

Particle Collider Simulator

Classroom worksheet · Interactive simulation: <https://lkforge.com/tools/physics/particle-collider/>

Name: _____ Date: _____

Learning objectives

- Apply conservation of energy and momentum to collisions.
- Explain how new particles are created from collision energy.
- Connect kinetic energy to mass via $E = mc^2$.

Variables to change

- Collision energy
- Particle types
- Beam configuration

Procedure

1. Collide particles at low energy and observe the products.
2. Increase the collision energy and observe heavier products appear.
3. Compare head-on collisions with fixed-target collisions.

Observations

Record what products appear as collision energy increases.

Questions

1. What is conserved in every collision?
2. Where do new, heavier particles come from?
3. Why do physicists build higher-energy colliders?

4. Why are head-on collisions preferred over fixed targets?
5. What does $E = mc^2$ tell us here?

Answer key (instructors)

- **1.** Total energy and total momentum (and charge and other quantum numbers).
- **2.** From the collision's kinetic energy, converted to mass via $E = mc^2$.
- **3.** Higher energy can create more massive particles, probing new physics.
- **4.** They put more energy into creating particles rather than into the motion of the products.
- **5.** Mass and energy are interconvertible, so energy can become new matter and vice versa.

In a collider, particles smash together conserving energy and momentum. Their kinetic energy can convert into mass ($E = mc^2$), creating heavier particles — so higher collision energies, especially head-on, reveal more massive and exotic particles.