The **Scholars** Programme

Acoustics: from basics to exotic materials for fighting noise pollution

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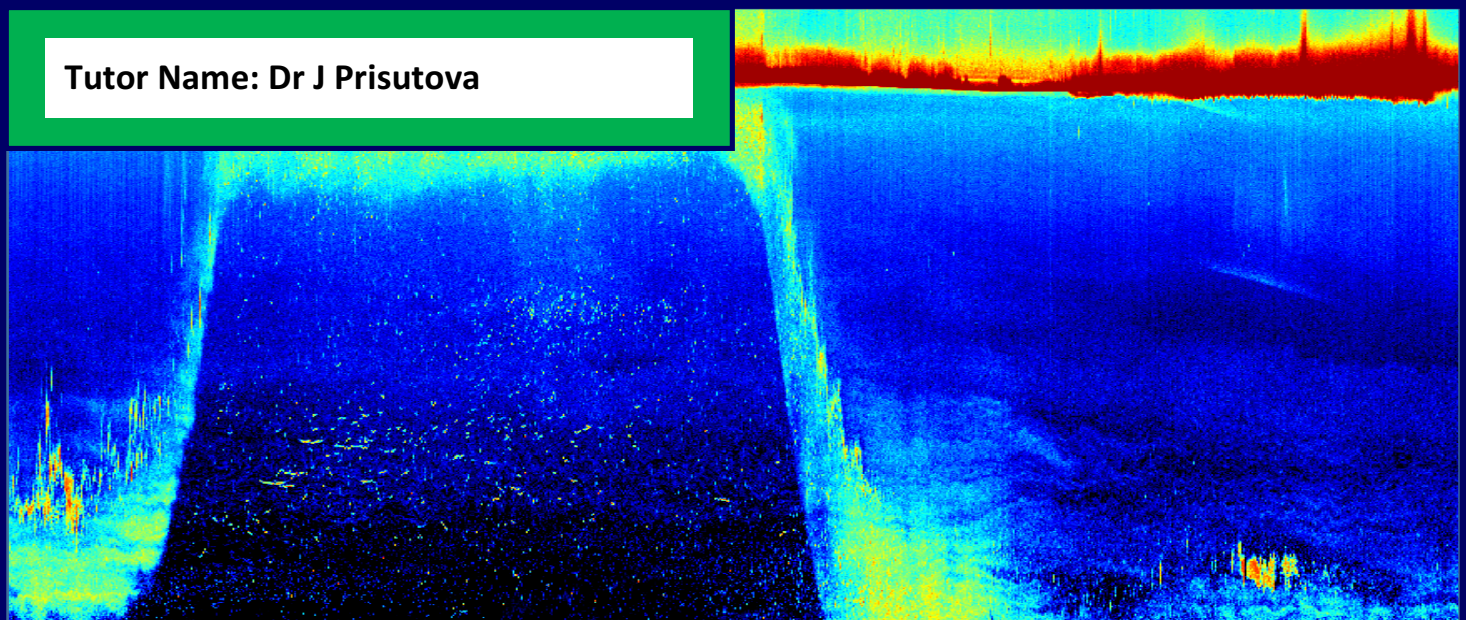

The Scholars Programme – [Term 1 2016-2017] – Pupil Feedback Report

Grade	Marks	What this means
1st	70+	Performing to an excellent standard at first year undergraduate level
2:1	60-69	Performing to a good standard at first year undergraduate level
2:2	50-59	Performing to an excellent standard at GCSE level
3rd	40-49	Performing to a good standard at GCSE level
Workings towards a pass	0-39	Workings towards a pass
Did not submit	DNS	No assignment received by The Brilliant Club

Lateness	
Any lateness	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

Name of PhD Tutor			
Title of Assignment			
Name of Pupil			
Name of School			
ORIGINAL MARK / 100		**FINAL MARK / 100**	
DEDUCTED MARKS		**FINAL GRADE**	

If marks have been deducted (e.g. late submission, plagiarism) the PhD tutor should give an explanation in this section:

Learning Feedback Comment 1 - *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority	**How you could improve in the future**
Learning Feedback Comment 2 – *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority	**How you could improve in the future**
Learning Feedback Comment 3 – *Enter Key Learning Priority Here*	
What you did in relation to this Key Learning Priority	**How you could improve in the future**
Resilience Comment	
How you showed learning resilience during the course	**How you could build learning resilience in the future**

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Course Rationale

Noise pollution is a major environmental problem in the European Union. Outside our homes, we are constantly exposed to road traffic noise, and its level is significantly higher than that suggested by World Health Organisation. At the same time, both road and rail traffic are expected to increase, whereas their source strength will not be decreasing. To protect people from the noise pollution, we need outdoor sound-absorbing solution. Together with tall sound barriers and conventional porous materials, living plants can be involved in making our cities quieter.

This course is aimed at introducing a notion of porous media and its acoustics, and an application of these concepts to living plants acoustics. At the beginning of the course, pupils will be familiarised with the basic ideas and principles of acoustics. Then, we will progress to acoustics of porous media and methods of measuring its absorption. Finally, we will discuss the characteristics of plants which make a difference to the amount of sound they absorb, and talk about the theory and laboratory work for estimating their sound absorption.

This course offers a review of acoustics and insight into one of its areas, porous media acoustics. Additionally, it shows how physics can be applicable to real-life issues, and it makes pupils aware of unconventional and interesting ways of dealing with vital problems.

Mark Scheme

Key Skill	1st	2.1	2.2
Knowledge and Understanding	☐ Accurate and comprehensive knowledge of key concepts covered in the course is demonstrated. ☐ Units are used consistently and correctly. ☐ Relevant and accurate use of scientific vocabulary.	☐ Broad knowledge of key concepts covered in the course, but not always accurate. ☐ Units and used mostly correctly and consistently. ☐ Accurate but limited use of scientific vocabulary.	☐ Limited knowledge of key concepts covered in the course. ☐ No consistency in using the units; or use of incorrect units. ☐ Limited use of scientific vocabulary, using simple terms instead; or incorrect use of scientific terms.
Research skills	☐ Use of relevant and reliable resources. ☐ Sources are referenced in an agreed format. ☐ Resource choice goes beyond the list suggested in the course.	☐ Some use of relevant and/or reliable resources. ☐ Most sources are referenced correctly and consistently. ☐ Few resources go beyond the list suggested in the course.	☐ Sources used are irrelevant to the subject, or their reliability is questionable. ☐ Incorrect referencing format; or inconsistencies in referencing throughout the document. ☐ Limited or no resources outside the provided material.
Logical Reasoning	☐ Correct methods are employed for derivations, proofs and analyses; they are justified and easy to follow. ☐ The final conclusion is expressed with clarity and in accordance with the provided data or methodology.	☐ Most derivations are made using correct and/or relevant methods. The argument is either easy to follow or is supported by used resources. ☐ The final conclusion is supported by provided data, but is not easy to follow.	☐ Use of incorrect and/or irrelevant methods for derivations, proofs and analyses. The argument is difficult to follow and is not sufficiently supported by used resources. ☐ The final conclusion is difficult to understand or it is not supported by provided data or methodology.
Application	☐ Making links between concepts covered in tutorials to perform independent study. ☐ Relevant use of concepts and data.	☐ Ability to make most links between covered concepts, but may require some directing. ☐ Most concepts are used relevantly, makes occasional mistakes.	☐ Limited ability to make links between covered concepts and independent studies; incorrect or irrelevant links; requires directing towards the correct resource / methodology. ☐ Uses concepts and data with limited relevancy, makes frequent mistakes.
Analysis	☐ Consistent use of the provided data and other sources of evidence to support the argument. ☐ Each step of analysis is relevant, logical and easy to follow. ☐ The conclusion of the analysis is correct based on the provided evidence and methods and well developed.	☐ Some use of provided sources to support the argument. ☐ Most analysis steps are logical and easy to follow. ☐ The conclusion of the analysis is correct, but some inconsistencies are present.	☐ May have difficulties applying the evidence to the problem; does not support the argument strongly enough or uses irrelevant proofs. ☐ No coherency in analysis, it is difficult to follow or some steps are irrelevant. ☐ May come to wrong results using the provided evidence; or obtain the correct results, but interpret them incorrectly.

Glossary of Keywords

Absorption coefficient

Amplitude

Flow resistivity

Frequency

Harmonic wave

Impedance tube

Listening room

Microphone

Particle velocity

Plane wave

Porosity

Porous media

- **Open pores**

- **Closed pores**

Reflection coefficient

Reverberation room

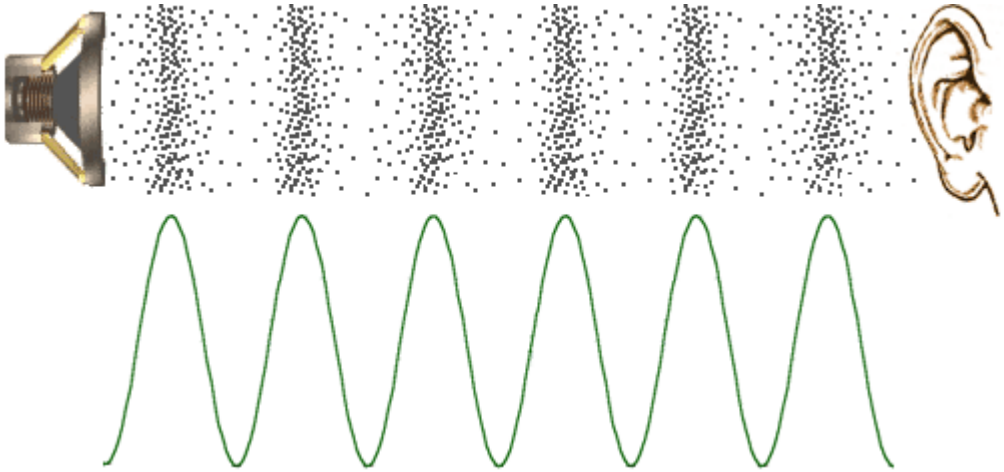
Sound pressure

Tortuosity

Wavelength

Wavenumber

Tutorial 1 – How does the sound propagate?



What is the Purpose of Tutorial 1?

- To analyse how sound propagates
- To introduce basic notions of acoustics

What is acoustics?

Acoustics is a science which deals with propagation of mechanical waves in different media and includes such areas as sound, vibration, ultra- and infrasound.

What is sound?

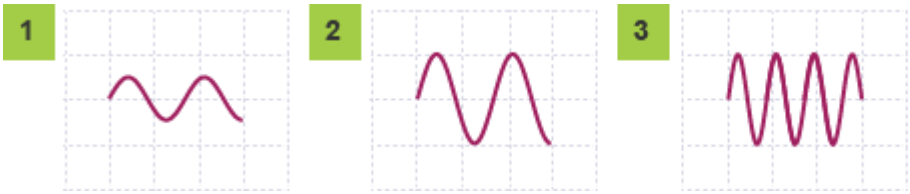
Sound is vibrations travelling in a medium.

What is the difference between a transverse and a longitudinal wave?

Based on two animations and classroom discussion, write down what is the difference between these two types of waves.

Wave properties

Odd One Out



What is the difference between the three depicted waves?

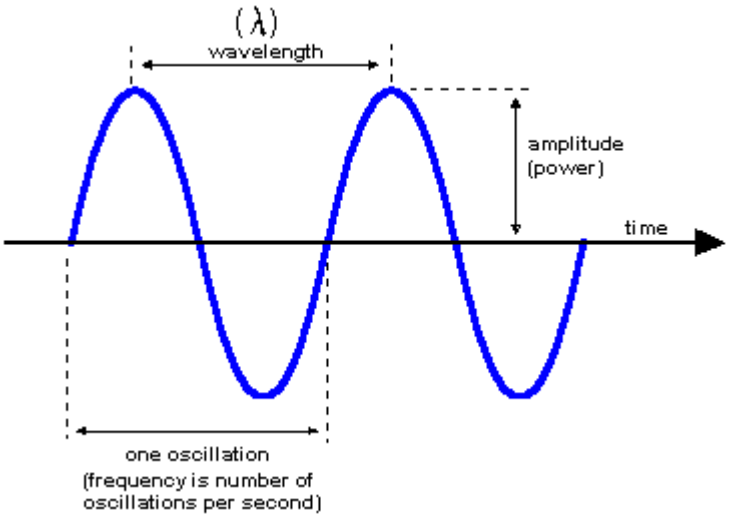
Speed of sound

Will sound propagate faster in air, sea or a brick? Why?

At room temperature (20°C), sound propagates with the speed of 343 m/s.
How does the speed of sound depend on temperature?

Why do we see lightning before we hear thunder?

Frequency, wavelength and amplitude



Frequency of a sound wave is responsible for pitch. Amplitude of a sound wave is responsible for loudness.
The range of hearing for humans is between 20 and 20,000 Hz.

The wave equation

$$v = f\lambda \qquad (1)$$

where v is _____

f is _____

λ is _____

Solve the following:

1. If the frequency of sound is 300 Hz and its speed is 320 m/s, what is its wavelength?

_____

_____

_____

2. If a sound wave propagates in a hall at a room temperature and its wavelength is 0.2 m, what is the frequency of sound?

_____

_____

_____

3. The temperature outside is 5°C. At what speed will sound propagate?
   Hint: use the expression $v = 331 + 0.6\,T$,
   Where T is temperature in degrees Celsius.

_____

_____

_____

_____

4. The weather the other day was horrible and sound was propagating at 319 m/s. If its wavelength was 11.8 cm, what was its frequency?

_____

_____

_____

_____

5. A scientist measures temperature in degrees Kelvin, the expression for which is $T_C = T_K - 273$. If the temperature is 318°K and the frequency of sound is at the very bottom of human perception, what is its wavelength?

_____

_____

_____

_____

_____

_____

Tutorial 1 Homework – Baseline Test

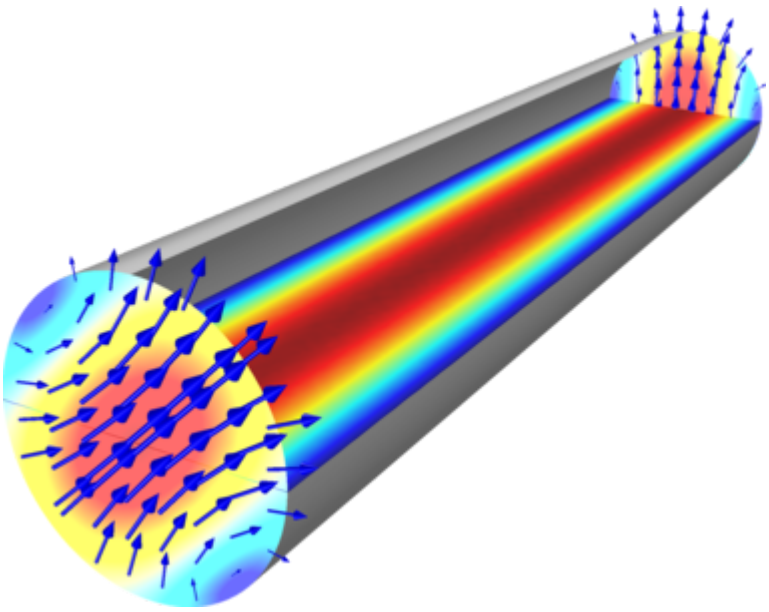
The homework assignment for the first tutorial is a baseline test to see your initial level of attainment in this subject area. The assignment will test for some or all of the subject specific skills that are required later in the final assignment. However, it is shorter than the final assignment and is will be an introduction to the subject as well as a challenge!

Do not worry too much about doing 'well' or 'badly' on the baseline test, it takes into account the fact that you may not be familiar with the subject area. It is designed to help you and your PhD tutor identify where you are at the start of the programme and to help you measure your progress along the way.

You will watch a video about acoustics, which can be found following this link: https://www.youtube.com/watch?v=26qvYE-w8Eo. Answer the questions based on the video:

1. What is sound caused by?
2. How does a created wavelength depend on a size of an object? What about frequency?
3. How does a loudspeaker affect air molecules?
4. Are sound pressures usually big or small?
5. What happens to sound when it gets further from a loudspeaker? Why?
6. How does clapping result in a sound wave?
7. How do cymbals produce sound?
8. What is a shock wave?
9. What is a sonic boom? What is the speed at which is happens called?
10. How does a whip make a sonic boom?

Tutorial 2 – Which acoustic quantities matter?



What is the Purpose of Tutorial 2?

- To review acoustic quantities important for sound measurements
- To study sound propagation in waveguides

Why are sound measurements important?

Read the following paragraph and discuss the ideas outlined there.

Very simply, sound can be observed as a propagating vibration in any substance. This substance can be air, water, wood, or any other material: in fact only in vacuum sound cannot propagate. Here, sound is observed where it is perceived most: in the air.
Sound is produced by a source, for example a firecracker, it travels through the air with a certain velocity (which is about 340m/s or 1225km/h) and can be reflected perhaps a few times by a wall or the ground. An ear or microphone detects it. After perceiving the sound of the firecracker one can distinguish its origin. Besides that, it can be said to be a loud bang and perhaps to be an annoying experience.

Sound pressure, affected by the number of air particles at a certain position, does not have a direction; sound pressure is a scalar quantity. Contrary, the velocity of air particles does have a certain direction: particle velocity is a vector quantity.
This annoying experience, or the quantification “loud”, is a subjective interpretation of sound. If large amounts of people are annoyed by a certain distress factor, regulations will follow. In this case sound measurements to quantify the amount of noise should be performed. Questions like “was it really a loud bang or was it somebody who didn’t like firecrackers?” should be answered in a proper way because of the subjectivity of perceiving sound.
To find out the direction of propagation of a sound wave, sound pressure and particle velocity must be measured simultaneously at one location. The product of both provides information about the direction of the sound wave.
The human ear is very sensitive for small pressure variations in the air. Not all frequencies are in a similar way similar. The human ear is most sensitive for pressure variations of about 3kHz (corresponding to 3000 variations per second). For frequencies of 30Hz the ear is about 200 times less sensitive. The static air pressure is about hundred thousand Pascal (Pa), a pressure variation of one Pascal is perceived as very loud at 1kHz, but as a soft tone at 20Hz.

The following paragraph is taken from a manual for a device which measures sound pressure and velocity. Read it and describe the acoustic quantities mentioned. Include as much detail as possible.

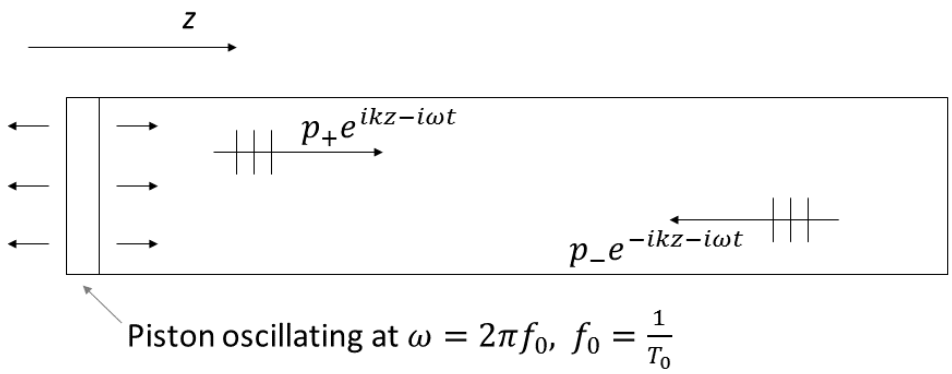
Sound can be understood as variations of the static air pressure *and* as a velocity of air particles: particle velocity. The following may explain this.
Pressure is defined as force per unit area. This force is caused by an amount of air particles at a certain position. So variations in the (sound) pressure is influenced by variations in the number of air particles. If the number of particles in a certain volume changes during time, there must be a particle motion towards that volume and backwards. The velocity of the movement of these air particles is called particle velocity. Therefore sound consists always of two parts: the compression and decompression of air, sound pressure, and the movement of the air: the particle velocity.
For the complete quantification of a sound field, both sound pressure as particle velocity should be measured.
In an electrical analogy, sound pressure corresponds to an electric voltage and particle velocity to electric current. The amount of power is quantified in Watts. Multiplication of voltage and current results in electrical power and analogously, sound pressure times particle velocity is associated with sound power in the acoustical domain.

In general the particle velocity is associated with the cause of an acoustic event and the sound pressure is associated with the result. If for example a loudspeaker is generating a sound wave in a room. Then the particle velocity measured close to the loudspeaker quantifies the level of vibration (the cause of the sound wave). The sound pressure measure in the room quantifies the amount of sound that is heard. If the walls of the room are hard reflecting, the measured sound pressure will be higher than if the walls of the room were fully sound absorbing. The particle velocity measured close to the loudspeaker is not affected by the acoustic properties of the walls.

Sound pressure, affected by the number of air particles at a certain position, does not have a direction; sound pressure is a scalar quantity. Contrary, the velocity of air particles does have a certain direction: particle velocity is a vector quantity.

To find out the direction of propagation of a sound wave, sound pressure and particle velocity must be measured simultaneously at one location. The product of both provides information about the direction of the sound wave.

Plane sound wave in a pipe



A sound wave travelling in a pipe has two components to it, forward-travelling and backward-travelling. The amplitude of which do you think will be higher?

An equation describing the sound propagation in a pipe is

$$p_0(x) = p_+ e^{ikz} + p_- e^{-ikz},$$

where $k = \omega/c$ is _____

p_+ and p_- are _____

_____

p_+ is always greater or equal than p_-. Their ratio is a reflection coefficient, which depends on acoustic properties of the reflecting surface:

$$R = \frac{p_-}{p_+}$$

The value of the reflection coefficient varies between -1 and 1 depends on boundary conditions of the pipe:

- R ≃ 1 – reflection from a rigid, or sound-hard boundary. The velocity of particles at this boundary in equal to zero.
- R = 0 – reflection from a sound-soft boundary, eg. a foam. At this boundary, sound pressure is equal to zero.
- R ≃ −1 – reflection from an open end of a pipe.

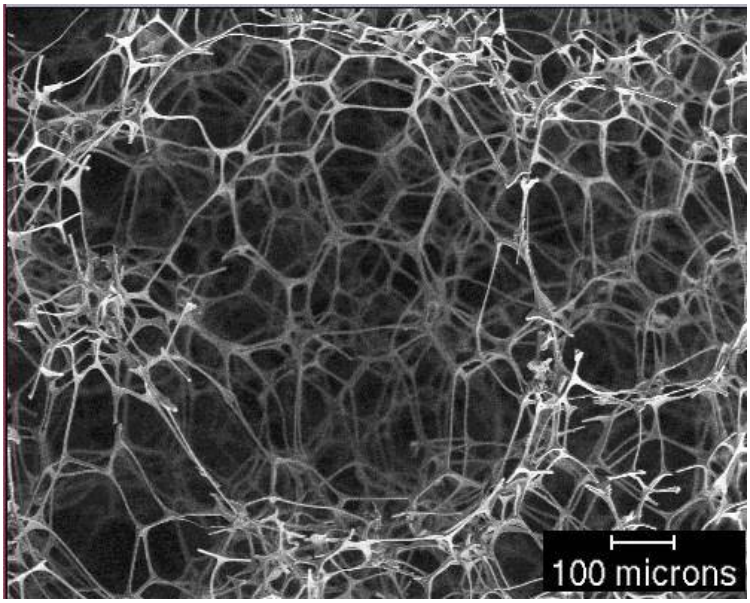
The transmission coefficient shows a ratio of transmitted to incident power and is expressed as follows:

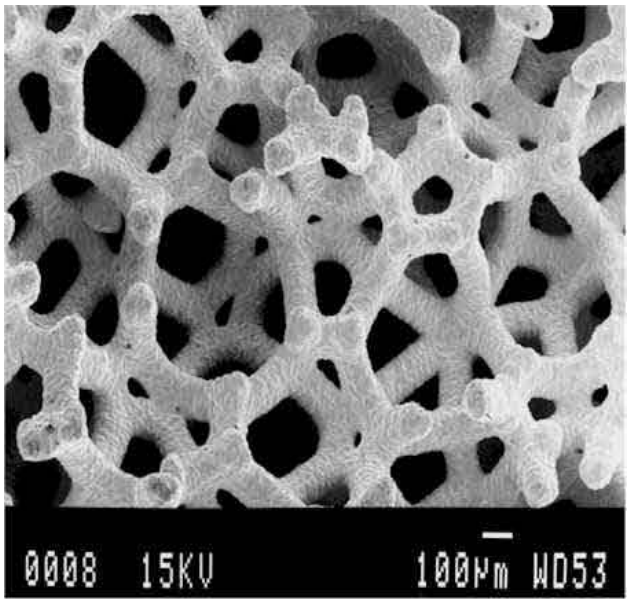
$$\tau = \frac{P_t}{P_+} = 1 + R$$

The absorption coefficient is a ratio between the absorbed and incident power and is expressed in the following way:

$$\alpha = 1 - |R|^2$$

Tutorial 3 – Porous media





What is the Purpose of Tutorial 3?

- To introduce porous media
- To discuss processes happening in them

Which industry branches use porous materials on a regular basis?

_____

_____

What are porous media?

Solid skeleton + network of interconnected pores.

The volume of pores should occupy 90% or more of the total volume of a porous material.

Types of porous media:

- foams
- ceramics

} continuous skeleton

- granular
- fibrous

} non-continuous skeleton

Why does the energy dissipation happen?

1. Structural losses

   _____

2. Thermal losses

   _____

3. Viscous losses

   _____

Porosity, tortuosity and flow resistivity

These are non-acoustical parameters of a porous medium, which determine its acoustic properties.

Porosity φ

$$\varphi = \frac{V_{air}}{V_{total}} \qquad (10)$$

where φ is _____

V_{air} is _____

V_{total} is _____

Means to measure porosity:

- density method
- image analysis
- porosimeter

Flow resistivity σ

$$\sigma = \frac{P_2 - P_1}{Qd} \qquad (11)$$

where σ is _____

P_1 is _____

P_2 is _____

Q is _____

d is _____

Means to measure flow resistivity:

- DC / AC methods
- acoustic method

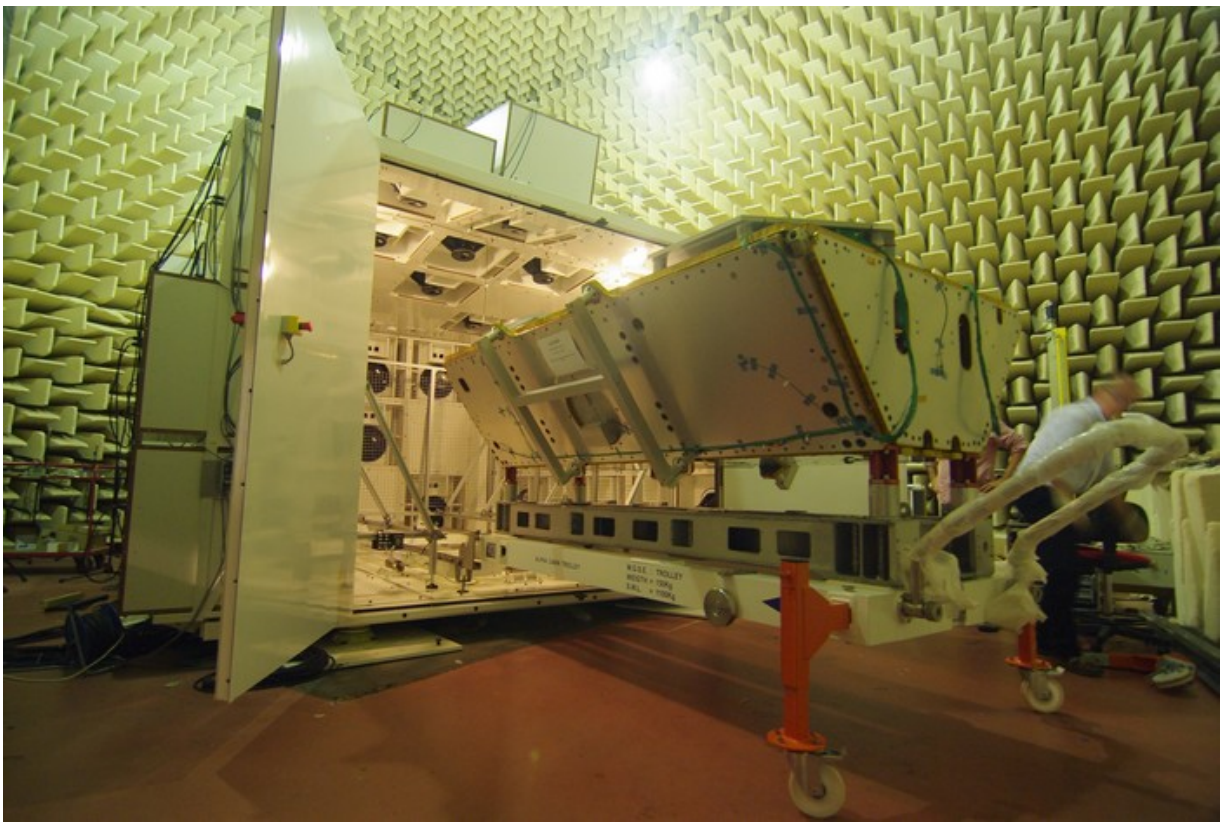
Tortuosity α_∞

$$\alpha_\infty = \frac{1}{\cos^2 \vartheta_p} \qquad (12)$$

where α_∞ is _____

θ_p is _____

Material characterisation methods



What is the Purpose of Tutorial 4?

- To introduce experimental facilities and measuring equipment
- To overview numerical methods to characterise porous media

How can one ensure that the acoustic measurements are reliable?

Laboratories

Anechoic, reverberation and listening rooms (chambers) – which one is which?

_____

_____

_____

What are these chambers used for?

- Anechoic chamber _____

  _____

- Reverberation chamber _____

  _____

- Listening chamber _____

  _____

Impedance tube

Governing standard: ISO 10534-2

What do you think a governing standard is, and why do scientists need to use it?

_____

_____

_____

Measuring sound pressure and velocity

Sound pressure: scalar quantity, which means that _____

_____

Sound pressure can be measured with _____

Sound velocity: vector quantity, which means that _____

_____

Measuring sound pressure and velocity simultaneously means that we can determine sound intensity, which is very beneficial for many applications, such as sound field visualisation, sound power measurements, non-destructive testing (NDT), etc.

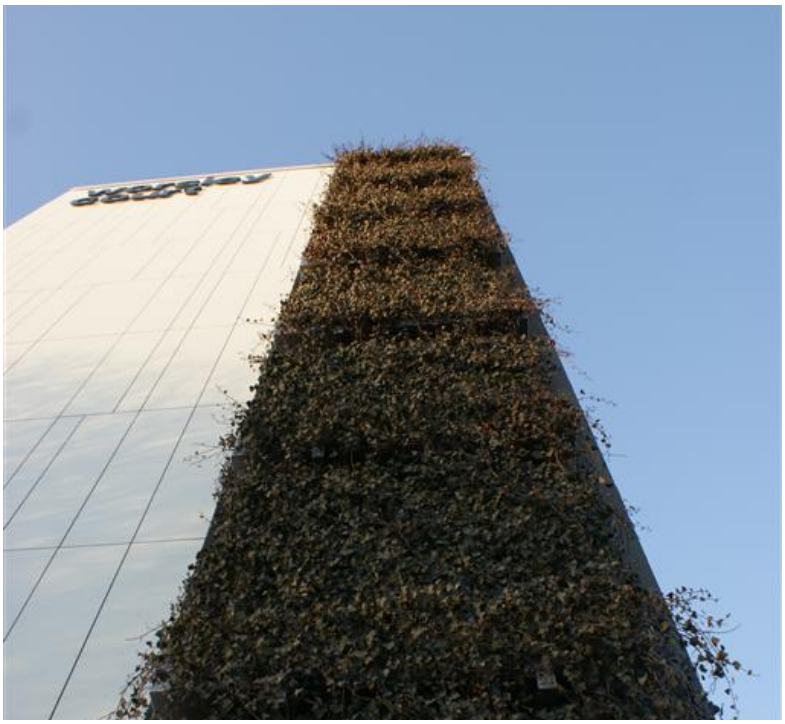
Means of measuring sound intensity:

- p-p method: two microphones
- p-u method: one microphone and a velocity transducer
- Microflown: one microphone and a Microflown two-wire transducer

Tutorial 4 – Homework: Draft Assignment

Your homework is to find any research (published papers or books, projects) which involve using any facilities / equipment which we talked about in this tutorial. You should describe the research carried out and state how your chosen piece of material characterisation fits in this research.

Tutorial 4 – Acoustics of living plants



What is the Purpose of Tutorial 4?

- To overview the history of using living plants as a means of noise reduction
- To determine which properties of living plants contribute to enhanced sound absorption
- To analyse how sound absorption by plants can be measured and predicted

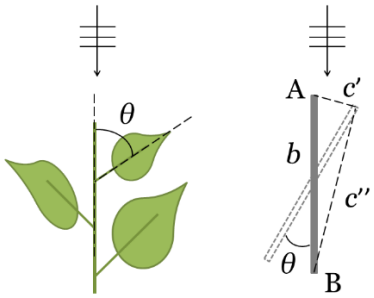
What are the main reasons to use living plants as a means of noise reduction?

_____

_____

Parameters influencing sound absorption by plants:

- leaf area
- number of leaves
- plant height and volume
- angle of leaf orientation



Predictions for living plants absorption:

- Porosity

$$\varphi = 1 - \frac{V_f}{V_p} \qquad (13)$$

where V_f is _____

V_p is _____

- Tortuosity

$$\alpha_\infty = \cos\frac{\theta}{2} + 2\sin\frac{\theta}{2} \qquad (14)$$

where θ is _____

- Flow resistivity

$$\log_{10}\sigma = 0.0083A_v + 1.413 \quad \text{when } \theta > 70^\circ \qquad (15a)$$

$$\log_{10}\sigma = 0.0067A_v + 0.746 \quad \text{when } \theta < 40^\circ \qquad (15b)$$

where A_v = _____ and is _____.

These parameters are subsequently substituted into the Miki model, to calculate the characteristic impedance and wavenumber, and then the surface impedance and reflection and transmission coefficients.

Experimental measurements were performed using an impedance tube method.

Parameters	Symbol	Units	Value
Height	h		
Number of leaves	n		
Avg thickness of leaf	d		
Avg area of leaf	A_o		
Avg volume of leaf	V_o		
Total area of leaves	A		
Total volume of leaves	V		
Volume of plant	V_p		

Useful formulae

To find the average volume of a leaf, you need to multiply its thickness by its area:

_____

To find the total area of leaves, you need to multiply the average leaf area by the number of leaves:

_____

To find the total volume of leaves, you need to multiply the average leaf volume by the number of leaves:

_____

To find the volume of the plant, multiply the area of the flower pot by the height if the plant:

_____

Tutorial 5 – Data for your final assignment

For your final assignment, you need to produce a 1,500-word scientific report on how plants absorb sound.

The main points of your report are:

- **Research** – background on porous media, sound absorption and using plants for these purposes. You are welcome to use the paper I gave you last tutorial, and do your own research in books / on the internet. Make sure you include the sources you used – look at the end of your tutorial book for help on that.
- **Hypothesis** – the starting point of your investigation, your educated guess about the scientific experiment you performed. What were you testing? What did you hope to achieve?
- **Method** – what did you do? How did you perform your experiment? Your method should be structured in such a way that if anyone decided to repeat your experiment, they would be able to repeat your steps with the help of your method.
- **Risk assessment** – were there any risks involved? If yes, list them and suggest action to avoid them or deal with them if they occurred.
- **Results and evaluation** – this is the section where your results would go. As you have your table of results and graphs printed, you don't need to include them here. Explain your results – is that what you expected? If not, suggest possible reasons for that. Compare your results with the rest of the class, the average results set and the experimental results I included with your graph and reflect on those – why are there similarities / differences?
- **Conclusions** – summarise your investigation and suggest improvements.

In order to understand your results better, you need to replot the graph I printed out for you on the graph paper provided below.

What does your graph show? Explain your results to the best of your knowledge.

_____

_____

_____

_____

_____

_____

Tutorial 6 – Feedback

What is the Purpose of Tutorial 6?

Reflect on skills learned on the programme with a view to encouraging resilience

Receive feedback on final assignment

What are the key questions?

- What strengths have I demonstrated in my work and what areas of development are there left for me to address?
- What steps do I need to take to improve my academic output?

Activity 2 – Marking your own

Using the mark scheme, identify three things you did well and three things you could improve.

What went well?

1.

2.

3.

What could be improved?

1.

2.

3.

Activity 3 – Responding to feedback

Read through your feedback sheet and highlight on your assignment where you received positive feedback (one colour) and areas for improvement (different colour). You might find it helpful to annotate this with a brief comment or two.

Appendix A – Academic writing guide

When writing your assignments for this course, you are expected to use academic language. Below is a list of a few guidelines to use. In addition, not only are you aiming for 100% accuracy in your vocabulary and grammar, but also you should remember that you are writing for someone else, so the punctuation and the structure (sentences, paragraphs, etc) are very important.

- Avoid aspects of informal English
  - do not use contractions (eg. it's, I'll, wouldn't, etc)
  - do not use slang or colloquial language
  - generally avoid phrasal verbs
  - do not use exclamation marks, dashes, direct questions
- Structure your writing carefully
  - write in complete sentences
  - use connecting words and phrases to make your writing easy to follow
  - use verbs such as suggest, claim, suppose
  - use verbs such as would, could, may, might, which can soften what you are saying
- Make your writing formal and impersonal
  - do not use personal language (eg. I, my, we, etc)
  - use impersonal subjects instead (eg. It is believed that … , it can be argued that …)
  - be objective, not subjective
  - use evidence from your source reading to back up statements you make and reference this correctly (see Appendix B)
  - write noun-based phrases rather than verb-based, use passive voice

Appendix B – Academic referencing guide

When referencing sources you used for your work, you are expected to use Harvard referencing style. In academic community, referencing is used to indicate where the evidence can be found. You need to reference your work for several reasons, such as (i) to avoid plagiarism, which is a form of academic theft, (ii) to give credit to authors whose work you used to complete your assignment, (iii) to demonstrate that you used a wide range of sources, and (iv) to enable the reader to consult for themselves the sources you used.

Harvard referencing system is known as Author and Date system. This means that whenever you use a quote, an idea, or any other information of evidence from a source you consulted, you should put either a year of publication, or both author's name and a year of publication in brackets. For example:

Here the real part is often called the active or mean active intensity (Fahy, 1995).

or

According to Fahy, the real part is called the active or mean active intensity (1995).

How to reference sources:

- Books (1 author)

  Surname, Initials. (Publication year in brackets) Book title - italicised. Series title and volume if applicable. Edition – if not the first. Place of publication: publisher.

  - MORSE, P. M. (1949) *Vibration and Sound*. Acoustical Society of America, New York: Mc-Graw Hill.

- Books (2 to 3, or more authors)

  FAMILY/SURNAME, Initials., FAMILY/SURNAME, Initials. and FAMILY/SURNAME, Initials. (Publication year in brackets) Book title - italicised. Series title and volume if applicable. Edition – if not the first. Place of publication: Publisher

  - MORSE, P. M and INGARD, K. U. (1987) *Theoretical Acoustics*. Princeton: Princeton University Press.

  FAMILY/SURNAME, Initials. et al. (Publication year in brackets) Book title - italicised. Series title and volume if applicable. Edition - if not the first. Place of publication: Publisher.

  - CAMPBELL, N. A. et al. (2008) *Biology*. 8th Ed. London: Pearson.

- Journal article (electronic/online)

  FAMILY/SURNAME, Initials. (Publication year in brackets) Title of article. Title of journal - italicised. [Online in square brackets] Name of Database the article is from if appropriate. Volume number (Part number/month in brackets). p. followed by the page numbers of the article. Available from: URL. [Accessed: followed by the date viewed in square brackets].

- ABRAHAM, B. M. and KEITH, W. L. (1998) Direct measurements of turbulent boundary layer wall pressure wavenumber-frequency spectra. *Journal of Fluid Engineering*. 120 (March). p.29-39. Available from: http://fluidsengineering.asmedigitalcollection.asme.org/data/Journals/JFEGA4/27126/29_1.pdf [Accessed: 6 September 2015].

- Journal article (printed)

  FAMILY/SURNAME, Initials. (Publication year in brackets) Title of article. Title of journal - italicised. Volume number (Part number/month in brackets). p. followed by the page numbers of the article.

  - AYLOR, D. (1972) Sound transmission through vegetation in relation to leaf area density, leaf width, and breadth of canopy. *Journal of the Acoustical Society of America*. 51 p.411-414.

- Newspaper (online)

  FAMILY/SURNAME, Initials. (Publication year in brackets) Title of article. Title of Newspaper - italicised or underlined. [Online in square brackets] Name of Database article is from if appropriate. Day and month of the article. Page number of the article if applicable. Available from: URL. [Accessed: followed by the date viewed in square brackets].

  - RANDERSON, J. (2008) Researchers find fish that can count up to four. The Guardian. [Online] 26th February. p.14. Available from: http://theguardian.co.uk. [Accessed: 22nd May 2012].

- Website

  Author of website FAMILY/SURNAME, Initials or WEBSITE name if no author is available. (Year - in brackets) Title of website in italics or underlined. Any numbers if necessary or available if website is part of a series. [Online in square brackets] Available from: URL. [Accessed: followed by date in square brackets].

  - MICROFLOWN (2014) Microflown Technologies. [Online] Available from: http://microflown.com [Accessed: 26 September 2014].

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University Applications Guidance

For course choices and careers information:	www.brightknowledge.org.uk
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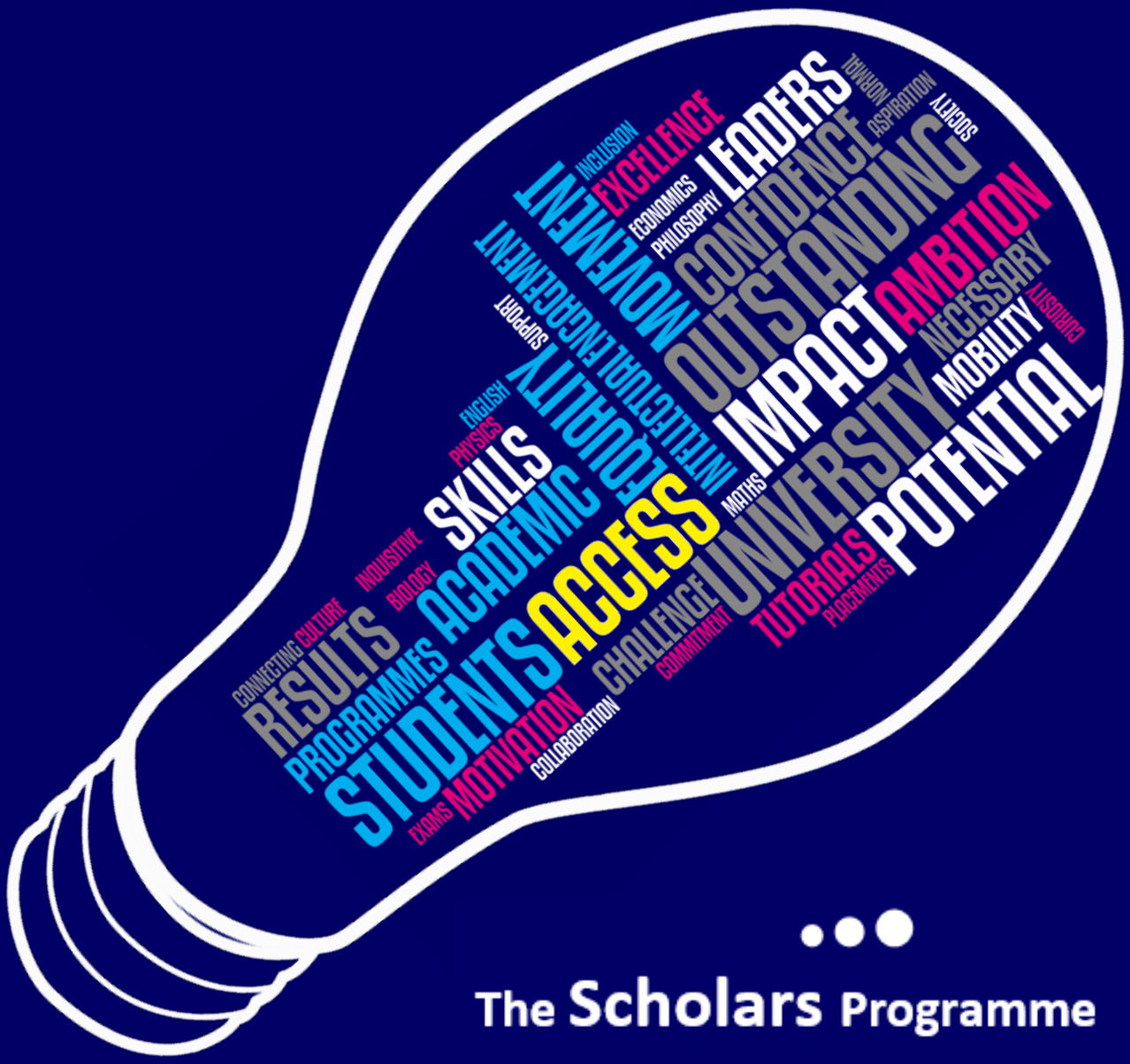

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