

MENTOR GUIDANCE

SESSION 1: THINKING LIKE A PHYSICIST

PART 1: SELF-STUDY RECAP

This first half of this tutorial is about highlighting the skills and techniques when solving Fermi problems, and trying to get students to see the relevance of it to a scientist.

TASK 2: TRYING FERMI PROBLEMS

1 How many Shreddies has the average 17-year-old eaten?

2 How many £1 coins can you fit in an average backpack?

Discuss the steps that your mentees have taken to complete these calculations. It's not about guessing, but making educated guesses. Highlight if you spot any point where a student has taken too much of a leap... and help them to break it down into smaller steps.

This is not about getting a firm answer, but about breaking a difficult problem into smaller, easier problems.



1a Examples of assumptions might be:

- We have ignored supermarket own brands
- All cereals are eaten equally
- A 1-year-old eats the same as a 17-year-old
- Children eat breakfast every day
- Children only ever eat cereal for breakfast

2a Examples of assumptions might be:

- All pound coins are identical
- All pound coins are exactly circular
- The size of an average backpack
- Assuming the inside of a backpack is uniform, or discounting pockets

All of these assumptions are very likely not accurate. But are they likely to dramatically affect the answer?

Not necessarily...

b Estimate the level of confidence you have in each assumption.

Probably a factor of two for each estimate. But the odd thing is that these are unlikely to be cumulative. So, with 4 estimates, we could be out by a factor of 16, but we're probably going to be closer than that.

TASK 3: LINKING TO PHYSICS

Some examples of skills might include:

- Proportional reasoning (knowing how one variable is likely to affect others)
 - e.g. if the size of a Shreddie goes up, then does the number of Shreddies in a bowl go up or down?
- Estimating real world values
- Dealing with large and small numbers
- Being able to perform a quick 'sense' check of an answer
- Critical thinking (evaluating confidence levels)

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PART 2: SKILLS PRACTICE

The second half of this tutorial gives students an opportunity to practice those skills with your support.

EXAMPLE FERMI PROBLEM

Guide the mentees through this example problem and encourage discussion. The working is provided in the PowerPoint.

● How much energy is needed to heat up a bath?

Think about asking the mentees these questions to prompt discussion:

- Which equation do I need?
 - Specific heat capacity equation
- What values do I need to estimate?
 - Specific heat capacity of water (mentees might need this given)
 - Volume of water in a bath
 - Temperature change of the water to heat it up

HAVE A GO AT SOME FERMI PROBLEMS

Now the mentees can have a go at some more abstract Fermi problems themselves. They can work on their own or in pairs in the sub-breakout rooms available. Feel free to wander between them and facilitate discussions. Alternatively, you can work through a few of the problems as a group if you wish to.

Make sure you bring the mentees back together around 10 mins before the end of the session to discuss their findings.

Some Fermi problem ideas:

- Has humanity produced enough paint to cover the entire land area of the Earth?
- Suppose you were to print, in 12 point text, the numeral 1 using a common cheap ink-jet printer. How many molecules of the ink would be used? At what numerical value would the number printed approximately equal the number of ink molecules used?
- If our Twitter timelines (tweets by the people we follow) actually extended off the screen in both directions, how tall would they be?

These and more questions have been discussed and “answered” on the What If? website: <https://what-if.xkcd.com/archive/>

Feel free to use any of these questions in your session!