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

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## Question 1

1/1 point (ungraded)

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

$$E=m_0c^2$$

and the complete energy equation:

$$E=rac{m_0c^2}{\sqrt{1-rac{v^2}{c^2}}},$$

using Taylor approximation.

To create a Taylor approximation for the function

$$E=rac{m_0c^2}{\sqrt{1-rac{v^2}{c^2}}},$$

we view  $oldsymbol{E}$  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.)

- lacksquare Use the variable v with center v=0 🗸
- Use the variable  $\boldsymbol{v}$  with center  $\boldsymbol{v}=\boldsymbol{c}$

- extstyle ext
- lacksquare Use the variable  $rac{v}{c}$  with center  $rac{v}{c}=1$
- $\hspace{0.4cm} \hspace{0.4cm} \hspace$



## **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  $\emph{v}$ , or some related quantity, as the variable.

Using the variable  $oldsymbol{v}$  with center  $oldsymbol{v}=oldsymbol{0}$  makes sense as long as  $oldsymbol{v}$  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  $rac{v}{c}=1$  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.

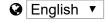
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Answers are displayed within the problem

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