Name(s)____ Date__________________

The Ultimate Cosmic Challenge

Background: One cold clear winter night in 1991, a single subatomic particle came hurtling through the atmosphere destroying atoms, causing the air to glow, and in general behaving like a normal cosmic ray, except for its energy. This single cosmic rayhad an energy of nearly 1020 electron volts, or nearly 50 joules! To put it in perspective,that is roughly equivalent to a 1 kg mass moving at 10 m/s, or a 90 mph fastball. The energy of a fastball is shared by 1025 atoms. Imagine one atomic nucleus having all that energy! This was the most energetic cosmic ray ever recorded, and it was observed bythe University of Utah's Fly's Eye detector.

The Fly's Eye detector is a detector that "looks" for cosmic rays. Of course cosmic raysare sub-atomic particles and are far to small to actually be seen. What the detector actually sees is the trail left by the cosmic ray as it bumps into the nitrogen in the atmosphere. The Fly's Eye detector is a series of mirrors, each pointed in a different direction. Because the mirrors are pointed all around, the Fly's Eye detector can "see" in all directions, the same as a fly. Which is why it is named the Fly's Eye detector.

Statement of Purpose: Cosmic rays are so small, and so fast, with so much energy, they don't behave like large objects. The purpose of this lab is to find how the laws of motion differ for cosmic rays.

Materials: Computer with Internet connection and lab notebook.

Procedure: Your teacher will instruct you on how to access the lab site. Follow those directions carefully.

Once you have accessed the lab site you will want to follow the instructions on the introductory pages. Read each page carefully, so that you know how to complete the lab.

Record the data on a data table. You will want to complete at least 8 trials. Try to determine when Newton's formula works, and when it fails.

Table 1: Coty Data

Mass (kg)	Energy (J)	Your Speed (m/s)	Isaac’s Speed (m/s)	Actual Speed (m/s)

Questions: Using the data you just collected answer the questions below.

1) Is there a limit to the speed of the particle? If so, what does it seem to be?

2) Is there a difference between

   a) your predictions and Newton's calculations?

   b) your predictions and the actual speed measurements of tiny things?

   c) Newton's calculations and the actual speed measurements of tiny things?

3) Which calculation in #2 are your predictions most similar to?

4) Under what circumstances did Newton get it right?

5) Given that the figures in the last column are the most accurate that we have been able to measure, how do you explain that Newton's law does not appear to work for small particles (such as cosmic rays) with high energies?

You may have concluded that Newton's law cannot explain the kinetic energy of a cosmic ray. This mystery is left to later investigations.