How much faster?

Annotation

Raj is able to use proportional thinking to find a rate and a ratio. He is able to use standard form, conversion to consistent measurement units, and appropriate rounding in his calculations. Raj shows an understanding of the importance of magnitude (decimal place) in his final answer.

Problem: How Much Faster?

The teacher poses this problem:

The Large Hadron Collider (LHC) in Switzerland is a 27 km (2.7 x 104 m) long circular tunnel that a typical proton will take 90 μs (90 x 10-6 s) to go around once. Compare this speed with that of a car travelling at 100 km/hour (27.78 m/s)?

Student response

$$\text{proton speed} = \frac{2.7 \times 10^4 \, m}{90 \times 10^{-6} \, s}$$

$$= \frac{27 \times 10^3}{9 \times 10^{-5}}$$

$$= 3 \times 10^8 \, m/s$$

how much faster?

$$\frac{\text{proton speed}}{\text{car speed}} = \frac{3 \times 10^8}{27.78}$$

$$= \frac{30 \times 10^7}{27.78}$$

$$= 1.08 \times 10^7$$

$$\text{Answer} = 10^7 \text{ times faster}$$
(10 000 000 times)

Teacher: Tell me about your calculations.

Raj: Well I needed the speed of a proton in metres per second to compare with the car's speed in metre per second. I got that by dividing the metre the proton went by the seconds it took. I expected it to be a very big number because the proton must have been going very fast, and I got 3 with eight zeros after it so that's pretty darned big.

Teacher: And was that exactly 3?

Raj: Well the answer I got was exactly 3, but the numbers I used wouldn't be exact because the tunnel might really be 27 km and a little bit. Also if you're timing something going around in 90 microseconds, you can't really time that exactly, surely!

Teacher: So you compared the proton's speed with the car's speed by dividing?

Raj: Yep. I was finding how much faster, so what number times the car's speed gives me the proton's speed. It's got to be huge to go from 28ish to three, zero, zero, zero...well, eight of those is a big number. Yep, so to get that number, I was dividing, I found a ratio.