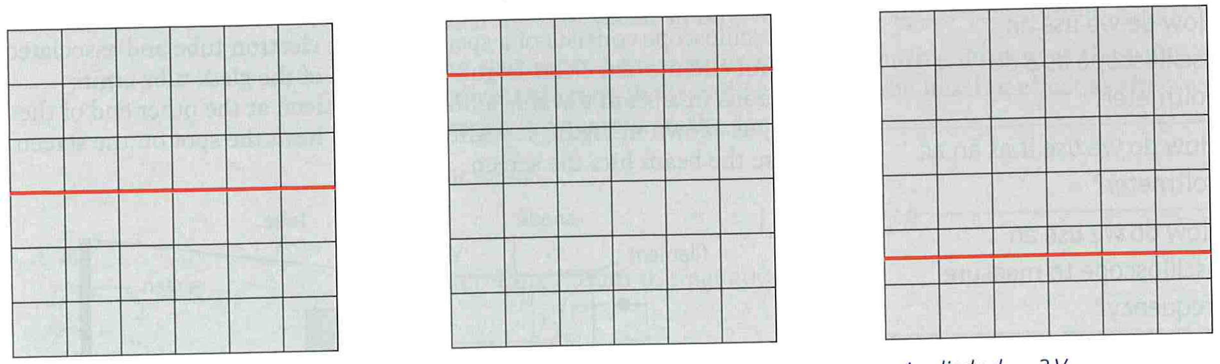

Figure 3 *Measuring a constant pd*

An oscilloscope can be used to measure a constant pd as well as the peak value of an alternating pd. Applying a constant pd to the Y-input makes the spot move across the screen at a constant height. Its vertical displacement does not change for a constant pd. The spot therefore traces a horizontal line on the screen above or below the 'zero pd' line according to whether the applied pd is positive or negative. By measuring the vertical displacement of the line and using the *y*-gain, we can therefore calculate the direct pd.

Note that an oscilloscope has a very high input resistance so the current it draws from a circuit is negligible, as it should be for any voltmeter.

Measuring the speed of ultrasound

The time base circuit of an oscilloscope can be used to trigger an ultrasonic transmitter so it sends out a short pulse of ultrasonic waves. An ultrasonic receiver can be used to detect the transmitted pulse. If the receiver signal is applied to the Y-input of the oscilloscope, the waveform of the received pulse can be seen on the oscilloscope screen, as shown in Figure 4.

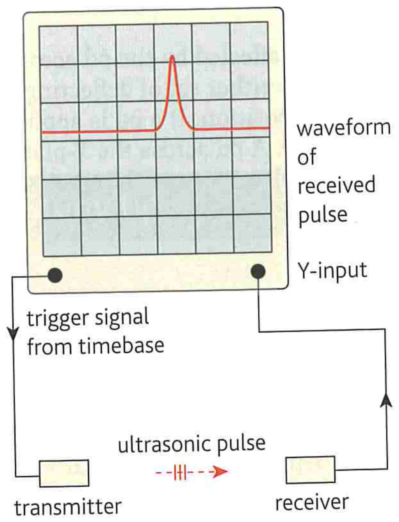

Figure 4 *Measuring the speed of ultrasound*

Because the pulse takes time to travel from the transmitter to the receiver, it is displayed on the screen at the point reached by the spot as it sweeps across from left to right. By measuring the horizontal distance on the screen from the leading edge of the pulse to the start of the spot's sweep, the travel time of the pulse from the transmitter to the receiver can be determined. For example, if the pulse is 3.5 cm from the start of the spot's sweep and the time base control is set at $0.2\,\text{ms cm}^{-1}$, the travel time of the pulse must be 0.7 ms (= $0.2\,\text{ms cm}^{-1} \times 3.5\,\text{cm}$). If the distance from the transmitter to receiver is known, the speed of ultrasound can be calculated (from distance / travel time).

Hint

Don't confuse the distance from the transmitter to the receiver with distances on the screen.

Summary questions

1 The trace of an oscilloscope is displaced vertically by 0.9 cm when a pd of 4.5 V is applied to the Y-input.

a Calculate **i** the *y*-gain of the oscilloscope, **ii** the displacement of the spot when a pd of 12 V is applied to the Y-input.

b An alternating pd is applied to the Y-input instead. The height of the waveform from the bottom to the top is 6.5 cm when the *y*-gain is $0.5\,\text{V cm}^{-1}$. Calculate **i** the peak value of the alternating pd, **ii** the rms pd.

2 The time base control of an oscilloscope is set at $10\,\text{ms cm}^{-1}$ and an alternating pd is applied to the Y-input. The horizontal distance across two complete cycles is observed to be 4.4 cm. Calculate:

a the time period of the alternating pd,

b its frequency.

3 Figure 5 shows the waveform on an oscilloscope screen when an alternating pd was applied to the Y-plates.

a The *y*-gain of the oscilloscope is $5.0\,\text{V cm}^{-1}$. Calculate the peak value and the rms value of the alternating pd.

b The time base setting of the oscilloscope was $5\,\text{ms cm}^{-1}$. Calculate the time period and the frequency of the alternating pd.

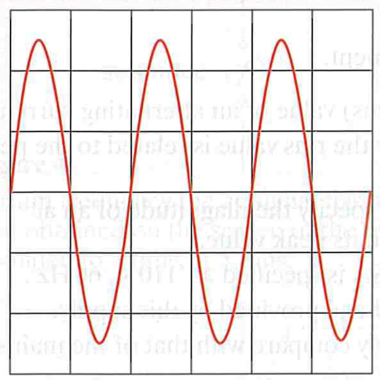

Figure 5

4 Copy the grid of Figure 5 and sketch the trace you would observe if

a a constant pd of 10.0 V was applied to the Y-input,

b a 10.0 V rms alternating pd of frequency 50 Hz was applied to the Y-input.