TOXIC TONES IN TOYS

This report was a science fair project done by a grade 8 student in Vancouver BC. We thought it might be a study with interesting (although expected) results. Here is the report info.

PURPOSE

The purpose of this experiment is to test whether the sound levels of young kids' toys can reach levels that would potentially damage their hearing, and if so, whether we can do something about it.

HYPOTHESIS

1. I believe that there are toys out there in homes and on store shelves that reach noise levels that could be high enough to be dangerous to human hearing.

2. As well, I believe that a simple, inexpensive home remedy, such as covering the speakers with duct tape, could lower the decibel level to safer levels.

THE EXPERIMENT

The experiment was conducted according to Health Canada's Consumer Product Safety Laboratory document entitled "Test Method to Determine the Noise Level of Toys" which is used by government regulators to test toys to see that they meet legislated safety requirements. In addition, the procedures in the instruction manual for the Radio Shack sound level meter were followed.

The noise levels of 33 toys were measured. Some were supplied by toy stores, some by friends and relatives. Most of the toys chosen were deliberately designed to produce noise. A few of those tested produced noise incidentally, rather than as a feature, such as remote-controlled toys that make a lot of sound by their movement. Such toys can generate significant noise levels, and they were included for this reason. The toys were intended for a variety of ages, according to the manufacturers' recommendations. Two toys were labelled for 6 months and up; 4 toys for 12 months and up;10 toys for 3 years and up; and 17 toys for 5 years and up.

Variables:

Since ideal test conditions use a soundproof lab, it was necessary to test the environmental noise to make sure it was below 40 dBA before testing each of the toys. In addition, sound testing is known to be reliable if there is greater than a 10 dB difference between the source being tested and the background noise level. All toys produced sound levels well above (more than 40dB louder) the background level.

The freshness of the battery in each toy will often make a difference to the sound volume. In the real world, children will be playing with toys that have batteries of varying freshness, and this experiment was designed to test a great enough number of toys to average this variable.

The variable of distance from the toy was controlled by pre-measuring and marking a stick at the 2.5 and 25 cm distances, and carefully positioning toy and sound meter for each sound level measurement.

Another variable to consider is reflected noise altering the measured noise level from the toys. The Radio Shack sound meter outlines the correct way of using the meter to minimize this interference, by having the observer positioned perpendicular to the the meter. See diagram below:

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The variable that was deliberately changed during the experiment was placing duct tape in front of the speaker of the toys, and comparing decibel levels with and without this patch. Because the majority of the toys were tested in the toy store, it was not possible to directly stick the tape onto the speaker, rather just place the tape patch tightly over the speaker so as not to damage the store's toys. For consistency, this same method was used with all the toys tested.

Preparation:

Make a chart to collect important data at the time of testing. This chart should include the name of the toy being tested, the mode in either fast or slow (see below), the distance from the toy, if it was tested with or without tape, the recommended age group for use, and if there were any warnings on the package regarding the noise level. Refer to data collection chart.
Gather as many noise-making toys as possible, from sources such as friends, family, and toy stores. 33 were collected.
Collect all necessary materials including the Radio Shack sound level meter cat. no. 33-2050 (with fresh batteries), duct tape, and a pre-marked measuring stick. The measuring stick should be marked at 2.5 cm (1 inch), and 25 cm (10 inches). Mark with tape or non-smudge felt pen.
Lay 17 cm long strips of duct tape side by side onto a single layer (one ply) of tissue (kleenex), forming a single layer 17 x 21 cm that will not stick to the toys.

Procedure:

1. Use a hand held Radio Shack sound level meter (which is self calibrating) set to A-weighted sound and fast response, as per the testing done for the Canada Health and Safety Board. Turn on the sound level meter. (Testing was also done in slow response, but for consistency, the data analysis and report were done in fast response following the Canadian Health and Safety Board guidelines).

2.Collect all the toys to be tested.

3. Measurements should be carried out in a quiet area where the background sound levels are below 40 dB. Before measuring each toy, test the background noise with the sound level meter. To do this, turn the meter on, set as noted in step 1, place it on the floor where the testing is to take place, and take two 30 second readings. Record the peak decibel reading, and make sure it is consistantly below 40 decibels before starting to test the toys.

4. Prepare to measure each toy one at a time, at two distances: 2.5 cm, simulating close to the ear use, and 25 cm, simulating an average arm's length of a child 3-15 years old. Place the premarked ruler on the ground with the toy's speaker at 0 cm and facing directly towards the meter. Place the sound level meter at the 2.5 cm mark, pointing directly at the toy's speaker. Make sure there is nothing blocking the path between the sound level meter and the toy. The test person should always sit perpendicular to the sound level meter to prevent interference, as recommended in the meter's manual.

5. Activate the toy and observe the decibel recordings for thirty seconds. Do this twice on the same toy and record the highest decibel reading on the data table.

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6. Now move the sound meter to the 25cm measurement on the ruler, pointing the meter at the toy's speaker that is still at 0 cm. Activate the toy and observe the decibel recordings for thirty seconds. Do this twice on the same toy and record the highest decibel reading on the data table.

7. Repeat all the same tests (step 3 -6) again, but with the duct tape patch (made earlier) placed tightly over the speakers of each toy before testing the decibel level at both distances again.

8. Change the sound level meter to slow response and repeat steps 3 - 7.

9. See if any of the toys tested have any warning labels regarding the volume of the toy and any noise danger. Also check the recommended age group. Note both of these on the data chart.

DISCUSSION

Results Without Duct Tape:

At 2.5cm from the microphone, the noise levels were found to be between 90dBA and 117dBA. 52% (17/33) exceeded the 100 dBA safety limit prescribed by Canadian law. According to the National Institute for Occupational Safety and Health (NIOSH), the toy that registered 117dBA would only be safely listened to for 20 seconds. 14 out of the 33 toys could only be safely listened to for 10 minutes or less. All were found to be above 85dBA at this distance.

When tested at 25cm, the "realistic distance" (according to the government) at which a child would hold the toy during normal play, the levels ranged from 80dBA to 98dBA. Although all were within the Canadian safety standards (i.e. under 100 dBA), 76% (25/33) were above 85dBA, which according to NIOSH (and accepted by the 157 member countries of the ISO as their recommended safety level), could be hazardous over longer periods of time. None of the toys were below 75 dBA (the WHO safety standard). According to the NIOSH guidelines discussed earlier, 4 of the toys should only be listened to for 30 minutes or less, and 10 toys for one hour or less, at this arm's length distance.

Results With Duct Tape:

Placing duct tape up against the speakers of all the toys at both distances lowered most of the toys' decibel levels.

At 2.5 cm, as shown above, without duct tape 52% were dangerous to hearing (above the 100 dBA Canadian legal limit), but with duct tape that number reduced to 13% of the toys. Looked at another way, the tape treatment lowered 12 of the 16 toys that had been above 100 dBA, to a level below 100 dBA, meaning that 75% of the more dangerous toys had been brought into a safer range. None of the toys at this distance were brought below 85 dBA. The tape did bring the toy that was at 117 dBA at 2.5 cm down to 106 dBA, allowing safe listening play time to increase from 20 seconds to 4 minutes. The average decrease was 5.3 dBA, ranging from 0 - 14 dBA.

At 25 cm, only 24% of the toys were within the NIOSH 85 dBA safe zone, while with duct tape, 50% could now be used without time restrictions (i.e. they were now below 85 dBA). The tape treatment lowered 8 of the 25 toys (32%) that had been above 85 dBA to a safer level below 85 dBA. The tape patch lowered the decibels by an average of 3.3 dBA, ranging from 0 - 10 dBA.

CONCLUSION

The first hypothesis was that there are toys available to young children that could be damaging their hearing. While the tests showed that all toys were "safely" below the Canadian government noise limits at 25cm (their assumed "normal play" at arm's length), it was shown that 51% exceeded this 100dBA threshold if held at 2.5cm (near the ear), which many children do during "normal play". As well, using the NIOSH guidelines of limiting exposure to noises above 85 dBA, it was found that 76% of the toys would have to be time-restricted even at the 25cm distance, and 100% of them would have to be carefully monitored for exposure time at 2.5cm. None of the toys were below the WHO recommended maximum of 75 dBA at any distance. By all these measures, it can be concluded that the first hypothesis was correct.

The second hypothesis was that one could lower these decibel levels by applying a simple home-made duct tape patch. The results have shown that at a 25cm distance, only 24% of the toys were within the NIOSH 85 dBA safe zone, while with duct tape, 50% could now be used without time restrictions. Similarly, at the 2.5cm distance at which many toddlers frequently hold their toys, 52% were dangerous to hearing (above the 100 dBA Canadian legal limit), but with duct tape that number was reduced to 13% of the toys. On average, the duct tape decreased decibel levels by 3.3 dBA at 25cm and 5.3 dBA at 2.5cm. Considering that each 3 dBA decrease allows a doubling of exposure time, these toys could be played with safely for much longer periods of time with the duct tape applied. Therefore, the second hypothesis was also correct.

Children are exposed to many sources of noise every day. Children's auditory systems are more fragile than those of adults. Since we know that cumulative noise leads to noise-induced hearing loss, the noise from toys should not add significantly to any risk which may already be present from other less easily avoided noise sources. Lowering the regulated decibel standards and applying warning labels to the toys can help in the future. In the meantime, the use of a simple method to decrease the decibel levels of the toys we have at home, and monitoring the length of time they are used could help save some of the hearing loss of children.