Relative Momentum

Law of Conservation of Momentum

- The momentum of a closed does not change. \[ p = mv \]
- However, when approaches , we must adjust the

\[ p = \frac{mv}{\sqrt{1 - \frac{v^2}{c^2}}} \]

- momentum is always than momentum because \( \sqrt{1 - \frac{v^2}{c^2}} < 1 \)
- Since we by the radical in the formula, the result is a number.
- Notice that when the is near 0, the momentum is near the .
- When the speed is near , the momentum increases .

In a game of Dom’Jot, a small ball (0.5 kg) is hit across a table. If the ball moving at 3 m/s and the speed of light in a vacuum is 4 m/s, what is the relativistic momentum of the ball?

The nonrelativistic momentum?

Homework

1. Find the momentum of a helium nucleus having a mass of \( 6.68 \times 10^{-27} \) kg that is moving at 0.200c. (OpenStax 28.35) \( 4.09 \times 10^{-19} \) kg m/s
2. What is the momentum of an electron traveling at 0.980c? (OpenStax 28.36) \( 1.35 \times 10^{-21} \) kg m/s
3. What is the velocity of an electron that has a momentum of \( 3.04 \times 10^{-21} \) kg·m/s? Note that you must calculate the velocity to at least four digits to see the difference from c. (OpenStax 28.39) \( 2.988 \times 10^8 \) m/s
4. Find the velocity of a proton that has a momentum of \( 4.48 \times 10^{-19} \) kg·m/s. (OpenStax 28.40) \( 2.00 \times 10^8 \) m/s
5. (a) Calculate the speed of a 1.00-µg particle of dust that has the same momentum as a proton moving at 0.999c. (b) What does the small speed tell us about the mass of a proton compared to even a tiny amount of macroscopic matter? (OpenStax 28.41) \( 1.12 \times 10^{-8} \) m/s, mass of proton is tiny