Scientists ask: Is the kilo losing weight?

April 24 2011, By Elizabeth Weise

Ensuring a pound of butter is indeed a pound, or a gallon of milk a full gallon, has long been the province of government agencies that deal with weights and measures. But now it seems scientists are having a little trouble with the golf-ball-size piece of metal that is used to set the standard weight for a kilogram, or kilo.

A bunch of these prototypes have been made over the years, seven of which are kept in a triple-locked vault at the International Bureau of Weights and Measures in Sevres, with one known as the International Prototype.

The problem is that as these prototypes have been taken out and weighed, which last happened in 1990, something odd has turned up - their weights began diverging. The International Prototype, for example, weighed 50 micrograms less than the others, meaning it had lost weight, or the others were getting heavier, or they were all moving a bit - no one knows for certain. And no one knows what caused the changing weights, either.

Americans might not think the definition of a kilo affects them, but it does. Since 1893 "the pound has been defined as a derived measure of the kilo," says Richard Davis, formerly the kilogram specialist with the U.S. National Institute of Standards and Technology and then the secretary of the Consultative Committee for Mass and Related Quantities.

Not that the 50 micrograms will affect someone buying a pound of

coffee in America or a kilo of potatoes in Germany. "It's a pretty small effect. It's the weight of a small grain of sand, and this has no consequence," says Michael Stock, director of the International Bureau's Electricity Department. "It's only people working at the highest levels of science who will be affected."

But to scientists, for whom very precise measurement is important, it's a big deal. So they decided to start working on a new standard based on a universal constant - a measure that relies on science principles rather than on an object whose size or other properties could change from one sample to another.

The standard for a meter, for example, is now defined as "the length of the path traveled by light in vacuum during a time interval of {99,792,458 of a second." Again, even for Americans who don't know a kilometer from a kleptomaniac, this is an issue because the official definition of a foot is exactly 0.3048 meters.

There are seven base units in the International System of Units (things like seconds, meters, degrees) and every one of them but the kilo has one of these universal constant definitions. Only the kilo is still defined by a manmade artifact - in this case a cylinder of metal made up of 90 percent platinum and 10 percent iridium that's 1.54212598 inches high by 1.54212598 inches in diameter. Which, by definition, weighs exactly 1 kilo (2.2046 pounds).

The whole system is based on a group of scientists in France who, after the revolution of 1789, started to set up a universal measurement system to get away from the hodgepodge of measurements then existing in Europe, many of which were based on things like the length of the current king's arm. "What do you do when you get a new king?" Stock says.

The system began to be adopted by the rest of the world in the 19th century when industrialization and international trade made having similar measuring systems important.

But finding a universal constant for a kilo isn't as easy as it might seem.

One suggestion was to create a precise sphere of pure silicon that weighed exactly 1 kilo, then count the number of silicon atoms it contained and define a kilo as the weight of that many silicon atoms. But while that sounds simple, it turns out to be technically very difficult.

Another idea was to base it on a relationship with an esoteric concept in physics called the Planck Constant, something even Stock had trouble expressing in layman's terms. But it would allow scientists to create a definition based on a universal constant.

Except that the experiments to establish it may be a little beyond science just yet. Groups in the United Kingdom, the United States, Switzerland and France have been doing the experiments and so far they have not come up with the same number.

"That's the problem," says Stock. "There are different results, and they don't agree."

It is unlikely that the universe is shifting under our feet, the researchers say. More that our measuring ability isn't quite up to capturing the extremely small thing being measured here.

For now, the kilo stays linked to the platinum/iridium cylinder locked away outside Paris. The meeting of the General Conference on Weights and Measures, which could adopt a new definition of the kilo, is scheduled for 2015.

Asked whether we can expect a definitive kilo by then, Stock smiles. "Probably yes, but good science takes time."