Are acoustics and sound the same thing - What physical phenomena are involved in acoustics?

Sounds are often considered to be those sensations which the ear can detect, however, acoustics is concerned with much more than just hearing. Before we explore the range covered by acoustics it is useful to ensure we understand how sound is produced.

Sound results from vibrations in the medium, whether it be a gas, a liquid or a solid. Consider a tuning fork. When it is 'sounded', the prongs vibrate back and forth creating fluctuations in the air pressure around the prongs. These fluctuations move away from the fork prongs, creating a sound wave. The bow causes a violin string to vibrate producing sound waves, while the bang coming from an explosion is caused by rapid changes occurring in the hot gas at the centre of the explosion. Speech is produced by the relatively complicated interaction of the lungs, vocal cords and passages in the throat, the resultant effect being the generation of alternatively compressed and rarefied regions of air immediately in front of the lips. Again, this region moves

away from the speaker as a sound wave.

The number of vibrations which occur in one second is called the frequency of the sound and is given the name Hertz (or just Hz.) after one of the early pioneers in acoustics. Normal speech contains frequencies ranging from 20 Hz to 20,000 Hz, which is also the range of human hearing. Often this is called the audible range. When the vibrations occur at frequencies less than 20 Hz they cannot be heard and are called infrasonic while ones above 20,000 Hz, which are also inaudible, are referred to as ultrasonic.

Acoustics includes the study of waves which range from infrasonic right through to ultrasonic waves - in fact any form of mechanical vibration in any media can be regarded as part of acoustics. This very broad definition is why acoustics is involved in practically all aspects of modern life.

The wavelength of sound is the distance travelled by the sound during the time of one complete vibration. It is of importance because the effect which an obstacle, such as a fence, has on the sound depends on its physical size relative to the wavelength of the sound. Most noticeable effects occur when the wavelength is smaller than the physical size.

There is an important relationship between the frequency (f), the wavelength (λ), and the speed of the sound (c) in the medium. Mathematically, the relation can be expressed as:

$$c = f \lambda$$

The speed of sound depends on the medium carrying the wave. As some examples, the speed is 344 m/s in air, 5,200m/s in steel, between 1,000 and 5000 m/s in wood depending on type and direction relative to the grain, and about 80 to 200 m/s in soils.

Note that every area of acoustics involves three aspects - the production of the sound or vibration, transmission of the sound through some medium and, thirdly, the reception or detection of the sound. While the production and detection are important aspects, in many

situations the most complicated area is often the transmission of the sound from source to receiver. This may involve reflection of the sound energy from a surface, diffraction where sound is bent around corners, interference where part of the sound wave interacts with other parts of the wave to cancel or enhance the overall effect and absorption where sound energy is changed into heat within the material. Often, many of these processes occur simultaneously.

What is the softest and the loudest sound - What is meant by Sound Level?

Sound waves are small fluctuations in the air pressure which reaches the ear. The size or amplitude of these fluctuations determines how loud the sound seems to the listener. The range of sounds is very large: the noise of a jet plane is around a million times greater than the buzz of a mosquito. Because of this huge variation, it is common practice to use a *logarithmic* scale to describe sounds. This scale uses a reference pressure (of P_o = 0.00002 Pascal) which corresponds to about the quietest sound a person can hear and then any other sound with a pressure P is compared to the reference sound by using the formula:

$$dB = 20 \log_{10}(P / P_o)$$

The result is known as the sound level in decibel or just dB. Because the ear has a different sensitivity to different frequencies, it is common practice to use an A-weighting system to adjust for this effect. Some typical A-weighted levels for common community situations are as follows:

	Day-time level	Night-time Level
A quiet country field, sound of distant tractor	45-50dB(A)	
Suburban street, distant traffic noise.	50-55dB(A)	39-43dB(A)
Beside a busy roadway carrying cars and trucks.	70-85dB(A)	60-70dB(A)
Near busy runway with large jet plane taking off	110-130dB(A)	

Notice that often the levels are different during day-time compared to night-time.

What are some of the developing areas of acoustics - What is the future of Acoustics?

Here are some areas of acoustics which are expanding and offer a bright prospect for future development.

CommunicationsWith the rapid development of computers it is already possible to communicate directly with them by voice control and to make them reply using sounds. Devices which routinely recognise and simulate speech will become increasingly common in the next few decades. Voice transmission over long distances by cable or microwave links are other areas where current technology is making rapid progress. **Underwater Acoustics** Detecting a submarine underwater, tracking schools of fish, determining the average temperature of large tracts of ocean to check on global warming are but a few applications of this expanding field. **Ultrasonics**
Detecting flaws in aircraft structures or in the welds of a huge oil rig are just two applications of ultrasonics. In medicine, similar principles apply to the detection of tumours in the body or of imaging an unborn baby. Ultrasonic baths are commonly used to clean contamination from sensitive surfaces, while ultrasound can also be used to cut holes in extremely hard materials where an ordinary drill would not penetrate.
Architecture
New and improved sound insulating materials are continually being included in modern architectural structures to produce quieter living environments and more pleasing concert halls and other entertainment venues.
Life Studies
Biological ears which can allow some deaf people to regain their hearing are already being utilised, but there is much more progress yet to be made in this field. How do birds or dolphins communicate using sound, what effects does changing the nature of a forest have on the ability of birds to communicate are areas under current study.

Acoustics is already playing a significant role in modern communities and there is tremendous scope for enthusiastic people to play an important role in continuing these developments by mastering and applying the principles of acoustics.

What is the scope of Acoustics - Why should you consider a career in Acoustics?

These are meaningful questions providing you understand what is meant by acoustics. Many people have a vague feeling that acoustics is something to do with noise - perhaps in association with road traffic or the properties of their favourite concert hall. In fact, acoustics is a wide ranging subject which has applications in health and medicine, in the arts, in engineering and many aspects of the sciences.

A career in acoustics can involve working in music, speech, medicine, physiology, mechanics, architecture or oceanography, to name but a few areas. Acoustic specialists could well be involved with the design of a concert hall or shielding communities from traffic noise, but other areas might involve developing improved hearing aids for the deaf or speech aids for the dumb, creating new acoustic materials or studying the physics of sound propagation in the earths atmosphere. Acoustics plays a role in detecting underwater submarines or atomic explosions, it is involved with making computers talk to you or helping them understand spoken commands. Detecting the presence of an unborn child or improving the quality of a musical instrument are further problems involving acoustics.

Often acoustic specialists are called in as part of a team effort. Some examples include joining with architects and engineers in the planning and construction of a new sporting complex or a super highway. Others may have a role in the design and testing associated with a very fast train project while some may consider the implications of shipping propeller noise as part of a study on the marine life around Australia's coastline. It may well be an advantage to future workers in acoustics if they have training in some other discipline, which is then enhanced by additional studies in acoustics. A wide background is invaluable in many job situations and none more so than in acoustics.

Today, people working in acoustics can be found in Government laboratories, in hospitals, in the armed forces, in industry and educational institutions. You can do fundamental research, applied problem solving, consulting, teaching or some combination of these areas. The scope is wide and a future in acoustics is limited only by your personal drive and ambitions. So take up the challenge consider a career in acoustics.

Where do people work in acoustics - What types of jobs are involved?

Industry

Many of the larger industrial organisations employ people to work on specific acoustic problems. They may be concerned with locating and reducing noise created by industrial plant, with hearing conservation or the design and construction of absorbing materials for use in offices or auditoriums. Other companies may be seeking defects in metal tanks using ultrasonics or improving speech over the telephone network. In the car industry, measurement of sound levels within the cabin of a vehicle and vibrations caused by the engine and wheels are two areas involving acoustics. Relatively few companies within Australia employ people to do basic research into aspects of acoustics; usually they prefer to incorporate such knowledge once it has been developed elsewhere.

Often companies will employ specialist acoustic consultants to solve their particular problems. This may be to assist in the design of industrial plant layout in order to minimise noise radiating out into the community or the construction of appropriate sound proof rooms for music lessons in a school. All the major cities of Australia have a number of acoustic consultant firms employing specialists capable of solving a wide range of problems.

Education

Universities and colleges of advanced education provide courses in acoustics and also undertake basic and applied research in many varied areas of the subject. Depending on the emphasis involved, the work may occur in Departments such as Physics, Electrical and Mechanical Engineering, Architecture, Music, Speech, Psychology and Medicine.

Often educational institutions include some acoustics within the subjects required for a Degree or Diploma, while many places offer post-graduate courses which will permit candidates to undertake research in aspects of acoustics. Such fundamental research may be funded by the Institution, through industrial sponsorship or from Commonwealth Grants.

Government

There are a number of government and semi-government laboratories undertaking research into acoustics. The major one in Australia is the National Acoustics Laboratories at Chatswood in NSW. The site was chosen because of the low background noise in the area as it is remote

from major roads and aircraft flight paths. This facility was opened in 1988 and contains four anechoic rooms, two adjacent reverberation rooms, a large quiet room for subjective listening tests, and high intensity noise rooms with a wide variety of excellent measurement systems. As well as conducting their own program of research into aspects of acoustics, the Laboratories can be hired by other organisations to run specific tests.

The Commonwealth Scientific and Industrial Research Organisation, CSIRO, is also involved in many research projects into aspects of acoustics. At Highett, Victoria, noise associated with buildings is being investigated in the Division of Building, Construction and Engineering while noise from textile machines was studied at the Geelong branch; to mention but a few. The Department of Defence, in their Aeronautical and Maritime Research Laboratory near Melbourne is using underwater acoustics to detect submarines as well as seeking new acoustic materials to reduce reflections from submarines. Noise and vibrations in aircraft are also investigated. Another branch, in South Australia, has been using the combination of acoustics and light -optoacoustics - to detect ways of detecting missiles.

How do you prepare for a career in acoustics - What subjects should I study?

There are few courses devoted entirely to acoustics, rather it complements a wide range of subjects. So the question really should be: What do I study for a career in Engineering or in Science or perhaps in Architecture or Medicine.

A driving curiosity to discover how nature works and how best to utilise these ideas for the betterment of society is a strong foundation for a prospective acoustician.

Because acoustics interacts with so many other areas, it is well to have a broad range of background subjects at secondary school - an interest in music and the arts is no less important than a study of physics and biology. However, a knowledge of basic mathematics and some skills in computing are essential these days. Computers are used in all aspects of the design, measurement, and data analysis in acoustics.

The ability to understand abstract ideas is part of the training of most students - and is needed to follow the mathematical and physical ideas involved in solving the problem of how nature works. It is an important task of the acoustical scientist to translate such abstract ideas into the practical solutions needed by the community. As the acoustician will often be working with people in industrial or government positions who have little scientific training, or with musicians, builders, private citizens and sometimes lawyers who have limited acoustical knowledge, an ability to communicate ideas simply and clearly is invaluable. In brief, a person interested in acoustics should have a well rounded background in the scientific aspects of the subject as well as being literate and interested in the arts.

While not all people working in acoustics have extensive formal qualifications, some basic training is necessary. As society becomes more and more conscious of the need for well educated citizens, there will be an increasing demand for people with formal qualifications in the acoustics work force, rather than the "self-trained" (although often very dedicated) workers who have only done a few short courses during their career. So the advice to people considering entering the area in future is to obtain as much training as you can while you are young, as it gets harder the older you get.

As a starting point, a broad background is preferable to a course which concentrates on solving a narrow range of specialised acoustic problems. Your course work should place an emphasis on basic physics and mathematics and include an understanding of wave-motion, basic computing and some electronics and instrumentation. Courses which include a study of optics and electromagnetic theory are useful, as many of the basic ideas and laws developed in these areas are directly transferable to acoustics.

Such subjects often occur within the framework of an engineering degree. Individuals may wish to complement the above studies with areas such as architecture, the life sciences including biology or psychology and/or an arts subject like music. Such choices will build the bridges necessary to lead the budding acoustician into the many and varied areas of acoustics.

Keen candidates may wish to extend their studies after obtaining a basic degree and undertake additional work towards a Masters or even a Doctoral degree in acoustics. A number of Universities include acoustics among the areas offered for such training. The following list indicates some types of Faculties and the kind of research topics which may be undertaken. However, the list is by no means comprehensive.

Mechanical Engineering: Research into the effects of vibration in various structures, production of turbulent sound from flowing fluids, active noise control.

Physics:
Interaction of sound with materials, basic properties of acoustic materials, behaviour of musical instruments.
Biology:
Communication between living organisms by means of sound, effects of noise on the behaviour of marine and land-based animals - including man.
Psychology:
Problems of speech and hearing and the intelligibility of communication.

What is the Australian Acoustical Society - Who can join the Society?

The Australian Acoustical Society is the society for people working in acoustics.

The Society has as its aim the promotion and advancement of the science and practice of acoustics in all its branches and the exchange of ideas between its members.

Towards the end of 1964, the concept of the society started to develop and it has grown from the original group of 18 interested people to the present membership of over 500. Divisions are established in New South Wales, Queensland, South Australia, Victoria (including Tasmania), and Western Australia.

A principle activity of the Divisions is the facilitation of technical and social meetings of the membership. Each year one of the divisions organises and hosts the national conference of the Society. Such conferences usually last for two to three days and attract international contributions. The Society is regularly involved in the staging of major international acoustical conferences (for example ICA, Internoise, Wespac, ICSV). The Society publishes the thrice yearly journal called
Acoustics Australia
.

As a learned society, AAS requires applicants to have reached an adequate standard of study in acoustics and/or have had a number of years experience working in the area, before they will be admitted as Members or Associates . Student Membership is available for interested

people who are continuing their studies.

Members who have made an exceptional contribution to acoustics may be elected as a Fellow of the Society.

Business and institutional organisations can support the work of the Society through Sustaining Membership
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The Society runs a number of annual awards both on a national and divisional basis, details of current awards (and how to apply) can be found at Awards and Grants

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