

Modern Physics

Tutorial 3

Special Relativity

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1 Relativistic Kinematics

A particle a travelling along the positive x axis of frame S with speed $0.5c$ decays into two identical particles, $a \rightarrow b + b$, both of which continue to travel on the x axis.

a) Given that $m_a = 2.5m_b$, find the speed of either b particle in the rest frame of particle a .

b) Find the velocities of the two particles in the original frame S .

2 A 2-D Problem

A particle of mass M decays into two particles of mass m_a and m_b , whose momenta are measured to be $\mathbf{p}_a \hat{y}$ and $\mathbf{p}_b \hat{x}$ respectively. Find the mass M and its speed.

3 Another Example of Decay

Particle A , at rest, decay into particles B and C ($A \rightarrow B + C$). Show that the energy of the outgoing particles, in terms of various masses is:

$$E_B = \frac{m_A^2 + m_B^2 - m_C^2}{2m_A} c^2$$

4 Collisions

Particle a is pursuing particle b along the x axis of a frame S . The two masses m_a and m_b and the speeds are v_a and v_b (with $m_a > m_b$). When a catches up with b , they collide and coalesce to form a single particle of mass m and speed v . Show that,

$$m^2 = m_a^2 + m_b^2 + 2m_a m_b \gamma(v_a) \gamma(v_b) \left(1 - \frac{v_a v_b}{c^2}\right)$$