MOMENERGY: THIS IS NOT YOUR MOM'S ENERGY

Objectives:

Given information regarding the workings of momenergy diagrams, students will be able to use an ejs-produced java simulation to create momenergy diagrams for relativistic particles.

State Frameworks/Professional Standards:

NSES Unifying Theme-

Form and function. (How momentum and energy interact at relativistic speeds.)
Evidence, models, and explanation. (design and construction of mini generator)

Instruction:

Motivation: We have discussed momenergy as cited in *Spacetime Physics* by Taylor and Wheeler. We can solve for inelastic collisions, and now we will be able to use the sim to solve for elastic collisions.

Key questions:

1. How are momentum and energy related in terms of momenergy?
2. How does the total momenergy of the system relate to the individual momenergies of the particles before and after the collision?
3. Can we use momenergy diagrams to model this relationship?

Vocabulary:

1. Momenergy is not mass. It is a 4-vector that sets momentum in the space-like part of a relativistic coordinate set and energy in the time-like part of the same set.
2. Momenergy^2 is $E^2 - p^2$.

Choice of research-based strategies:

1. This is basically a discovery-learning lesson. Kids will understand the working of momenergy in elastic collisions by interacting with the simulation. The simulation allows for students to work with particles that would normally be moving at relativistic speeds.

Transitions and timing:

1. The lesson takes about 30 minutes. After presenting momenergy as the resultant of the sum of the 4-vector with momentum in 3 dimensions and energy as the fourth, students will work with elastic collisions.

Materials/Technology:

1. Students need access to a computer with the momenergy simulation already loaded.
2. Students need the worksheet that goes with the simulation.

Outline of Lesson Process:

The task is presented
Student opens simulation.
Student uses practice sheet to find momenergies, momenta and energies of particles.
Each student is then given a chance to present their model and related diagram.
Continue with discussion on conservation of energy, momenta, and discuss what happens to the total momenergy of the system and why mass is not conserved in a relativistic collision.

Assessment:

Students are assessed on how well their final product meets the defined goals.

Does their model conserve momentum? Energy?

Reflection:

Performed after lesson