

Quantum engineering

with Stefan Zeppetbauer

Talking points

Knowledge

1. How is the length of a second defined?
2. When were quartz clocks invented?
3. What is the most common type of clock today?
4. What has Stefan discovered so far, and what is he hoping to do next?

Comprehension

5. What happens if a GPS satellite is off by just one microsecond?
6. How is coherent feedback different to measurement-based feedback?
7. How has Stefan designed his experiment to allow him to look solely at quantum noise?

Application

8. What would you ask Stefan to learn more about his work or his journey into quantum engineering?
9. Besides those mentioned in the article, what other applications do you think quantum engineering can have?

Synthesis

10. Quantum clocks allow us to measure time with greater accuracy. How could quantum engineering help us measure other characteristics, such as distance and weight, more accurately?

Evaluation

11. To what extent do you think studying the nature of time is important, and why?
12. What skills do you have to tackle the challenges posed by quantum engineering? which skills would you need to develop further?

Activities

1. Some of Stefan's work is funded by the Foundational Questions Institute (FQxI) who last year ran an essay-writing competition on the question 'How Could Science Be Different?' Read some of the winning entries from last year (qspace.fqxi.org/competitions/home), such as 'How Could Science Be Different?' Ask a Feminist!' and 'Can Artificial Intelligence Improve Scientific Collaboration?'

Write your own answer to the question 'how could science be taught differently?' You can either deliver this as an essay or as a presentation. When thinking of your answer, reflect on the ways that science has been taught in your school. What have you liked or disliked? How do you think science could be taught differently in the future? How do you think diversity and inclusivity affects science?

2. Create a timeline of the history of clocks and time measurement, and how this has progressed. The following website has some great information on how we got from sundials to cutting-edge atomic clocks:
www.measuringexpert.com/how-are-clocks-measured

Draw out images of your clocks, making sure to include labelled descriptions of sundials, pendulums, quartz clocks and atomic clocks. After you have finished, think about what might come next in the timeline of measuring time!

More resources

- Watch this brilliant 5-minute TED talk on how the length of a second is decided: www.youtube.com/watch?v=OKms5a0nGO4
- Take a 3D lab tour of the research lab where Stefan works: www.sqdlab.org/3d-lab
- Stay updated with the news at Stefan's lab, the Superconducting Quantum Devices Laboratory, to see what Stefan and his colleagues find out next: www.sqdlab.org/news