Unit 2, Lesson 17: A Fermi Problem

Lesson Goals

- Apply reasoning developed throughout this unit to an unfamiliar problem.
- Decide what information is needed to solve a real-world problem.
- Make simplifying assumptions about a real-world situation.

Required Materials

- tools for creating a visual display

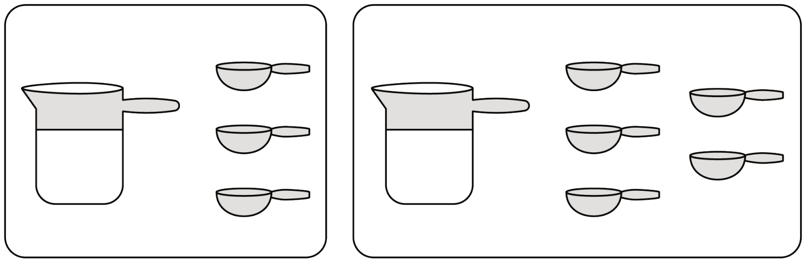
17.1: Fix It! (10 minutes)

Setup:

Students in groups of 2. Display the image for all to see. 2 minutes of quiet think time, followed by a whole-class discussion. (Optional demonstration.)

Student task statement

Andre likes a hot cocoa recipe with 1 cup of milk and 3 tablespoons of cocoa. He poured 1 cup of milk but accidentally added 5 tablespoons of cocoa.



1. How can you fix Andre's mistake and make his hot cocoa taste like the recipe?

2. Explain how you know your adjustment will make Andre's hot cocoa taste the same as the one in the recipe.

Possible responses

1. Answers vary. Sample responses: add 1 more tablespoon of cocoa and 1 cup of milk; add $\frac{2}{3}$ cup of milk.

2. The ratios are equivalent.

17.2: Who Was Fermi? (15 minutes)

Setup:

Introduce Fermi problems and choose one for the class to explore. Consider giving students the option to either work independently or in groups of two.

Student task statement

1. Record the Fermi question that your class will explore together.
2. Make an estimate of the answer. If making an estimate is too hard, consider writing down a number that would definitely be too low and another number that would definitely be too high.
3. What are some smaller sub-questions we would need to figure out to reasonably answer our bigger question?
4. Think about how the smaller questions above should be organized to answer the big question. Label each smaller question with a number to show the order in which they should be answered. If you notice a gap in the set of sub-questions (i.e., there is an unlisted question that would need to be answered before the next one could be tackled), write another question to fill the gap.

Possible responses

Answers vary.

17.3: Researching Your Own Fermi Problem (30 minutes)

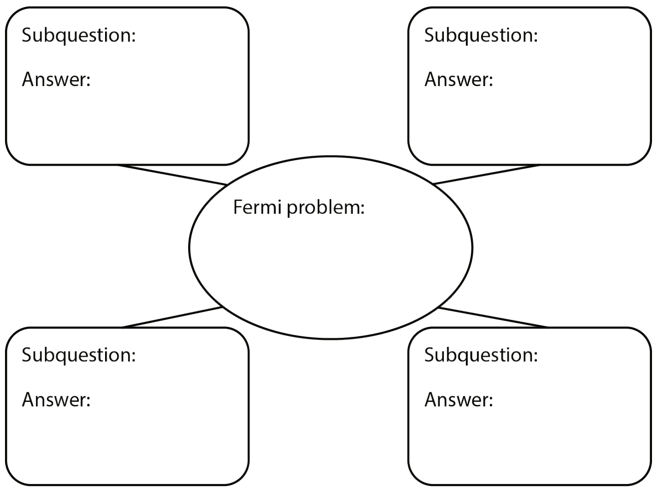
Setup: Students in groups of 2, if desired. Access to tools for creating a visual display.

Student task statement

1. Brainstorm at least five Fermi problems that you want to research and solve. If you get stuck, consider starting with “How much would it cost to . . .?” or “How long would it take to . . .?”

2. Pause here so your teacher can review your questions and approve one of them.

3. Use the graphic organizer to break your problem down into sub-questions.



4. Find the information you need to get closer to answering your question. Measure, make estimates, and perform any necessary calculations. If you get stuck, consider using tables or double number line diagrams.

5. Create a visual display that includes your Fermi problem and your solution. Organize your thinking so it can be followed by others.

Possible responses

Answers vary.

Anticipated misconceptions

Students may think of problems that do not lend themselves to ratio reasoning because they only involve one quantity. If they have trouble coming up with any good options, offer them some examples. It may also be helpful to have a list of sample problems that students could refer to in creating their own problem.

Lesson Synthesis (5 minutes)

How did you use ratio reasoning to explore your Fermi problem? How were different representations used? What were some cases where we had to make the problem simpler in order to proceed?