A Cosmic Clock for the Classroom

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A Cosmic Clock for the Classroom

Keywords
cosmic year, Carl Sagan, Cosmos, Cosmic Calendar

Abstract
Teachers who watched the first episode of Carl Sagan's Cosmos show on the Public Broadcasting System may have been impressed by his use of the "Cosmic Calendar" to dramatically introduce the evolutionary time scale of the universe. In this calendar, which Sagan first represented in The Dragons of Eden, the 15 billion year history of the universe is compressed into a single year. Each month represents 1.25 billion years, each day 40 billion years, and each second 500 years. At this scale the entire recorded history of mankind flashes by during the final 10 seconds of the cosmic year. [excerpt]

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ft/sec (11 x 10³ cm/sec). There are several possible reasons for the disagreement, among them the retarding influence of the foil. In addition, the manufacturer's claim must refer to the first pellet fired. We noted a 1000% decrease in speed towards the end of a CO₂ cartridge's lifetime. The last few pellets were not even capable of breaking the aluminum foil strips.

A Polaroid camera is very helpful. Although the plateau on the oscilloscope is discernible visually, a photograph is necessary for reliable data. The baseline in Fig. 3 is badly overexposed. This is unavoidable and is due to the rapid sweep of the scope. Turn down the intensity of your sweep a bit. The shooter should fire when he hears the opening click of the camera shutter and the photographer should close the shutter immediately after the shot. The room lights should be fairly dim but, obviously, the shooter must have enough light to see the foil strips. In any case, the plateau will be readily observed on your photograph.

It has also been suggested that this method may be used later in the year in other experiments. For example, one could determine the speed of a heavy pendulum bob as it passes through its equilibrium position. Kinetic energy could then be compared to initial gravitational potential energy. Another application might be in verifying the speed of the projectile in the ballistic pendulum experiment.

An added bonus of the demonstration is that it introduces the oscilloscope early in the year in an elementary, nonelectrical context. While I don't go into details, the students see that it is nothing more than a moving dot which rises when "electricity" is applied.

Fig. 3. The oscilloscope trace.

A cosmic clock for the classroom

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Teachers who watched the first episode of Carl Sagan's Cosmos show on the Public Broadcasting System may have been impressed by his use of the "Cosmic Calendar" to dramatically introduce the evolutionary time scale of the universe. In this calendar, which Sagan first presented in The Dragons of Eden,¹ the 15 billion year history of the universe is compressed into a single year. Each month represents 1.25 billion years, each day 40 million years, and each second 500 years. At this scale the entire recorded history of mankind flashes by during the final 10 seconds of the cosmic year.

A simple classroom demonstration graphically illustrates this time scale in a similar fashion. An electronic counter set to total up the pulses from an audio-frequency square-wave oscillator serves as a digital cosmic clock. By adjusting the frequency of the oscillator and by interpolating each count as a certain number of years, the entire cosmic history can be squeezed into a single classroom period.

In the setup we have used, for instance, an 8-digit Heath frequency counter (the more digits the better) is attached to a 5-KHz source. Each count is interpreted as 1 millennium = 1000 years. Thus our counter accumulates 10⁶ counts, or 1 billion years, every 3 minutes, 20 seconds. The full 15 billion years is registered after 50 minutes, the duration of a class period.

For the purposes of the demonstration, the digits of the display can be labeled in millions and billions of years. While the least significant digits change too rapidly to be distinguished by the students (recorded history shoots by in a millisecond!), the overall scale of time for the formation of galaxies, the evolution of the solar system, and the development of life on earth can easily be appreciated. Alternatively, the instructor may choose to lower the oscillator pulse rate, compressing the universal time scale only into a week or a semester. The display may then be mounted in a public place and students can check on the progress of cosmic evolution over a longer period of time.

Reference