Name: _____ Date: _____

A Compass, a Desk and the Speed of Light

Reading level 8 (4th grade) · 718 words

Hold a compass flat in your hand. Turn your whole body, and the needle still points the same way. Albert Einstein wrote that a compass amazed him when he was four or five years old. He said his father showed it to him. How could a needle act like that, with nothing touching it?

Einstein was born in Ulm, Germany, on March 14, 1879. Years later he wrote a book of notes about his life. In it he said the compass left a deep mark on him. He wrote that he could still remember it, "or at least believe I can remember." Even he was not sure the memory was exact.

Einstein trained in Zurich, Switzerland, to be a physics teacher. He finished his studies. But he could not find a teaching job. In June 1902 he got a different one. It was at the patent office in Bern. A patent is an official paper that says an invention is yours.

A month later he stood at a lectern in room 86. A lectern is a tall desk you stand at. His job was to look at new inventions. He decided if they could get a patent. He called it his "cobbler's trade." One account says it paid well and was easy for his quick mind.

The same account says he split his day in three. Eight hours were for work. Eight were for his own science and other things. Eight were for sleep, but he often wrote instead. In 1905 he was 26. That year he signed four science papers, plus a long report for his doctor's degree.

At 16, he wrote, he asked what a beam of light would look like if he raced after it. In his own later account, it would look frozen in place. He called this a paradox, a puzzle that seems to break the rules. He later said it helped lead him to relativity.

In 1905 he wrote a paper that began with two rules. One said that light in empty space always moves at the same speed, whatever moves the lamp. His math then said a clock carried from one place to another falls behind a clock that stayed put. The gap is tiny, but it is there.

He also wrote that light comes in tiny packets. This helps explain what happens when light hits metal. Tiny bits called electrons get knocked loose. Many did not believe it. Yet his Nobel Prize in Physics named the photoelectric effect. It was the 1921 prize. He got it in 1922.

In 1915 Einstein finished a new idea about gravity. It said the Sun's gravity should bend starlight that passes close to it. To check, scientists had to photograph stars right next to the Sun. You can only do that in a total eclipse, when the Moon blocks the Sun's glare.

On May 29, 1919, two British teams watched an eclipse. One was on the island of Principe, off West Africa. The other was in Sobral, Brazil. At Principe, thick clouds hid the sky. Only two photos were good enough to use. They were made on glass plates.

The teams checked their photos against pictures of the same stars taken at night. The stars near the Sun had moved a tiny bit. The move fit Einstein's number better than the older theory's. On November 6, 1919, the news was told in London. The next day, it was in the papers.

Now look at your phone. A map app uses GPS. GPS satellites circle about 20,200 kilometers up. Each one has clocks inside. Two of Einstein's ideas pull on those clocks in opposite ways. Speed slows them. Weaker gravity up high speeds them up. In the end they run fast.

It adds up to 38 millionths of a second a day faster than clocks on the ground. That sounds like nothing. But NIST, a US science agency, says that without constant fixes, the satellites' signals would soon be useless. Engineers had to build Einstein's rules into the system.

A compass needs no clocks. It just points. A phone's map is different. It needs clocks that follow his rules. NIST says that in a way, GPS has become the longest-running test of his theories. Every time a blue dot finds you, that test goes on.

Questions

1. What did Einstein say his father showed him when he was four or five?

A. A telescope
B. A compass
C. A clock

2. What was Einstein's job at the patent office?

A. Building clocks
B. Teaching physics
C. Looking at new inventions

3. Why did scientists need a total eclipse to test the idea about starlight?

A. The Moon blocks the Sun's glare so stars show
B. Eclipses make stars much brighter
C. Telescopes only work at night time

4. In "a clock carried from one place to another falls behind," what does falls behind mean?

A. Drops to the floor
B. Runs slower
C. Stops forever

5. What does NIST say would happen if GPS clocks were not fixed all the time?

A. The signals would soon be useless
B. The phones would get hot
C. The Sun would look bigger

6. Why do GPS clocks need fixing all the time?

A. Two effects pull their time in different ways

B. They run out of power

C. The Moon pulls on them

Words to know

compass: direction tool

patent: invention paper

eclipse: Sun blocked

paradox: puzzling contradiction

satellites: orbiting machines

Answer key: A Compass, a Desk and the Speed of Light

1. B. A compass
2. C. Looking at new inventions
3. A. The Moon blocks the Sun's glare so stars show
4. B. Runs slower
5. A. The signals would soon be useless
6. A. Two effects pull their time in different ways