RELIGION & PHILOSOPHY

When Christ said that the poor in spirit would gain the kingdom of heaven, he meant those who are "empty of pretensions, free of compulsions and desires . . . unfilled with accumulations of dogmas, theories, principles, and rules," writes Drengson. A Christian so transformed will focus his reason, emotions, and will on the task of helping particular people in particular situations.

SCIENCE & TECHNOLOGY

Newton's Apple

"Newton's Discovery of Gravity" by I. Bernard Cohen, in *Scientific American* (Mar. 1981), 415 Madison Ave., New York, N.Y. 10017.

Sir Isaac Newton (1642–1727), formulator of the landmark law of universal gravitation, also dabbled in "fiction." It was he who spread the tale about being inspired by a falling apple. Did his discovery (that all objects attract each other with a force that varies directly with the product of their masses and inversely with the square of their distance) spring from a sudden stroke of genius? Or did Newton pirate an insight of physicist Robert Hooke, with whom he corresponded? The two scientists' writings disprove both ideas, says Cohen, a Harvard historian.

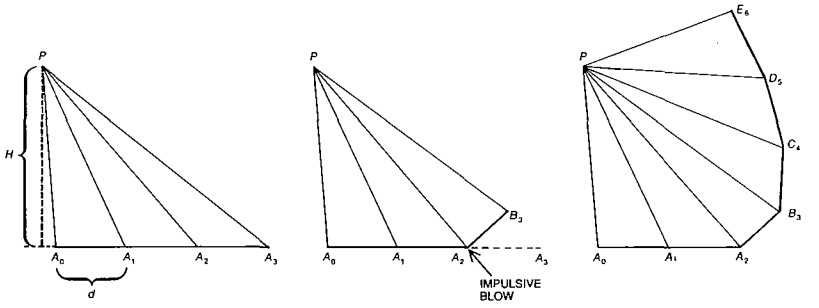
It started with the mystery of orbiting bodies. In a 1679 letter, Hooke convinced Newton that the motion of an orbiting body results not from a centrifugal, or "center-fleeing," force but from two elements—an inertial force propelling the body in a straight line and a centripetal force drawing it toward the center. Hooke even proposed that the "attractive motion" between the sun and a planet varied inversely with the square of their separation. But at this point, Cohen writes, "Hooke was stuck." Hooke believed that centripetal force was a "one-way street" emanating solely from the center body. Why, then, were the planets' orbits elliptical, as the Dutch astronomer Johannes Kepler had observed 70 years earlier?

Hooke's way of subdividing curved motion set Newton on a new path of inquiry. Using Kepler's observation that a line stretching from a planet to the sun sweeps across equal areas in equal periods of time, Newton deduced that the forces Hooke described produced elliptical orbits (see Newton's geometric proof, next page). Therefore, he reasoned, the planets' movements around the sun must result from Hooke's forces.

Newton knew that the sun was not at the physical center of planetary orbit. He also knew that in the actual world (as opposed to the ideal world of mathematical constructs) "attractions customarily are directed toward bodies" and that, by his own law of action and reaction, the "actions of attracting and attracted bodies are always mutual and equal." Newton figured that the sun and planets must attract *each other* (he never claimed to know how) and that they all rotate around a

common center of mass. Again, he turned to astronomy for confirmation. Examining Jupiter and Saturn, he discovered perturbations in their orbits when they were closest together.

The apple anecdote that Newton circulated was a ploy to refute Hooke's claim to a share of credit for the law of gravity, Cohen speculates. In fact, Newton displayed a combination of genius, thoroughness, and persistence that left his peers far behind. He repeatedly compared mathematical models to the observed physical world until theory explained reality.



Sir Isaac Newton showed, at left, that a body moving past a point (P) at constant speed describes equal-area triangles at equal intervals of time (e.g., at A_1 and A_2). In the middle diagram, he showed that a force pushing it toward the point creates yet another equal triangle. Repeating the process and making the centripetal impulse a constant reveals an ellipse.

Cancer Confusion

"The Cells That Would Not Die" by Michael Gold, in *Science 81* (Apr. 1981), P.O. Box 10790, Des Moines, Iowa 50340.

While routinely processing flasks supposedly containing live human cancer cells from Russia in 1973, Berkeley biologist Walter Nelson-Rees made an astonishing discovery: The cells actually came from Henrietta Lacks, a black woman from Baltimore who had been dead for 22 years. According to Gold, a *Science 81* staff writer, the accidental spread of Lacks's cells has led many cancer researchers astray.

Before Lacks died of cancer at the Johns Hopkins clinic in 1951, doctors delivered part of a strange purple lesion from her cervix to colleagues who were trying to grow live tumor cells. Lacks's culture turned out to contain the first human cancer cells vigorous enough to thrive and multiply in the lab. "HeLa" cultures became much in demand. Their ability to support human viruses, for example, helped scientists to develop polio vaccines.

But HeLa grew too easily. If only a few cells entered a different culture, they crowded out their host within days. Nonsterile equipment and sloppy lab procedures hastened their spread—a few stray cells on a