Inverse square law physics worksheet

CONTENT WAVES PRE-TEST: Answer T (True) or F (False) on each of the following: 1. Current technologies associated with information transfer use waves of one kind or another. 2. Light and sound are both examples of types of waves. 3. A light wave can travel through a vacuum, but a sound wave cannot. 4. The wavelength of a wave is defined as the distance between two consecutive identical points on the wave, for example, between two peaks. 5. Sound waves travel faster through the water than through the air. 6. Light travels about 300 000 km in one second through the air. 7. An echo is just a reflected sound wave. 8. Thick wool curtains are better silencers than a concrete wall. 9. When two waves travel through the same material at the same time, the total movement of the material at any time is the algebraic sum of the individual movements at that point. 10. Gamma rays and radio waves are both part of the electromagnetic spectrum. 11. Short wave radio waves are able to travel over the observable horizon because they are reflected from the ionosphere. 12. Microwaves are used to communicate with satellites partly due to their ability to pass through the ionosphere. 13. Infrared radiation can be used to guide missiles and connect computers in networks. 14. Light waves can information enormous distances through optical fibers with little or no loss. 15. Lasers are very useful tools in the communications industry. 16. An advantage of an FM signal over an AM signal is that it is not sensitive to electrical interference. 17. Doppler radar can determine the speed of an approaching target. 18. Digital Versatile Discs (DVDs) store data in digital form. 19. Light that comes into our eyes from the environment is usually partially polarized. 20. Many communication technologies use applications of the reflection and refraction of electromagnetic waves. Back to worksheet content No.1. A wave traveling on a string has a wavelength of 0.10 m and a frequency of 7 Hz. Calculate the speed of the wave. 2. A sound wave travelling in the water at 1440 ms-1 has a wavelength of 0.5 m. Determine the frequency of the wave. 3. An electromagnetic wave moving through free space at 3 x 108 m/s has a frequency of 4.62 x 1014 Hz. Look for the wavelength of this wave and express it in nanometers. 4. A water wave moves over the surface of a lake in an easterly direction. The wave has a wavelength of 2 m and a frequency of 2.5 cycles/s. Draw a diagram of this situation, looking down from above the lake, with 5 wave fronts. Label the wavelength and show the direction of reproduction using a beam. 5. A sound wave moves through the air. The wave has a wavelength of 0.65 m and a frequency of 512 Hz. Draw a diagram of this situation, with 5 moving north. Label the wavelength and show the direction of reproduction using a beam. 6. A light wave moving east through the air at 3 x 108 m/s has a frequency of 5.55 x 1014 Hz. Hz. with 4 wave fronts, wavelength and reproductive direction. 7. The following two graphs represent data from the same wave travelling westwards via a particular medium. From the graphs: (a) the wavelength; (b) amplitude; (c) the period; (d) the frequency and (e) the speed of the wave. 8. Give an example of each of the following: (a) a one-dimensional cross wave; (b) a two-dimensional cross wave and (c) a three-dimensional longitudinal wave. Back to content WORKSHEET no.2: 1 Calculate the absolute refractive index for a clear plastic material, if the speed of light in the plastic is 2.5 x 108 ms-1. (1.2) 2 A beam of light in the air is an incident at an angle of 40,8 o on the surface of the same plastic material used in Q.1. Determine the angle of refraction in the plastic. (33o) 3 A beam of light goes from kerosene to glass. The angle of light is 45.2 o and the relative refractive index from kerosene to glass is 1.08. Calculate the angle of refraction in the glass. (41o) 4 Using relevant information from Q.3, you calculate the absolute refractive index for kerosene if the absolute index of glass refraction is 1.5. (1.39) 5 A beam of light passes from air to a glass prism at an angle of 35o. If the angle of refraction in the glass is 23.7o, what is the speed of light in the glass? (2.1 x 108 ms-1) 6 The absolute refractive index of water is 4/3 and glass 3/2. Find the relative refractive index for light traveling from water to glass. (9/8) 7 The critical angle for diamonds is 24o. Determine the refractive index of diamonds. (2.46) 8 Molten silica has a refractive index of 1.46. Calculate the critical angle. (43.2o) Find the following paths of light beams internally on the surface of molten silica at angles of: (a) 35o (b) 65o 9 Describe an application of the total internal reflection used in the communications industry. 10 For yellow light, the glass refractive index is 1.6 and the water refractive index is 1.2. Which of the following statements is correct? a) The wavelength of yellow light in glass is longer than the wavelength of yellow light in water. (b) For the same angle, yellow light is broken more by water than by glass. (c) Total internal reflection cannot occur when yellow light passes from water to glass. d) Light travels faster in glass than in water. Back to content OSCILLOSCOPE PRACTICAL WORKSHEET 1 Students write a report to present the results of each of the sections below. 2 Briefly explain how an oscilloscope works and what it is used for. Add the meaning of the y and x axes (wave amplitude & period respectively). 3 Make sure that the oscilloscope timescale is set to normal instead of 5X magnification. These buttons are found in the timescale control area of the oscilloscope. 4 Attach the oscilloscope probe to a microphone and demonstrate each of the following. Please note that the oscilloscope oscilloscope only and will of course depend on the type of microphone used.¨A wave of single frequency (use a tuning fork) produces a sine wave on the oscilloscope. Initial oscilloscope settings – Time = 0.5 to 2.0 ms/div & Volt = 50 mV/div and adjust from there.¨The whistling of a single frequency produces a sine wave trace.¨Singing a song, talking and clicking ones fingers together produce more complex waveforms.¨The louder the sound, the higher the amplitude (vertical axis) of the waveform.¨The higher the pitch of the sound, the closer together the waves seem to catch along the x axis. That is, the higher the pitch, the lower the period and the higher the frequency of the waveform.¨Measure the period of the signal from a 320 Hz tuning fork and calculate the frequency. You should be able to get pretty close to 320Hz. Running time = 1 or 2 ms/div (with variable sensitivity set to maximum) and volts = 10 mV/div.¨Show the production of beats using two identical tuning forks, with a small amount of blue tack added to a point of one of the forks to produce a slightly lower frequency. Show what the waveform looks like by using the microphone to receive the signal. 5 Attach the probe to the low output terminals of an audio frequency signal generator. Select sine wave & microphone on. Show what a signal generator does. Measure the frequency of a given signal using the oscilloscope. (for example, set the signal generator to 400 Hz & measure the period of the wave produced. From this calculation of frequency. Running time = 1 ms/div.) Also show once again that if you increase the frequency of the input signal, the horizontal distance between combs on the screen decreases – that is, the wave's period decreases. 6 Attach the wave generator to input A of the oscilloscope and the AC terminals of a powerpack set to 2 or 4 volts to B. Display both signals simultaneously on the oscilloscope using the A&B display buttons. Adjust the signal from the signal generator until the frequency is almost identical to the powerpack signal. Then display the two waveforms that are added together with the A+B button. Note the oscilloscope track vary with time in the usual beat mode. (Settings: 2V AC power pack signal – Volts = 2 V/div & time = 5 ms/div; 50-60 Hz approx wave generator signal – Volts = 50 mV/div & time = 5 ms/div.) 7 OPTIONAL: Attach an oscilloscope probe to the exposed wires of an earphone jack that receives an AM signal from a radio – preferably receiving speech instead of music. Ask a student to check whether the wave pattern on the oscilloscope appears to match the earphones' tuning pattern. Point out the carrier wave and amplitude modulated signal on the To. This prac should last 1 to 1.5 periods, but focuses on different sections of the syllabus: 8.2.1 Column 3 point 3 and 8.2.2 Column 3 dots 1 & 2. Back to Content The following is a sample Practical Report write-up. The Prac itself is NO NO required by the syllabus, but can still be used to provide students with an example of how to write physics practical reports. After performing the practice, the students receive the Aim, Method & Results sections as shown below & they are asked to write the Discussion & Conclusion. Alternatively, if time is short, the Prac doesn't even need to be done. The Teacher can simply hand out the Aim, Method & Results sections, discuss the results with the students & show how a discussion & conclusion can be written. GOOD PRACTICAL DATE DONE: 15/3/02 AIM: Investigate the extent to which different materials reflect and absorb sound. METHOD: 1. Data on the reflection and absorption properties of different materials were examined to allow the selection of suitable materials for this study. The data used came from Harding, J. et al. (1996). Physics Concepts & Applications VCE Units 3 & 4 Melbourne: Macmillan Education Australia Pty Ltd 2. Using the experimental arrangement in diagram No.1, a sound intensity meter was used to measure the intensity of the sound of constant frequency, produced by an audio frequency generator, after the sound had travelled the length of cardboard tube A. The end of Tube A in contact with the audio generator was placed in such a way that the speaker exhaust at the back of the generator was completely covered. 3. The sound intensity was then measured at the end of tube B, after the sound was reflected by flat surfaces consisting of different materials. The plane surfaces were positioned in such a way that the opening at the intersection of tube A was covered with tube B, as shown in the diagram. 4. The results were atteated and qualitatively analysed to determine the extent to which different materials reflect sound. 5. On the basis of the experimental arrangement in diagram No 6. Styrofoam cups with various absorbent materials were then placed in turn to completely cover the loudspeaker exhaust. For each material, the sound intensity was measured at the set distance of the generator. 7. The results were atteated and qualitatively analysed to determine the extent to which different materials absorb sound. RESULTS: Reflection of sound from different materials: Sound intensity at the end of tube A (i.e. for reflection), I1 = 110 dB Background sound intensity with audio generator from was much lower than 110 dB and was neglected in this experiment. Table Number 1: Sound Intensity Values – Reflection Type of Material Reflected Sound Intensity, I2 (dB) Difference I1 – I2 (dB) Foam rubber 104 6 Low pile Carpet 105 5 Felt 104 6 Human skin/flesh 105 5 Leather 107 3 Styrofoam 107 3 Thick pile of paper 108 2 Thick cardboard 108 2 Hard 109 1 Wood 110 0 Glass 110 0 * Note: Sound intensity at the end of tube B when no material was placed over the opening at junction of tubes A and B = 104 104 (It's worth considering why you have a sound intensity at all in Tube B as there seems to be nothing to reflect sound in the tube. Think of boundaries. The air limited in Tube A is from slightly different density to that outside tube A. So there is a border on the open side of tube A and reflection, transmission and absorption all occur on this border.) Absorption of sound by different materials: Sound intensity at set distance of audio generator when no absorbent material related to speaker exhaust, I1 = 88 dB Background sound intensity with audio generator from was much lower than 88 dB and was neglected in this experiment. Table No 1/2005 I2 (dB) Difference I1 – I2 (dB) Foam Rubber 68 20 Paper towels (crumpled in balls) 70 18 Styrofoam* 75 13 Bubble Plastic (as used in the packaging) 75 13 Wood chips (fine)* 70 18 *Note: To prevent spills, several tissues were used to pack the end of cups containing these materials. DISCUSSION: To help you write your discussion, consider the following questions:¨What do the data in Table No.1 suggest about the sound reflection properties of the materials used? What is the best reflector? What's the worst reflector? Is this what you expected? If not, why not?¨Were there any anomalies in the data? If so, how do you count these?¨How do you explain the result stated in the Note at the bottom of table No.1?¨What were some possible sources of errors in this experiment?¨What suggestions do you make to improve the precision and accuracy of this experiment?¨ Discuss the data in table no. CONCLUSION: If you have written a short discussion section, complete this report by writing an appropriate conclusion, below that heading. Back to Contents Inverse Square Law for Light Experiment Instructions: While you wait to do your prac, start preparing your report. Goal: To demonstrate that the relationship between the intensity of light and the distance from the light source is an inverse square relationship. Method: Use a high wattage light bulb bulb as a light source. Measure the light intensity at the set distances of the source using a digital data logger connected to a light intensity sensor or an analog light intensity meter. Use a tape measure to mark the distances. Draw a diagram of the set-up - so leave room for this. Mention that you are analyzing the results by drawing a graph of light intensity versus (1/distance squared). Remember - past tense and no personal pronouns. Results: Create the table as shown below. You complete the second column. Table 1: Light Intensity vs. Distance Distance (m) 1/distance squared (m-2) Light intensity (lux) 1.0 1.5 2.0 2.5 3.0 3.5 4.0 Use chart paper AND sign the graph manualLY NOT in a spreadsheet on a computer. make sure you scaled as large as possible. You try to fill as much of the chart paper as possible. All charts have a title at the top and have both axes labeled with the name of the quantity beinggraphed and the unit of that quantity. All data points must be visible after you draw your chart, so mark them clearly, usually with a small cross. Remember that you are plotting light intensity versus (1/distance squared) NOT light intensity versus distance. Think carefully before mapping your points. Also remember that you are looking for a straight line chart – but the best thing you hope for in most experiments is a straight line of the best fit. If you have a straight line of the best fit when you plot your chart, clearly indicate in your results section what that means – that the two variables plotted are proportional to each other. Therefore, the light intensity is proportional to the reverse square of the distance to the source. Discussion: Discuss the meaning of your results. Did you get what you expected? If so, it says what that was. If not, try to explain the results you have obtained. In both cases, you should comment on the main sources of errors in this experiment & how to improve the experiment. Note - Avoid using terms like human error when discussing errors in experiments. Be specific. If you mean that it was difficult to keep the light sensor stable when recording values of light intensity, say that and explain how that might have negatively affected the results. Questions to help you write your discussion: 1. Identify the independent and dependent variables in this study. ______________________________ 2. Specify what physical factors you've tried to stay constant and explain why you've tried to do so. ______________________________ ______________________________ ______________________________ 3. Identify the physical factors that are likely to have negatively affected the accuracy of your results, and explain how each factor affected accuracy. ______________________________ ______________________________ ______________________________ ______________________________ 4. Describe how you would improve the reliability of your results. ______________________________ ______________________________ ______________________________ 5. Comment on the validity of your investigation. ______________________________ ______________________________ 6. Identify the relationship independent and dependent variables in this research and provide evidence to support your opinion.

Return to Contents LIGHT PRACTICAL AIM: Het bestuderen van de reflectie en breking van een elektromagnetische golf (licht), met behulp van de standaard school laboratorium Optics Kit. METHOD: 1 Using the light source and slit plate, observe the path of light rays and build both a beam chart and a wave front diagram to indicate the direction of travel of the light. 2 Present information using beam diagrams to show the path of waves reflected from:¨A flat surface¨A concave surface¨A convex surface In each diagram, the angle of view (i), the angle of reflection (r) and the normal surface are clearly labeled. 3 The data collected in Part 2 in tabular and comment on any similarity between the size of the angles and reflection. 4 Present information using beam charts to show the path of light as it moves from air into a glass or perspex prism for five different angles ranging from 15o to 60o. Clearly notice the angle of view (i), the refractive angle (r) and the normal on the surface. 5 Type the data collected in part 4 into table, with separate columns for i, r, sin i, sin r and sin i/sin r. 6 Plot charts (on graph paper) of:¨Angle (vertical axis) v's angle of refraction (horizontal axis)¨Sin i (vertical axis) v's sin r (horizontal axis) 7 For a certain pair of media, it can be shown that the ratio in i/sin r is called a constant called the relative refractive index of the material for light going from medium 1 to medium 1 in medium 2. For light going from air to glass (or perspex), the theoretical value of the relative refractive index is 1.5. Calculate from the sin i v chart of your sin i v an experimental value for this relative refractive index. Compare the result with the theoretical value and suggest an explanation for each difference. 8 Using the semicircular perspex prism, observe the total internal reflection of light. Draw a beam diagram to record this observation and clearly label the critical angle (ic). 9 Since the theoretical value for IC is given by: where m1 = absolute of medium 1 (1.5 for glass & perspex), calculate the theoretical value for the critical angle of glass or perspex and compare it with the experimentally obtained value. Back to content REFRACTIVE INDEX PRACTICAL PURPOSE: Determine the refractive index of a material. METHOD: 1. Using a standard school laboratory Optics Kit, set up a ray box with a single crack aperture. Connect it to a DC power supply set to 12V. 2. Place a rectangular perspex prism in the middle of a white sheet of A4 paper so that the long edge is parallel to long edge of the paper. 3. Carefully trace around the prism to mark its position on the paper. 4. Remove the prism and at a point somewhere near the center of the left side of the prism pull the normal on the side of the prism (using a protractor or set square). 5. Draw three straight lines (representing beams of light) from the point chosen in 4, which touch the side of the prism at angles of 30o, 45o and 60o. Clearly label the angles. These lines will be used to direct light rays to hit the prism below those angles. 6. Shine a single beam of light to hit the prism at an angle of 30o and clearly trace on the paper the path of the broken beam originated on the other side of the prism. Repeat for the other two corners. 7. Measure and label the hook angles for each of the angles. Tabulate these results in the table in the Results section. 8. Enter all entries in the table and the other details required in the Results section. RESULTS: Angle (o) Angle of Refraction (o) Sin i Sin r Refractive Index 30 45 60 Average = 1. Show how you calculated the refractive index of the prism from the 30o angle. 2. Determine an average value for the refractive index of the prism by calculating an average of all three refractive index measurements in the table. 3. Propose two methods to improve the reliability of this experiment. CONCLUSION: Now write a simple conclusion for this practical. Return to Contents RESEARCH ASSIGNMENT Choose an application of physics related to waves from the following list:¨The Global Positioning System¨CD Technology¨The Internet (digital process)¨DVD technology For this application: · Identify (name) at least three different sources of information about this application. Give all the details of each source. · Collect, process, and present information from secondary data sources to identify areas of current research into this application of physics. · Use the information available to discuss some of the underlying physical principles used in the application you've chosen. This declaration document will be presented on Tuesday 30/4/02 for marking at the beginning of the Physics Period. Word limit: Up to 500 words. WARNING: Plagiarism does not. Communicate the ideas in your own words. DATE ISSUED: Back to content