



## National Unit specification: general information

**Unit title:** Stringed Instruments: Introduction to Acoustics (SCQF level 6)

**Unit code:** H1YB 12

**Superclass:** LJ

**Publication date:** October 2012

**Source:** Scottish Qualifications Authority

**Version:** 02

### Summary

This Unit provides candidates with an appreciation of the scientific principles of acoustics in relation to music making and to the construction and maintenance of musical instruments. Candidates will gain knowledge and understanding of basic concepts relating to sound waves, modes of vibration of a string, harmonics, timbre and modes of vibration of an instrument top.

This is a mandatory Unit within the National Certificate in Stringed Musical Instrument Making and Repair at SCQF level 6, but may also be taken as a freestanding Unit.

This Unit is suitable for candidates who are studying instrument making and repair, and those studying other related areas in music or sound reproduction who wish to understand how instruments function acoustically.

### Outcomes

- 1 Describe basic concepts relating to mechanical vibrations and sound waves using recognised terminology.
- 2 Describe the factors affecting the modes of vibration of a string under tension.
- 3 Demonstrate an understanding of the factors governing instrument body resonance.
- 4 Test the principal modes of vibration of a guitar and violin top.
- 5 Describe how string vibration is converted to amplified musical sound.

### Recommended entry

Entry is at the discretion of the centre.

## General information (cont)

**Unit title:** Stringed Instruments: Introduction to Acoustics (SCQF level 6)

### Credit points and level

1 National Unit credit at SCQF level 6: (6 SCQF credit points at SCQF level 6\*)

*\*SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

### Core Skills

Achievement of this Unit gives automatic certification of the following Core Skills component:

Complete Core Skill                      None

Core Skill component                      Critical Thinking at SCQF level 5

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

## **National Unit specification: statement of standards**

**Unit title:** Stringed Instruments: Introduction to Acoustics (SCQF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

### **Outcome 1**

Describe basic concepts relating to mechanical vibrations and sound waves using recognised terminology.

#### **Performance Criteria**

- (a) Accurately describe sound waves.
- (b) Correctly identify amplitudes, nodes, anti-nodes, wavelengths, periods and frequency from given waveforms.

### **Outcome 2**

Describe the factors affecting the modes of vibration of a string under tension.

#### **Performance Criteria**

- (a) Accurately state the relationship between the fundamental frequency and the higher harmonic modes.
- (b) Accurately state the relationship between the plucking point and excitation of a particular mode of vibration.
- (c) Explain the effects of harmonics on timbre.

### **Outcome 3**

Demonstrate an understanding of the factors governing instrument body resonance.

- (a) Identify the Helmholtz resonance of instrument bodies.
- (b) Accurately describe the relationship between the soundhole and instrument body air cavity.
- (c) Accurately describe the effect of coupling on an instrument.

### **Outcome 4**

Test the principal modes of vibration of a guitar and violin top.

- (a) Correctly identify the principal modes of vibration.
- (b) Correctly test two principal modes of vibration to produce Chladni patterns.

## National Unit specification: statement of standards (cont)

**Unit title:** Stringed Instruments: Introduction to Acoustics (SCQF level 6)

### Outcome 5

Describe how string vibration is converted to amplified musical sound.

- (a) Correctly describe how string vibrations transfer to an instrument body and surrounding air.
- (b) Correctly identify the effect of acoustic impedance at the bridge.
- (c) Correctly identify the effect of different bracing patterns.

### Evidence Requirements for this Unit

Evidence is required to demonstrate that the candidates have achieved all of the Outcomes and Performance Criteria.

#### Outcome 1

Written evidence is required which demonstrates candidates can draw a sound wave and accurately label the following:

- ◆ wavelength
- ◆ amplitude
- ◆ frequency
- ◆ node
- ◆ anti-node

Written and/or oral recorded evidence is required to demonstrate that candidates can describe a standing wave; state the relationship between the frequency and pitch of a wave and describe the amplitude and intensity of a wave.

#### Outcome 2

Written evidence is required to demonstrate that candidates can:

- ◆ Draw the harmonic series for a string and accurately label the frequencies of the first seven partials of the fundamental frequency.

Written and /or oral evidence is required to demonstrate that candidates can:

- ◆ identify nodes and anti-nodes
- ◆ state why two or more frequencies sounded together will either give harmony or discord.
- ◆ explain why a different timbre is produced on the same instrument and two different instruments

Performance evidence is required to demonstrate the first three harmonics in a series using the 5th string (A 110 Hz) on a guitar as the fundamental.

## National Unit specification: statement of standards (cont)

**Unit title:** Stringed Instruments: Introduction to Acoustics (SCQF level 6)

### Outcome 3

Performance evidence is required to demonstrate that candidates can identify the Helmholtz resonance of two different sized instrument bodies.

Written and /or oral evidence is required to show that candidates can:

- ◆ describe the relationship between soundhole and body air cavity with regard to low frequencies and high frequencies
- ◆ describe the coupling relationship between the air cavity/soundhole/front/back /sides and instrument surface with regard to low frequencies and high frequencies

### Outcome 4

Written and /or oral evidence is required to demonstrate that candidates can identify the following principal modes of vibration of an instrument plate:

(a) Guitar

- i. Monopole
- ii. Cross Dipole
- iii. Long Dipole

(b) Violin

- i. Mode 1
- ii. Mode 2
- iii. Mode 5

Performance evidence is required to demonstrate that candidates can excite an instrument top to produce Chladni patterns for a minimum of two principal modes of vibration.

### Outcome 5

In satisfying the Performance Criteria for Outcome 5, candidates must provide written and/or oral evidence which demonstrates the relationship between transfers of string vibration to the top, for the following:

- ◆ low frequencies
- ◆ high frequencies
- ◆ attack
- ◆ sustain
- ◆ wolf notes
- ◆ bridge
- ◆ bracing patterns
- ◆ loudness

## **National Unit specification: support notes**

### **Unit title:** Stringed Instruments: Introduction to Acoustics (SCQF level 6)

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

### **Guidance on the content and context for this Unit**

This Unit is a general introduction to the fundamental principles of acoustics.

#### **Outcome 1**

The interpretation of sound waves could include wavelength, crest, trough, amplitude, frequency, period, node and anti-node. In addition, the tutor should provide a brief description of a transverse wave, longitudinal wave and standing wave. The relationship between sound wave frequency and pitch of a note and the wave amplitude and intensity of sound can be examined. It will be useful to mention the importance of nodes and anti-nodes with regard to plate modes of vibration, which will be considered later on.

#### **Outcome 2**

The harmonic series can be illustrated and the relationship between the fundamental frequency and the higher harmonic modes (upper partials) discussed. How the plucking position can determine which modes are vibrated should be outlined. The relationship between frequencies that determine whether the combined sound provides harmony or discord can be analysed. The timbre of a frequency should be discussed and consideration given to what shapes a particular tone on the same instrument, and what shapes a tone on two different instruments. Spectrum analysis can be used to compare similar frequencies sounded on different instruments. Reference could be made to formants.

#### **Outcome 3**

The Helmholtz resonance should be explained and demonstrated. Factors governing body resonance and the relationship between air cavity and soundhole, the coupling of the top to the air cavity, back and sides can be discussed.

#### **Outcome 4**

Monopole, cross dipole and long dipole modes of vibration could be discussed and the type of frequencies with which they are associated. The historical association of the violin modes 1, 2 and 5 can be examined. Methods of producing Chladni patterns and the typical frequency ranges certain modes might be expected to occur within, could be examined.

#### **Outcome 5**

How string vibration transfers to the surrounding air and through the nut and saddle to the instrument should be discussed. The relation of bridge impedance to top and brace structure in order to provide an effective and sympathetic coupling system should be looked at, and constructive and destructive coupling should be discussed.

## National Unit specification: support notes (cont)

### Unit title: Stringed Instruments: Introduction to Acoustics (SCQF level 6)

The difference in sound and vibration modes associated with the following, should be looked at:

- ◆ ladder bracing
- ◆ cross bracing
- ◆ fan bracing

Other topics that could be discussed are fixed/moveable bridges and high/low bridges, and high/low string break angles.

At the time of writing, there are no National Occupational Standards to which this Unit aligns. However, centres should consider National Occupational Standards as part of the context for delivering this Unit, when they are available.

### Guidance on learning and teaching approaches for this Unit

The Unit should be chronologically taught, building on a knowledge base that allows for each assessment to be given one at a time at the conclusion of each Outcome. Tutor led input is required for all Outcomes but wherever possible, tutors should make use of practical work to illustrate the concepts involved. It is intended that acoustical concepts should be further explored and exemplified in the context of those musical instruments in which candidates have a particular interest. Where possible, the learning for all Outcomes could be enhanced by the inclusion of handouts, articles, videos, films, worksheets and visits.

There are many animation clips of sound waves available online, especially standing waves, which could be used to illustrate waveforms.

Group work can be used in this Unit, for example, with candidates asked to make a spectrum analysis of an open guitar string to help visualise the first seven partials which they have been asked to draw. Candidates could then test this concept in practice on a guitar string in pairs or small groups, checking results with an electronic tuner.

Group work could be used when candidates produce chladni patterns and when they find the Helmholtz resonance of instrument air cavities.

### Guidance on approaches to assessment for this Unit

Outcomes 1–5 could be assessed using short answer written and/or oral tests under open-book conditions.

It is envisaged that the tests are given one at a time, at the conclusion of each Outcome. Some tests could be covered using multi-choice assessments.

The performance evidence for all Outcomes could be gathered using a checklist.

## National Unit specification: support notes (cont)

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### Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003)*, *SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

### Opportunities for developing Core Skills

In this Unit, candidates will look at basic concepts related to sound waves, modes of vibration of a string, harmonics, timbre, sound intensity and loudness and reverberation in auditoria. They will perform calculations and use software to investigate standing waves, beat frequencies and wave interference. Candidates will:

- ◆ read text relating to sound
- ◆ use ICT to investigate sound
- ◆ answer questions relating sound

This means that as candidates are doing this Unit, they may develop aspects of the Core Skills of *Communication*, *Problem Solving* and *Information and Communication Technology (ICT)*.

This Unit has the Critical Thinking component of Problem Solving embedded in it. This means that when candidates achieve the Unit, their Core Skills profile will also be updated to show they have achieved Critical Thinking at SCQF level 5.

### Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website [www.sqa.org.uk/assessmentarrangements](http://www.sqa.org.uk/assessmentarrangements)



## History of changes to Unit

Version	Description of change	Date
02	Core Skills Component Critical Thinking at SCQF level 5 embedded.	09/10/2012

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