**Determining the speed of sound in air using a resonance tube**

**Introduction**

In this experiment the students will be determining the speed of sound in air by using the resonance of a tube.

They are expected to be familiar with the formula *v=fλ* relating the velocity of a wave to its frequency and wavelength.

They are also expected to have studied the differing patterns of resonance in open and closed tubes, relating to resonance at different harmonics and be able to deduce that the difference in distance for points of resonance is equivalent to half a wavelength.

The experiment also offers the opportunity to demonstrate the ability to use an oscilloscope.

**Aims and skills covered**

* To determine the speed of sound
* To consider uncertainty

**Links to Specification**

**Physics A**

* 4.4.1(b)(i) displacement, amplitude, wavelength, period, phase difference, frequency and speed of a wave
* 4.4.1(b)(ii) techniques and procedures used to use an oscilloscope to determine frequency
* 4.4.1(c) the equation 
* 4.4.1(d) the wave equation *v* = *f λ*
* 4.4.4(a) stationary (standing) waves using microwaves, stretched strings and air columns
* 4.4.4(b) graphical representations of a stationary wave
* 4.4.4(e)(ii) techniques and procedures used todetermine the speed of sound in air by formation of stationary waves in a resonance tube
* 4.4.4(f) the idea that the separation between adjacent nodes (or antinodes) is equal to *λ*/2, where λ is the wavelength of the progressive wave

**Physics B**

* 4.1a(i) production of standing waves by waves travelling in opposite directions
* 4.1c(i) wavelength of standing waves
* 4.1d(i) using an oscilloscope to determine frequencies
* 4.1d(v) determining the speed of sound in air by formation of stationary waves in a resonance tube
* 4.1c(iii) path differences for diffraction grating, for constructive interference

*nλ* = *d* sin*θ*

**Practical Skills**

* 1.2.1(b) safely and correctly use a range of practical equipment and materials
* 1.2.1(c) follow written instructions
* 1.2.1(d) make and record measurements
* 1.2.1(e) keep appropriate records of experimental activities
* 1.2.1(f) present information and data in a scientific way
* 1.2.1(j) use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification
* 1.2.2(a) use appropriate analogue apparatus to record a range of measurements
* 1.2.1(c) use of methods to increase accuracy of measurements, such as timing over multiple oscillations, or use of fiduciary marker, set square or plumb line
* 1.2.1(f) correctly constructing circuits from circuit diagrams using DC power supplies, cells, and a range of circuit components, including those where polarity is important
* 1.2.1(h) use of a signal generator and oscilloscope, including volts/division and time-base
* 1.2.1(i) generating and measuring waves, using microphone and loudspeaker

**CPAC**

* (1) Follows written procedures
* (2) Applies investigative approaches and methods when using instruments and equipment
* (3) Safely uses a range of practical equipment and materials
* (4) Makes and records observations

**Mathematical skills**

* M0.1 recognise and make use of appropriate units in calculations
* M0.2 recognise and use expressions in decimal and standard form
* M1.1 use an appropriate number of significant figures
* M1.2 find arithmetic means
* M1.5 identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined by addition, subtraction, multiplication, division and raising to powers
* M2.2 change the subject of an equation
* M2.3 substitute numerical values into algebraic equations

**Equipment**

* signal generator
* loudspeaker
* tube (tall measuring cylinder)
* stand, clamp and boss to support metre rule
* metre rule
* oscilloscope

**Health and safety**

Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.

**Notes**

* These practical activities are not controlled assessments, should not be carried out in exam conditions and can be adapted by the centre. Students can collaborate during the activities which should take place as part of the normal teaching sequence. They are intended to be formative with students acquiring and practising skills throughout the course.
* To achieve a pass in the Practical Endorsement each student is required to demonstrate competence in all the skills, apparatus and techniques listed in section 1.2 of the specification and assessed against the Ofqual Common Practical Assessment Criteria (CPAC) at the end of the course.
* The skills, apparatus and techniques can be demonstrated during any practical work undertaken during the A Level course whether an OCR practical activity or not.
* There are numerous resources available on the internet which address this topic for example: <http://hyperphysics.phy-astr.gsu.edu/hbase/waves/opecol.html>

**Recording**

* Learners should not need to re-draft their work but rather keep all their notes as a continuing record of Practical Activity.
* As evidence for the Practical Endorsement learners should have the data they collected from their own readings in a clear and logical format.

In addition, to support the assessment of practical work in the written examinations:

* Learners should have commented on the uncertainty of each reading
* Learners should have drawn conclusions on the uncertainty consistent with the evidence obtained
* The extension questions could be addressed with supporting justification.