
Fermi Problems

What is a Fermi Problem?

A Fermi problem is a multi-step problem that can be solved in a variety of ways, and whose solution requires the estimation of key pieces of information.

Linking Assessment, p. 116

Why Start Grade 8 with Fermi Problems?

The purpose of the first week of school is to set the tone for a positive academic environment and community of learners, which foster both mathematical processes and affective processes. The Fermi problems and social skills introduced in the first week of classes combine to “generate the kind of involvement and thinking processes that are at the root of quantitative literacy. Because important information is missing, students must ask themselves more questions about what they need to know and what they already know. Then they must construct a path of estimates that leads from the knowledge they have to the knowledge they need to acquire. The focus of this activity is on the process rather than the answer – a process that mirrors the ‘number sense’ we apply in everyday life when we make ‘ballpark’ estimates of our fuel consumption, our bank balances, or the time we’ll need to mark a class test.”

Impact Math, Number Sense, p. 17

Who was Enrico Fermi?

Fermi (1901-1954), a famous physicist, was known to mathematicians for his legendary estimation problems. He was able to answer impossible questions by mentally estimating large quantities for which there seemed to be insufficient information. “How many piano tuners are there in Chicago?” was one of his well-known problems. This seemingly unanswerable question often puzzled people. Fermi developed a series of subordinate questions leading to an estimate that was the right order of magnitude. The information in the table below is a summary of the sequence of questions, answers, and estimates listed in *Impact Math, Number Sense*.

Question	Answer
What is the population of Chicago?	3×10^6
To estimate pianos should we estimate people or households?	Households rather than individuals tend to own pianos.
Approximately how many households are there in Chicago?	There may be an average of 4 people per household in Chicago, so the number of households is about $3 \times 10^6 \div 4$.
What proportion of households in Chicago has pianos?	Maybe about 1 in 10 households has a piano. That would suggest that there are about $3 \times 10^6 \div 4 \div 10$ or 7.5×10^4 pianos in Chicago.
How many piano tuners are needed to tune those pianos?	Assuming a piano is tuned once a year, then 75 000 piano tunings are needed. If a piano tuner tunes approximately 3 pianos a day, and works 200 days a year, the number of tuners needed is about $75\,000 \div 600$ or 125.
How many piano tuners are there in Chicago?	There are about 125 tuners in Chicago.

Setting a Context for Solving Fermi Problems:

- Fermi problems at first might appear not to have an answer. Your initial response may be “I need more information or there is not enough information.”
- There are many different ways to solve a Fermi problem. Be creative. Use any necessary tools.
- You may use a variety of estimation strategies and need to take a few risks. Don’t be afraid to piggyback on someone else’s ideas.
- You will be working as a team and sharing strategies and ideas, encouraging and supporting each other using social skills that we will reinforce each day.