

Understanding Einstein: The Special Theory of Relativity

A Stanford Online Course
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Week 1 Introduction: “Einstein in Context”

A. Einstein quotes of the week

“It is not the result of scientific research that ennobles humans and enriches their nature, but the struggle to understand while performing creative and open-minded intellectual work.”

“Science as something already in existence, already completed, is the most objective, impersonal thing that we humans know. Science as something coming into being, as a goal, is just as subjectively, psychologically conditioned as are all other human endeavors.”

“When I examine myself and my methods of thought, I come close to the conclusion that the gift of imagination has meant more to me than my talent for absorbing absolute knowledge.”

B. Thought experiment (the principle of relativity)

Imagine: You wake up inside a room with no windows and one locked door (you checked). You cannot see outside. Looking around you see a table with a number of items on it: a desk lamp (plugged in and turned on), a tennis ball, a bunch of string, a pitcher of water and a cup, a candle, a box of matches, and a music player with headphones. A skateboard and a wooden stool are also in the room. The music player has a sign on it saying “Turn on for instructions,” so you do. You are told that you are in a specially designed vibration-proof and noise-proof train car on a set of straight and level train tracks. Your task is to use one or more of the items in the room, perhaps in combination with each other, to determine whether the train car is stationary or is moving on the tracks. There is a thirty-minute time limit for your test (or tests), and destroying or modifying the walls, floor, or ceiling of the car is not permitted. Can you think of some creative ways to use the items that might indicate whether you are moving? (Spoiler alert: The principle of relativity asserts that there is no way for you to tell whether the train car is moving. So once you think of some creative ways that might seem to be able to tell you whether you are moving, think about why they fail to do so. If you have a car, you might even try some experiments in it while it is stationary and while it is moving, with a friend driving, not yourself!)

Also note: For those of you who know about Foucault pendulums, note that (a) the train car is unlikely to be tall enough for a Foucault pendulum to give a practical result, and (b) even if it was, the pendulum would only show whether the train car was rotating with the earth, not necessarily whether it was moving on the tracks. (If the train were moving in such a way that its latitude position on the earth were changing, in principle it would be possible to use a very sensitive pendulum over a long enough period of time to detect the train’s motion on the tracks, because the precession of a Foucault pendulum depends on the latitude. But for the purposes of our thought experiment, assume that the train’s latitude doesn’t change.)

C. Optional reading: Read the profile on the young Einstein (L. Randles Lagerstrom, “Young Einstein: From the Doser! Affair to the Miracle Year,” available for \$2.99 from Amazon Direct Publishing at <https://www.amazon.com/Young-Einstein-Doser!-Affair-Miracle-ebook/dp/B00BKKHS4U/>). Based on the

profile, what would you point to as some of the secrets of Einstein's success? What surprised you about his early life and work? What didn't you understand?

D. Week 1 lessons

Note: Most of the video lectures in each lesson have a corresponding handout that gives a basic outline of the lecture and/or additional information, with room for you to take notes. They are available as pdf files, listed as "Readings" before each video lecture at the course website.

1. Week 1 introduction
2. Physics and Einstein *circa* 1900
3. To the miracle year
4. The miracle year
5. Week 1 final quiz