

$$E = mc^2$$

One powerful equation

If you could convert the mass of a paper clip (.03 ounces) entirely to energy, how big a punch would it pack?



- a. one ton of TNT
- b. an atomic bomb
- c. burning 20 gallons of gasoline

If you could turn every one of the paper clip's atoms into pure energy, the paper clip would yield 18 kilotons of TNT—that's roughly the size of the atomic bomb that destroyed Hiroshima in 1945. Einstein's breakthrough realization was that energy and mass are different forms of the same thing. Under certain conditions, mass can be converted into energy, and vice versa. On earth, however, there is no practical way to convert a paper clip or any other object entirely to energy. It would require temperatures and pressures greater than those at the core of our sun.

Energy

The ability to do work or cause change. Energy comes in many forms (such as mechanical, thermal, electromagnetic, and chemical), and it can change from one form to another.

Mass

A measure of the amount of matter (material) in a physical object.

Speed of Light

The maximum possible speed in the universe. That's approximately 300,000 kilometers per second (186,000 miles per second). The c stands for the Latin word *celeritas*, meaning swiftness.

$$E = mc^2$$

What does it mean?

Equals

Einstein's key revelation: Energy and mass are the same thing. Each can be converted into the other using c^2 —a number so huge that the amount of energy bound up in even the smallest mass is mind-boggling.

Squared

Multiplying a number by itself. The enormous size of c^2 —90,000,000,000 (km/sec)² or 34,596,000,000 (miles/sec)²—means that a tiny mass yields a vast amount of energy.

$E = mc^2$

What has it done for *you* lately?

Keeps You Safe

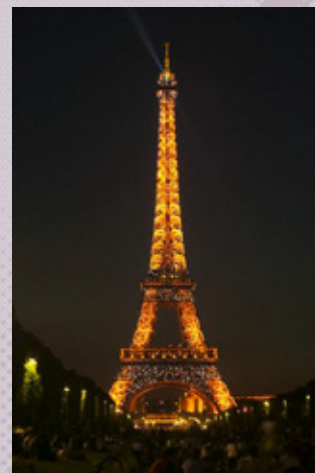


Getty Images

Many smoke detectors contain a tiny amount of a radioactive element called americium that continuously converts a very small fraction of its mass into energy, powering a smoke-sensitive beam for months or years on end.

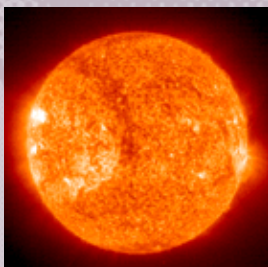
Generates Electricity

Inside a nuclear power plant, nuclear reactions convert tiny amounts of mass into large quantities of energy. For some countries, such as France, nuclear power is a primary source of electricity.



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Warms the Earth



SOHO (ESA & NASA)

At the heart of the sun, under tremendous pressure, hydrogen atoms fuse together to form helium. Each new atom of helium, though, has less mass than the four original hydrogen atoms that created it. In accordance with $E=mc^2$, the "lost" mass radiates off as energy that warms the earth 93 million miles away.

Adapted from *E=mc²: A Biography of the World's Most Famous Equation* by David Bodanis (Berkeley Books: 2000).

