

# Change in the definition of 'Kilogram'

## Why in news?

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The Definition of the Kilogram is about to change by redefining the International system of units(SI).

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### How does the measurement of kilogram evolve?

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- There are seven fundamental units and every other unit of measurement can be derived from one or more of these seven units.  $\n$ 

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# THE SEVEN FUNDAMENTAL UNITS

UNIT	QUANTITY	HOW IT IS/WILL BE DEFINED
Meter*	Distance	Based on speed of light
Kilogram**	Mass	To be based on Planck constant
Second*	Time	Based on radiation of caesium-133 atom
Ampere**	Current	To be based on an electron's charge
Kelvin**	Temperature	To be based on Boltzmann constant
Mole**	Amount of substance	To be based on Avogadro constant
Candela*	Luminous intensity	From efficacy of light of specific frequency
		*Current definition stands ** Being redefined

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• Three of the seven fundamental units are already based on unchanging properties of nature.

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• These are the second (time), the metre (distance), and the candela (luminous

intensity, a measure for light's brightness).

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- Hence, scientists want to create a measurement system that is based entirely on unchanging fundamental properties of nature.
- The first kilogram (originally called a grave) was defined in 1793 by a commission of the French Academy of Sciences, who wanted a better standard than the <u>fixed amounts of grain</u> that had traditionally been used. n
- The commission decided that the new measure would be the mass of <u>one</u> <u>cubic decimetre of distilled water</u> at 4 degree celcius (the temperature at which water has its highest density under standard conditions).  $\n$
- This had the advantage in that most properly equipped labs would be able to reproduce this standard.  $\n$
- Subsequently, a prototype of this mass was cast in brass.  $\n$
- Unfortunately, this definition/calculation of mass depended upon another variable measurement, the metre.  $\n$
- At this point, the metre was only provisionally defined as part of the distance from the North Pole to the equator.  $\n$
- However, once the value of the metre and the temperature of water at its densest were more accurately defined, a new prototype was cast in platinum to represent this mass(kilogram).
- These variable measurements were finally replaced with the <u>international</u> <u>prototype kilogram</u> (IKP), used today, which is a **metal** cast from a <u>mixture</u> <u>of platinum and iridium</u> to make it very hard and prevent it reacting with oxygen.
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- Since 1889, countries who are members of the General Conference on Weights and Measures have agreed to use this standard block of metal kept near Paris to define the kilogram.
- This made the kilogram to be the only base unit in the SI still <u>defined by a</u> <u>physical object</u>.
- Six Copies of the IKP are transported across the world to ensure all participating countries use the same standard.
- But although this metal is stored in a highly controlled environment, its

weight can change by tiny amounts as <u>wear and tear</u> causes it to lose mass and dirt causes it to increase.

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• Hence, even the modern IPK to measure the kilogram can gradually change in mass.

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## What is the proposed measure?

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• To address this problem, scientists around the world have spent nearly two decades discussing how the kilogram could instead be defined in relation to <u>constant measurements</u> of nature.

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- So they decided that instead of measuring the kilogram against a block stored in a vault, it should be based on precise values of constants of nature.  $\n$ 

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• Thus the kilogram's definition is set to change and the new definition of the kilogram uses a measurement from another fixed value from nature, <u>Planck's constant</u> (h).

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- Planck's constant will be defined as  $6.62607015 \times 10-34$  joule seconds and can be found by dividing the electromagnetic frequency of a particle of light or "photon" by the amount of energy it carries.
- The constant is usually measured in joule seconds but this can also be expressed as  ${\bf kilogram}$  square metres per second.  $\n$
- Since 1967, the second has been defined as the time it takes for a certain amount of energy to be released as radiation from atoms of Caesium-133.  $\n$
- This became the basis of all measures of time, and is used in atomic clocks.  $\ensuremath{\sc vn}$
- The SI unit of the metre is also based on another universal constant, namely the speed of light.  $\gamma_n$
- The metre is defined as the distance travelled by light in vacuum in 1/299,792,458 of a second (which is already defined).  $\n$

• Thus, since definition of a second and a metre have already adjusted to universal constants, by adding these measurements, along with an exact knowledge of Planck's constant, a very precise definition of the kilogram can be reached easily.

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### Does this redefining really help science?

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- The change in definition of the second, previously, has helped ease communication across the world via technologies like GPS and the Internet.  $\n$
- In the same way, the change in the kilogram will be better for technology, retail and health.

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• For most people, everyday life will carry on as normal despite the redefinitions.

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- One standard bag of sugar will contain as much sugar as it ever did.  $\slash n$
- But some of these changes will mean practical advantages for scientists making very precise measurements.  $\gamman \ensurement$
- Thus, to answer the question how much is a kilogram, we will no longer have to compare blocks of platinum or worry about scratching them.  $\n$

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### Source: The Indian Express, The Wire

