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FULL CIRCLE: ON THE CHANGE IN KILOGRAM'S DEFINITION

Relevant for: Pre-Specific GK | Topic: Miscellaneous Facts

As of May 20, the kilogram joined a bunch of other units — second, metre, ampere, kelvin, mole and candela — that will no longer be compared with physical objects as standards of reference. The change comes after nearly 130 years: in 1889 a platinum-iridium cylinder was used to define how much mass one kilogram represented. Now, a more abstract definition of the kilogram has been adopted in terms of fundamental constants, namely, the Planck's constant h, and the metre and second which already have been defined in terms of universal constants such as the speed of light. With this redefinition, the range of universality of the measurement has been extended in an unprecedented way. Earlier, if a mass had to be verified to match with a standard kilogram, it would be placed on one of the pans of a common balance, while the prototype would have to be placed in the other pan — and mass would be measured against mass. Now, by using a Kibble balance, which balances mass against electromagnetic force, to measure the mass of an unknown piece, the very methodology of verification has been altered. The constants involved are known precisely and are universal numbers. Hence, whether the mass is measured on earth or, say, on the moon, it can be determined with precision.

Kilogramme redefined: Formula replaces mass of a platinum-iridium lump

This is the culmination of a series of historical changes, which are also described by Richard S. Davis et al in their 2016 article in the journal *Metrologia*. Originally the definition of mass was in terms of what was then thought of as a universal physical constant. In 1791, 1 kg was defined as the mass of one litre of distilled water at its melting point. Thus, the density of water was the physical constant on which this definition hinged. In 1799, the kilogram came to be defined using a cylinder of platinum – the first time an artefact was used for this purpose. But it was also defined as equivalent to the mass of one litre of distilled water at atmospheric pressure and at about 4 degrees Celsius, the temperature at which water has the maximum density. This was done away with in 1889 when the community adopted the International Prototype of the Kilogram — a cylinder made of an alloy that's 90% platinum and 10% iridium. The reference to the 'physical constant', i.e. mass of one litre of water, was abandoned. Now, as a culmination of this historical process, we come back full circle and find that the kilogram is defined again in terms of a fundamental physical constant — the Planck's constant. Planck's constant is a robust number to match. Not until the art of travelling at relativistic speeds, close to the speed of light, is mastered, will we have to redefine these abstract definitions. Until then, it looks like metrologists are on a stable berth.

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