HarvardX: CalcAPL1x Calculus Applied!

Help

1.1.3 Exploratory Quiz: The Energy-Mass Equation and Taylor Approximation

Bookmark this page

Question 1

1/1 point (ungraded)

As Mboyo mentioned, we can understand the connection between the famous equation:

$$E = m_0 c^2$$

and the complete energy equation:

$$E = \frac{m_0 c^2}{\sqrt{1 - \frac{v^2}{c^2}}},$$

using Taylor approximation.

To create a Taylor approximation for the function

$$E = \frac{m_0 c^2}{\sqrt{1 - \frac{v^2}{c^2}}},$$

we view E as a function of a single variable, and choose a center around which to expand the function.

Recall we are trying to understand what happens to the energy of a moving object compared to its rest energy (its energy at $v = 0$ when it is observed from a resting frame).

Which of the following seem like reasonable choices to you and why?
(There may be more than one.)

- [x] Use the variable v with center $v = 0$ ✔
- [ ] Use the variable v with center $v = c$

- [x] Use the variable $\frac{v}{c}$ with center $\frac{v}{c} = 0$ ✔
- [ ] Use the variable $\frac{v}{c}$ with center $\frac{v}{c} = 1$
- [ ] Use the variable m_0 with center $m_0 = 0$

✔

Explanation

We're comparing an object at rest (speed zero) to what happens when it is moving with some speed. Thus m_0 should be considered constant and we want to use v, or some related quantity, as the variable.

Using the variable v with center $v = 0$ makes sense as long as v is close to zero. This is since Taylor approximations are generally only useful within a radius of the center.

It also could make sense to use $\frac{v}{c}$ as the variable with center $\frac{v}{c} = 0$. This represents the speed of the object relative to the speed of light.

Using center $v = c$ or $\frac{v}{c} = 1$ does not make sense since E is undefined at that value. Also, we're not likely starting with an object moving near the speed of light.

Submit

Answers are displayed within the problem

Learn About Verified Certificates