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## **Dr. Smith vs. The Lawyer**

**By:** Joseph L Ruby, Wiley, Rein & Fielding (law firm), 1776 K Street, N.W.,  
Washington DC 20006                      e-mail: jruby@wrf.com

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**A lawyer's use of some very simple science and math.** The facts are true, although simplified; the company names have been changed.

Acme Enameling Company operated a cast-iron foundry and enameling plant, where it made bathtubs and sinks for twenty-seven years. It dumped factory wastes on vacant property behind the plant. Zenith Construction Company then bought the property and used it as a construction waste landfill.

Years later, Zenith decided to develop the property as an office park. In preliminary testing, Zenith discovered that the property was contaminated with lead. The State will not allow any development until the lead is removed to permissible levels. Zenith sues Acme, claiming that Acme's factory wastes are the source of the lead, and demanding that Acme pay \$26 million to clean up the problem. Acme says that almost all its wastes were clean sand and foundry wastes, containing no lead. Acme retains an expert, Dr. Smith, who submits a report saying that the levels of lead contamination on the site could not have come from Acme. He says that the landfill must be the source of the lead contamination.

**As the lawyer for Zenith, I learned the following facts:**

- 1) Acme manufactured about 10 tons (20,000 lb.) of enamel every working day. All the raw materials used in the manufacture of the enamel wound up in the finished product.
- 2) The factory operated 5 days a week, 52 weeks a year, and was closed for holidays. Because there are about 10 holidays, we can assume that the factory ran 250 days per year.
- 3) The enamel formula contained about 4% lead oxide (PbO) by weight as a raw material. Although the lead's chemical form changed from lead oxide to lead silicate in the manufacturing process, all the lead wound up in the finished product.
- 4) The plant had an "enameling yield" of about 90%. This means that 10% of all pieces (tubs and sinks) were defective.
- 5) The defective pieces were shot-blasted to remove the enamel from the cast iron, so that the iron could be re-enamelled. The blasted-off enamel was a fine, powdery material. It was disposed of by being dumped onsite with the foundry sand and slag.

6) Lead, Pb, has an atomic weight of 207. Oxygen, O, has an atomic weight of 16. Lead oxide, PbO, has an atomic weight of 223. Lead oxide is  $207/223 = 92.8\%$  lead by weight.

**I now take the deposition of Dr. Smith.** I take him through the facts in through 1 - 6 above, which he agrees are true. **I then take him through the following calculations:**

- 1) Out of the 20,000 lb. of enamel made each day, 4% by weight started out as lead oxide, so 800 lb. was lead oxide.
- 2)  $800 \text{ lb.} \times 92.8\% = 742.4 \text{ lb.}$  per day of lead used in the manufacture of enamel.
- 3) Because 10% of the finished product was defective and had to be shot-blasted, 10% of all the enamel wound up as enameling waste from the shot-blasting process.
- 4)  $10\% \times 742.4 \text{ lb.} = 74.24 \text{ lb.}$  of lead (rounded to 74 lb.) in the enameling waste per day.
- 5) Therefore, Acme dumped 74 lb. of lead on the property per day. Because the plant was in operation 250 days per year, Acme dumped  $74 \times 250 = 18,500 \text{ lb.}$  of lead on the property per year. Because the plant was in operation for 27 years, Acme dumped  $18,500 \times 27 = 499,500 \text{ lb.}$  or about **half a million pounds of lead** on the property during its years of operating the plant!

**At the end of this line of questioning, Dr. Smith admitted that Acme's wastes caused at least some of the lead contamination at the site. Thus he was forced to repudiate the conclusion in his report.**

**Author's note:** The important math concept is that multiplication of even small quantities can yield large quantities. The important science concepts are: (1) repetition of seemingly trivial events over a long enough time can have real-world consequences, and (2) often, information that is easily obtained allows you to calculate results that you might have thought were unknowable.

Very simple math and science can reveal important truths, even to non-scientists, that mere words will never uncover -- especially if it is someone's intent to hide the truth. There are people in the world who appear quite respectable (like Dr. Smith), and yet bend the truth. Such people may tell obvious sorts of untruths because they know that most people are simply not equipped to detect them. But with just a little knowledge -- sometimes science and math, sometimes history, sometimes something else -- many of these lies are quite easy to expose.

My major incentive for writing this example is to show non-science oriented kids -- kids who want to be lawyers, or journalists, or business people, or whatever -- how, if you're not afraid of science and math, you'll do better in whatever profession you choose.