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The Acoustics House

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"The Acoustics House" curriculum is a modularized, individualized problem-solving scientific/ mathematics activity for students in high school math. Contents of the packets focus on architecture sound and its relationship to science and mathematics. The curriculum is designed to integrate reading, writing, collaboration, science and mathematics. The intended outcome is to enable students to demonstrate and interpret steps used to attain solutions for real life problems.

In this high-tech age, modern technology flourishes. It is imperative that students understand how data is processed and translated into meaningful knowledge. This curriculum will present students with a variety of math and science problems that each student can attempt to solve. Students will use writing skills to solve problems that are developmentally appropriate. Students will acquire enough knowledge to be used to examine data and to process ways of analyzing the data in order to later write about it. Consequently, writing and problem-solving abilities of the students will improve as they practice multiple approaches.

Students will gain expedience in using the scientific method, solving problems to the best of their ability, and analyzing old and new information. They will receive a variety of guided explanations and demonstrations on problem-solving, along with reviewing basic language skills and learning to monitor their own progress.

Students will also work in cooperative groups as cooperative groups play an important role in school and outside of school. Students will interact and work in small groups throughout each of the activities. Team building and cooperation are important skills students will need to meet the challenges of our changing world. For some students, working with others will be a new experience. The expected outcome is to develop the skills involved in collaboration and respect for the ideas of others.

As students are working in groups, sharing and listening to others become the key to successful mathematical/ scientific decision making. The teacher's role will be that of facilitators. This includes listening and asking effective questions to help students stay on task. Each student has a role in the group, such as recorder or manager so that they become responsible for their own learning. Students assume new roles as they change activities so that each group member has an opportunity to fill each role.

Finally, it is important that the teacher discusses with the class, either verbally or in writing, how the group has functioned. Questions such as "In what ways did your group work well together?" "How was everyone in the group given the opportunity to speak and to be heard?", and "Describe how the responsibilities were shared" help determine the effectiveness of the group and where improvements need to be made.

As students interpret data, discuss and support approaches to problems, read maps, write reports, defend solutions, and draw conclusions, each student may not have the same level of proficiency required to carry these out. Therefore, to foster participation and effective communication by all students, the teacher must try to obtain an idea of the students' communication skills. This can be accomplished by listening to the students as they talk about and interpret the task. Who is having difficulties understanding the requirements?

Which students cannot identify and explain the components and objectives of the activity? Next, the teacher needs to examine the written work. Which students cannot fully explain the solution? Is this due to a lack of mathematical or scientific knowledge or the inability to express thoughts in written or oral form? Some reasons for this diversity among students include lack of proficiency in English, poor knowledge of mathematical or scientific terminology, limited exposure to the rules and use of language in mathematical or scientific contexts, and the lack of background and experience with technical forms of communication.

Overall, "The Acoustics House" is a curriculum designed to promote cooperative groups, scientific thinking, problem-solving, communication skills, and mathematical/ scientific applications in the area of environmental science and management. This curriculum is designed for students taking problem-solving, but it can be altered easily for other grades. Students will find this curriculum extremely interesting and useful as it fosters creativity, curiosity, and imagination of our environment.

GENERAL CONCEPTS

FREQUENCY, OCTAVE, and WAVELENGTH

Frequency (f) is the number of cycles that the periodic signal completes in one second. The unit Hz (Hertz). The pure tone or the sine wave has a single frequency. The sound and the noise usually are not pure tones. Depending on Fourier theory (the complex signal can be synthesized from sine signals (or pure tones) of different frequencies, different amplitudes and different time delays or phases), we can describe the sound as many pure tones with defined amplitudes (or intensities). We can hear sounds with frequencies 16 Hz to 20,000 Hz. Sounds that are out of this range can not be heard regardless of their intensities. The human hearing system (the ears and related perception system in the brain) is more sensitive to frequencies in the range of 1000 Hz-3000 Hz.

The human hearing system is unable to distinguish between two separate sounds with frequencies too close to each other. In other words, slight change in frequency of the tone will not be audible unless the frequency changing is greater than a defined value. The higher the given frequencies, the wider the frequency of the tone can be changed without audible differences. As a result, we can divide all the audible frequencies into 220 ranges, the higher the frequency the wider the range. Therefore, we need a certain name or unit to describe these ranges. This is exactly the concept of the octave. The interval between two frequencies having a ratio of 2:1. When we need a greater frequency resolution for some studies we can use less value unit like 1/3 octave.

SOUND LEVELS and DECIBEL

These definition are related to the amplitude of the signal. We can describe the absolute value of the sound intensity (I) in Watts per meter square or W/m^2. As we discussed for frequency, the change in the sound intensity (or sound pressure level, SPL) should be more than certain values in order to be noticeable. The full range of the audible sound intensity values can be divided into 100 ranges, the higher the sound intensity (louder the sound) the wider the range. To determine the intensity in regard of this human perception it was good idea to use the Bel: the logarithm of the ratio of two power values. If we have, for example, intensity I=0.1 W/m^2 and we change it to 1 W/m^2, the resulting sound level (note that, we added the word level when we use logarithmic values) will be 1 Bel considering 0.1 W/m^2 as the reference value (to take the log). Hence the Bel unit is considerably large, we use one tenth of it(the same concept as we discussed earlier for more frequency resolution), and the resulting unit we call decibel or (dB). In sound application the reference value is 20mðRða for sound pressure or 10E-12 W/m^2 for sound intensity. These values give the 0dB sound level, and represent the human threshold of hearing (the lowest level that can be perceived). The threshold of pain or feeling (the level which causes pain in the ears) is about 120 dB.

SOUND ABSORPTION COEFFICIENT

This coefficient describes the efficiency of the material or the surface to absorb the sound. The ratio between the absorbed sound energy and the incident energy is the sound absorption coefficient. The sound absorbing materials and constructions can be divided, for architectural purposes, into 4 types depending on the way the absorption is mainly performed: 1-turning the sound energy into heat, like fiberglass or carpet. 2-vibrating with a specific frequency when the sound hits the surface, like lightweight panels or 5/8" gypsum board. (These materials effectively absorb the sound only at certain frequencies usually with some kind of distortions in the resulting sound) 3-turning the sound energy into heat in the neck of the cavities (Helmholtz resonator) like sound blocks. (This construction has good absorption at low frequencies) 4-allowing the sound to go through like some types of grid system or lay-in ceiling with sound leakage about it.

The most common way to measure sound absorption coefficient is to lay the piece of the material in the reverberation room (a room which has very long Reverberation Time, or RT), then measure the RT so the coefficient can determine this procedure. The value of the coefficient for the same material varies with the type of the mounting in the test room. Mounting types are frequently given in acoustical panel manufacturers data sheets.

DIFFRACTION

Diffraction is the change in the direction of propagation of sound waves passing the edge of the obstacle. Diffraction phenomenon significantly depends on the relationship between the wavelength of the sound and the size of the obstacle. The longer the wavelength the stronger is the sound diffraction. This effect happens also to the sound transmitted through openings.

ROOM ACOUSTIC

PHYSICAL and GEOMETRICAL (RAY) ACOUSTICS

The sound behavior in the room is strongly effected by the ratio of the frequency (or the wavelength) of the sound to the size of the room. As a result, the audible spectrum can be divided into four regions.

MODES

Modes are the resonant frequencies on which the waves interface and form maximums and minimums of sound pressure at certain points of the room. This happens, at low frequencies in comparison with the dimension of the room. The calculation of modes in a rectangular enclosure is simple. The modes become complex and sometimes unpredictable in rooms of different shapes. There are 3 types of modes: axial (2 parallel surfaces contributed to the generation of the modes), tangential (4 surfaces) and the oblique mode (6 surfaces).

The lower frequency of all modes is axial, and it can be calculated as f=c/2L, where c is the speed of sound and L is the room length.

It is important to note that, the modes of the enclosure are weak (in pressure amplitude) when the walls are sound absorbing. To splay the walls (in practice rooms for example) makes modes unpredictable and less organized which, sometimes, can weaken the well defined structure of the maximum and minimum values of the sound pressure.

SOUND DIFFUSION and DIFFUSERS

Sound in an enclosure can described as diffused if the intensity of the sound energy is equal in every location of the room, or the sound energy flows equally in every direction. Many different factors can enhance the diffused sound. These include geometrical irregularities, absent of focusing surfaces, the distribution of absorptive and reflective elements randomly scattered through the space, and the existence of diffusing objects (furniture) or panels (diffusers).

Diffusing panels scatter the sound in all, or in certain directions depending on their type and geometrical dimension. A new type of diffuser is the Schroeder diffuser (Quadratic-residue diffusers). Its diffusion characteristics do not depend solely on its geometrical dimensions but also on an array of wells with depths determined by a listed quadratic residue sequence.

REVERBERATION TIME (RT)

Reverberation time is the time required for the sound level in the room to decay 60dB, or in other words, it is the time needed for a loud sound to be inaudible after turning off the sound source.

The calculation of reverberation time using the Sabin equation assumes that the sound in the room be diffused. In practice, RT equations are close enough to describe the sound build up and attenuation in the room. In the case where the sound in the room is not diffused enough, like rooms with good absorption surfaces in certain areas, or with an unusual shape (long and narrow, very low ceiling, or many different focusing surfaces), the RT calculation is not accurate. There is a Fitzroy equation to correct the RT calculation for rooms with good absorptive surfaces on a certain axis of the room. The optimum reverberation times for different rooms depends on the volume of the space, the type of the room, and the frequency of the sound. In general terms, the optimum RT for rooms with speech programs is less then the optimum RT for rooms with music performance.

HOUSE DESIGNING

Help you discover how much fun and useful math is. The Acoustics House includes sample problems and solutions typical of those professional designers and builders encounter in their work. Whether you are planning a real or fantasy building project, or using the Acoustics House as an educational tool, this curriculum can help students learn about design and math.

Designing and building a model teaches important math concept and sharpens practical skill from basic arithmetic, measurement and scale to geometry, trigonometry and spatial relations. The predominant skills developed and nurtured while working with complex problem solving and precision are the same skills which are crucial to success at all levels of mathematics and on the job.

To design a house, you have to constantly analyze many things at the same time, establish priorities, and try various approaches to each problem, strategies also important to math and work. For example, if a wall is moved, it generally has multiple consequences. Moving one wall not only changes the area and proportion of the room you are working on, but it changes the space on the other side of the wall as well. In a chain of events, you start by moving one wall, then have to move other walls in other rooms to keep their proper size and shape. Next, the windows and doors have to be moved to compensate for the wall changes, which affect the elevations and possibly the layout of the other floors and roof. These complex, interdependent relationships are what makes house design so challenging and interesting.

DESIGNER AND BUILDER PROBLEMS (Appendix)

Cut and assemble the house on graph paper. Design your own arrangement of windows and doors. These can be cut out of the walls or you can arrange the window and door by cut them out of graph paper. Sketch a floor plan and then organize the furniture, stairs, fireplace and other features to plan your own interior design.

Design a geometric floor pattern for one room. Use the Appendix as a guide to make a list of materials needed for your design. Calculate the area of the walls and ceiling in each room. If one gallon of paint cover 400 square feet, how much paint is needed to cover the walls and ceilings in each room and the entire house? Now, determine how many 4-ft. by 8-ft. sheets of wood paneling are needed to cover the walls. You can sketch the panels on graph to determine the most economical layout for the panels. Calculate the ratio of the window area to floor area habitable room including bedrooms, living room and den. For new single-family home construction, it is recommended that the window area be at least 8% of the floor area. This is necessary for adequate natural light. Determine the volume of each room. To do this multiply the length times the width time, the height of each room. The volume is needed to determine the size of the heating and air conditioning systems.

Calculate the volume of concrete needed for a 4-inch thick floor slab for one room or your entire house. After determining how many cubic feet of concrete are needed, convert your answer into cubic yards, which is how builders order concrete.

Measure and draw the angle of the roof on your home. Designers and builders refer to the slope of a roof by its vertical rise in inches for each horizontal foot. For example, a roof which rises 6-inches for each horizontal foot has a 6/12 pitch. To draw a roof with a 6/12 pitch, use graph paper, make a right triangle with a horizontal length of 12 grid boxes and a height of 6 grid boxes; then use a straightedge to draw the roof slope by connecting the ends of the lines.

Allow students to solve solve math problems in their own way. Encourage students to use graphics to solve math problems. Make students aware that there is no right way to solve a problem. Don't give answers, instead ask questions that make students think. Encourage teamwork.

NOISE CONTROL

NOISE PATHS

Noise paths in a building, air path through opening, air-borne noise, solid-borne noise.

NOISE LEVEL

The human hearing system has different sensitivities at different frequencies. This means that the perception of noise is not equal at all frequencies. Noise with significant measure levels at high or low frequencies will not be as annoying as it would be when its energy is basically in the middle frequencies. In other words, the measured noise levels will not reflect the actual human reception about the loudness of the noise.

COMMUNITY NOISE

Community noises constantly change in their levels and duration. It can reach 50 dB changes in short time.

ROOM NOISE

Noises in buildings are more stable (over time) than outside community noise. The maximum acceptable background noise level generated by mechanical systems in a building is usually specified in terms of averages A-weighted sound levels, NC, RC, or NCB. The noise criteria (NC) values are determined from the measurements of the octave-band sound levels in an occupied room when the air-conditioning system is on. Then we compare the measured value to standard NC curves. The room criterion (RC) is mostly used for acoustical design of HVAC systems. The measurement values should be taken in an unoccupied room (you can have students calculate echoes Appendix 3).

AFRICAN HISTORY AND OVERVIEW

AFRICAN MUSIC IN SOCIAL CONTEXT

Authentic African music, the traditional music of the black peoples of Africa, is little known abroad. The non-African listener can find the music strange, difficult, and unattractive; and therefore often concludes that it is not of interest. Both African and non-African music are human inventions and individual notes contain the same elements such as pitch, duration, tone color and intensity. Music plays a similar role in most societies, as work songs, lullabies, battle songs, religious music, and so on. Generally speaking the same categories of instruments are found in Africa as in Europe, namely stringed instruments, wind instruments, and percussion.

The African concept of music is totally different to the Western one though. Traditional African musicians do not seek to combine sounds in a manner pleasing to the era. Their aim is simply to express life in all of its aspects through the medium of sound. The African musician does not merely attempt to imitate nature by music, but reverses the procedure by taking natural sounds, including spoken language, and incorporate them into the music. To the uninitiated this may result in cacophony, but in fact each sound has a particular meaning. To be meaningful, African music must be studied within the context of African life.

Music has an important role in African society. Music is an integral part of the life of every African individual from birth. At a very early stage in life the African child takes an active role in music, making musical instruments by the age of three or four. Musical games played by African children prepare them to participate in all areas of audit activity including fishing, hunting, farming, grinding manize, attending weddings and funerals and dances.

An intimate union forms between man and art in Africa. It amounts to a total communion that is shared by the whole community. This may help explain why some languages in black Africa have no precise noun to define music. The art of music is so inherent in man that it is superfluous to have a particular name for it. The drum is so important in African society that it is sometimes equated with a man. Women must consequently treat it with the same respect that they would show towards their men folk. In some African countries women are not even allowed to touch a drum under any circumstance, though Islam and European colonial influence have softened some of these traditions. African music is nearly always coupled with some other art such as poetry or dance and id one of the most revealing forms of expression of the black soul.

It seems logical to conclude that everyone in black Africa must be a musician by definition. Nevertheless, it would be a mistake to assume that all African are necessarily musicians in the full sense of the word. In some African societies music is a dynamic and driving force that animates the life of the entire community. This communal music may be quite elaborate in form. In other societies musicians form a semi-professional group. They earn their livelihood from their music for only part of the year and rely on some other activity for the remainder of the time. In numerous African societies, the right to play certain instruments or to participate in traditional ceremonies is not open to all, but is the privilege of the professional musician. Such musicians live solely by their art and belong to particular families or castes. Griot is the term used throughout West Africa to designate professional musicians. The role of the griot extends far beyond the realm of music and magic. He or she is the relater of history, philosophy and mythology, the archive of the peoples' traditions. He or she dispenses a healing therapy for the medicine man. He or she is a praise-singer, a troubadour, the counterpart of the medieval European minstrel. People fear griots, admire them but often treat them with contempt because they belong to one of the lowest castes. The fact that music is at the heart of all of the griot's activities is yet further proof of the vital part he or she plays in African life. The equivalent of the griot in equatorial Africa is the player of the mevt (harp-zither). This person is, in some ways, more fortunate than the griot because the admiration that he enjoys is not tinged with scorn, maybe because he does not normally sing the praises of the rich and powerful like the griot does.

The African musician is feeling the effects of the revolution that is currently sweeping the entire continent. Music, as it is conceived in traditional society, is not a function which enables its exponents to meet the demands of modern life. Furthermore, the competition is enormous and under these conditions music as a profession offers very little opportunity. In some societies, music is not conceived as a profession at all, a fact which is even more limiting. As things exist today, traditional music is threatened with eventual extinction and will gradually disappear unless the musician's future is assured. This is especially true for African traditional music which is of course not written down, but handed down from generation to generation.

DRUM MAKING

Drums have played a role in every known culture. Their rhythm transcends race, language, age and gender, appealing to something innately human within us. Perhaps because each of us comes into the world having spent nine months listening to the beat of our mother's heart-drum. Today, thousands of people are rediscovering drumming as an exhilarating way to reduce stress, create a sense of community and center us within our hearts. Best of all it's easy and it's fun!

There are so many different ways to go about making drums. The body of the drum can be carved out of a solid piece of wood, pieced together from staves (long pieces of wood), or adapted from existing objects, such as barrels or tubes. There are other ways to create shells with other materials, such as clay and metals.

If you have never made a drum before, you might want to start out by "re-creating" a shell by modifying a found object. In Africa, nothing is wasted. People will pick-up wooden matches off the ground and use them in making some object. One type of object that may be available almost anywhere is cardboard tubing used in construction projects as a form for pouring concrete pillars. No, I'm not talking about something flimsy like the tube that comes inside a roll of toilet paper. These things are thick and solid. They come in different diameters, suitable for making small drums about the size of bongos to big barrel sized pieces suitable for making djun-djuns (the large two sided drums that accompany djembe drums and are played with a stick). If you want your students to making one of these type of drums, start out by trying to find some of these cardboard tubes.

TYPES OF DRUMS

Students will make drums from different parts of the world. The Ashiko is a long, conical hand drum of staved construction, similar to the N'goma drums of Nigeria. Drums styled like Ashikos are found in Cuba, Haiti, Brazil and throughout the Americas. In Cuba they are called El Boku' and are used for playing comparasas at carnivals and festivals. The diameter at the top is different than the diameter at the bottom. The top has goatskin stretch over it.

The Djun-Djun is a cylindrical double headed bass drum. Found throughout South America and West Africa, these powerful drums are worn over the shoulder and player d with two sticks, one for the thunderous bass and the other for a bell tied to the side of the drum. Often the player also has a whistle with which to blow calls and breaks to dancers. The top and bottom has goatskin or calfskin heads stretch over it.

The Tinya one of the most widely-used Andean percussion instruments. The tinya is a small drum with two skins made from the leather of different animals. The musician dangles the tinya from his left hand and plays the drum with a drumstick. It is used in traditional peasant music, particularly in dances and ritual ceremonies (cattle branding, harvest time, etc.).

Students will look at other drums and see how they are put together. Drums will be made of plastic pipes, tan cans, cheese containers, bent wood strips, wood strips (Appendix 7).

DRUM HEAD ATTACHMENT

For drum heads raw hide from cows and goats have been used. The goat hide is good for lots of drums. Typically the cow raw hide is too thick and heave, but sometimes they have thinner stuff. For our drums we will use cellophane, clear sealing tape and a shrinks film to make the drum head (Appendix 6).

MATH FOR THE DRUM

Mathematically modeling the flow of sound in an enclosed dimensional space requires some advanced techniques in the field of "partial differential equations", and many of the solutions require numerical approximation techniques to actually come up with numerical answers, since many of the functions involved can not be expressed in terms of familiar, everyday functions like addition, multiplication, exponential, trigonometric functions, ect.

The 1-dimensional situation (e.g., a guitar string, or a thin pipe) is quite easy to analyze. Think about a wave of sound stretched out along the string or pipe, starting with zero amplitude at the end, and rising and falling as you move along the pipe. The amplitude has to be back at zero at the other end (for instance, in a vibrating string, the ends are tied down and not free to move).

Over the course of one cycle (one wavelength), the displacement of the string (or the compression of air in a pipe) starts at zero, rises to a positive value, drops back down through zero to a negative value, then rises again. So the only places at which it is zero are at the start and end of cycles, and half-way through. In other words, the reason of the spatial pattern in the tube has to do with the reflection of the wave from the end of the tube at specific frequencies.

In order for sound to resonate in the string or pipe (open at both ends), the displacement of the string must be zero at the finishing end as well as the starting end and the pressure must be almost zero at both ends of the pipe, so the length L of the pipe must be an integral multiple of lð/2. Thus, the only wavelengths that will resonate are when lð ð= 2L, lð ð= 2L/2, lð ð= 2L/3, etc. Frequency f is related to the wavelength by f ð=ð ðc/lð ðwhere c is the speed of sound. Therefore, the resonant frequencies are c/(2L), (2c/2L), 3c/2L), and so on; in other words, the fundamental frequency of the string or pipe Is c/(2L); the other are higher octaves. The speed c of sound in a pipe depends on the air density, humidity, temperature, altitude, ect. In a string it depends on the string material and, most importantly, on the string's tension; that's why changing the changing the tension changes the frequency of sound produced.

However, none of this simple analysis applies to drum, where you are dealing with sound waves in three dimensions. Probably the best thing to do is to hunt down a book on the construction of drums; it would likely contain the measurements for an optimal sound. However, you should realize that those measurements (while as accurate in practice as any computer's computation) were likely obtained by good old fashioned trial and error! In truth, these sorts of measurements are always better than those a computer gives you because there are always many overlooked discrepancies between the mathematical model of the drum and the actual drum (every piece of wood is different, as is every piece of goatskin).

While the modelling process is fascinating in its own right, trial and error (or even better someone else's trial and error) may well be the best route in this particular case.

APPENDIX 1

Teaching Objective

Students will gain understanding of how drums produce sound by building and playing a simple drum.

Resources

*Large empty can
*Piece of heavy plastic trash bag
*Ruler
*Marker or chalk
*Scissors
*Larger rubber band
*Spoon or pencil
Teaching Sequence
*Provide each student with a copy of Instruments.
*Have students read the materials.
*Discuss with students how a drum is constructed and how it produces sounds.

*Have students measure the diameter of their can, then mark a circle two inches larger in diameter on their piece of plastic with the marker or chalk.
*Students then should cut out the circle of plastic and stretch it tightly on the top of the can, securing it with the rubber band.
*Ask students to play their drums using the spoon, pencil or their hands to strike the top of the drum.

EVALUATION

Do students demonstrate an understanding of how drums produce sound?

APPENDIX 2

Room Acoustics Enhancement

By placing a combination of absorptive and diffusive panels at key points in the room, sonic control and imaging can be greatly enhanced. This activity introduces your class to decimals, ratio, proportion, percent and fractions without the boring theoretical math by designing your acoustic house. Penetrate their minds by applying the methods to real life situations as you teach instead of after you teach basics. Learn about Areas and Perimeter while designing your own dream acoustic home. Students must use their logical thinking skills to analyze sizes of common household rooms with acoustics enhancements.

Lesson 1 - Measurement and Proportion

Students will discover scale and how to find the actual size of an item through the use of scale. By designing sound absorption plank, cube, angle, and tube. What is a scale? How is used on a map? Look at a map. What is the scale? What does this mean? You will want to look at several maps.

Lesson 2 - How do you Find Area (Materials Graph paper and Best Home Plans)

Students will be able to discover the formulas for area of rectangles, parallelograms, triangles and trapezoids.

Lesson 3 - Finding the Area and Volume of each rooms in a House (BHP)

Calculate the volume of concrete needed for an entire house. Calculate the Reverberation Time (RT) for each room in a house (See Appendix 3)

Lesson 4 - Designing your Home (See Appendix 5)

Students will design their home.
Best Home Plans Graph paper
Students can share their home designs with the class. What makes theirs special?

APPENDIX 3

Equation

Area of Each wall = Length * Height

Area of Ceiling = Length * Width

Area of Floor = Length * Width

Area of Window = Height of Window * Width of Window

Area of Trapezoid = Height * (b1ð+b2) _ð 2

Area of Triangle = Base * Height * .5

Number of gal. of Paint = Total Area to be Painted _ð 400 Sq. Ft./Gal.

Ratio of Window to floor area = Window Area _ð Floor Area

Volume = Length * Width * Height

Volume = Length * Width * Depth

Cubic Yds. = Cubic Ft. * 1 Cubic Yd. _ð 27 Cubic Ft.

Echoes time for round trip is T= D/C , D is distance between boards and C is sound velocity (1100 ft/s)

Frequency = C/D = 1000/D

Reverberation Time (RT) The reverberation time in a room at a given frequency is the time required for the mean-square sound pressure in that room to decay from a steady state value by 60dB after the sound suddenly ceases. This is one of the most vital, though not the only, measures of a rooms acoustic properties and can be a guide to the suitability of a room for a given purpose.

Where RT = Reverberation Time (s), V = room volume (feet^3), S = total surface area of room (feet^2), µð = the average absorption coefficient (dimensionless)

RT = 0.05 * V _ð (µð * S), (see Deaf Architects & Blind Acousticians?)

FLOOR PLAN WORKSHEET APPENDIX 4

(figure available in print form)

APPENDIX 5

DIRECTIONS FOR BUILDING YOUR HOUSE

Draw the elevations of the building you want to build in scale on the graph paper. Don't forget each square = 1'. Include all walls and the roof. Be sure your drawings are accurate. Indicate outside measurements only. It is not necessary to indicate windows and doors right now. Cut out the elevations from the graph paper with scissors. Place elevations against either side of the building board (cardboard). Check all corners for proper and neat angles. Be sure of all your measurements. Using an X-acute cutting knife, or single side razor blade, cut out all elevations from your building board. Make cuts as straight and clean as possible. You will find it easier if you do your cutting on hard surface. Glue together, with a quick drying cement, the walls only, of your scale model. If your model has more more than one floor level, construct each level by itself and then glue to remainder of building. Do not glue the roof on! Again, using the cut out graph paper elevations, mark the exterior finishes that you want to use for your walls and roof on construction paper. Use a very light pencil line. Add 1/8" to the ends of the exterior finishes. This additional allowance will make your final finishing neater. Cut out the exterior pieces using scissors. Glue on your exterior finishes on the walls and roof using quick drying cement. Be sure, if you are using the same finish for two joining walls that you match the exterior finish before gluing. The extra 1/8" that you have left on the ends of your finishes will now let you trim and glue down the ends neatly. Cut out, the windows and doors you will need from the construction paper. Glue the windows and doors into position. Place the roof on the house. It is not necessary to glue the roof down. With a removable roof, you will be able to place room sizes. Now, you can go ahead and add driveway, sidewalks, patio, fences, ect. Landscape and finish the house to suit your fancy.

APPENDIX 6

DRUM HEAD APPLICATION INSTRUCTIONS:

1. Make sure surface is clean, dry and free from grease, dust, dirt and moisture.

2. Apply double-faced tape to outside edge of the drum head. Peel off paper liner to expose adhesive.

3. Measure drum head for outside edge. Cut shrink film, leaving at least 2 inch extra for the sides of the drum.

4. Start at top of drum and press film to tape. Pull film taut and attach to tape to side. You can remove film and reposition, if necessary.

5. Secure film to tape by running finger over taped surface.

6. Shrink the film with hand-held hair dryer set at highest heat setting. Do not touch film with dryer.

7. Cut off excess film with scissors, knife or protected razor blade.

APPENDIX 7

DRUM MAKING

There are so many different ways to build drums. The shell (body) of the drum can be pieced together from staves (long pieces of wood), or adapted from existing objects, such as barrels or tubes. One type of object that may be available almost anywhere is cardboard tubing used in construction projects as a form for pouring concrete pillars. They come in different diameters, suitable for making small drums about the size of Taiko to big barrel sized pieces suitable for djun-djun, ashiko and taiko.

The African-Peruvian drum is made out of wood. The dimensions are not critical. The drum is a box which the top, bottom and two sides made of 1/2 or 3/4 inch wood. Cut glue and nail the wood parts together. Use shrink film or clear sealing tape for drum head.

APPENDIX 8

MATERIALS LIST AND COST ESTIMATE CHART
(list available in print form)

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