DETERMINATION OF THE SPEED OF SOUND USING STATIONARY WAVES

Specification reference: **AS Component** **2.5 - Wave properties**

A level Component **3.2 - Wave properties**

Theory:

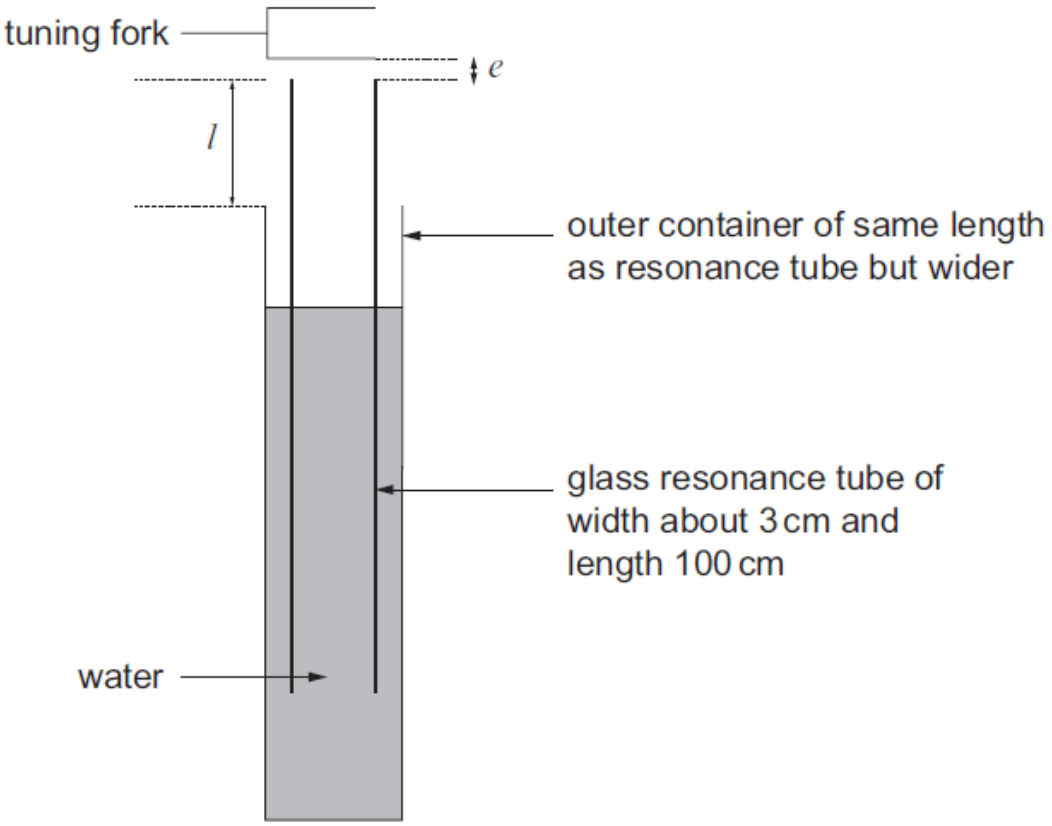
When resonance first occurs the length of air in the tube, l, plus a small end correction, e (to account for the position of the tuning fork above the tube) will be equal to a quarter of a wavelength. Hence:

$$l + e = \lambda/4 \qquad \text{but} \qquad \lambda = c/f$$

$$\text{so} \qquad l = c/4f - e$$

If a graph is plotted of l (y-axis) against $1/f$ (x-axis) it should be a straight line with a small negative y-intercept. The gradient of the graph equals $c/4$, and so the speed of sound, c, can be found. The small negative intercept will give the end correction.

Apparatus:



A range of at least five different tuning forks will be needed along with a metre ruler of resolution ± 0.001 m.

Further guidance for technicians:

An alternative to the above would be to use a very wide burette (about 3 cm diameter) and allow the water to drain out as the tuning fork is held over the top of it.

Experimental method:

Initially place the resonance tube as deep as possible into the water. Then gradually raise it. As this is being done hold a vibrating tuning fork over the top. When resonance occurs (a loud sound will be heard) measure the length of the tube above the water level.

Repeat the above for each of the tuning forks. Plot a graph of length (y-axis) against 1/frequency (x-axis). Use the gradient to determine a value for the speed of sound.

Extension:

The resonance tube could be raised past the first resonance point until the second resonance point is reached. The results could then be used to show that for the two resonant lengths l_1 and l_2 then:

$$\text{Speed of sound, } c = 2f(l_2 - l_1)$$

Practical techniques:

- Use appropriate analogue apparatus to record a range of measurements (to include length/distance, temperature, pressure, force, angles, volume) and to interpolate between scale markings.
- Use signal generator and oscilloscope, including volts/division and time-base.
- Generate and measure waves, using microphone and loudspeaker, or ripple tank, or vibration transducer, or microwave / radio wave source.