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.
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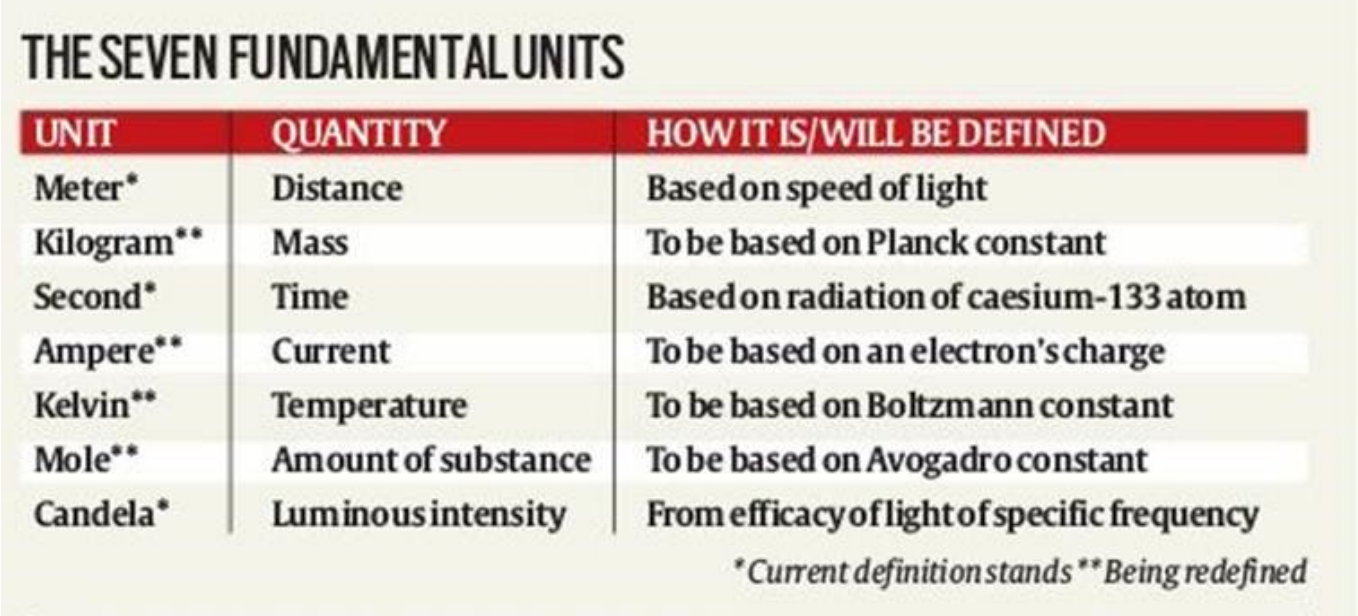

THE SEVEN FUNDAMENTAL UNITS

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.
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- 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 fixed amounts of grain that had traditionally been used.
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- The commission decided that the new measure would be the mass of one cubic decimetre of distilled water at 4 degree celcius (the temperature at which water has its highest density under standard conditions).
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- This had the advantage in that most properly equipped labs would be able to reproduce this standard.
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- Subsequently, a prototype of this mass was cast in brass.
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- Unfortunately, this definition/calculation of mass depended upon another variable measurement, the metre.
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- At this point, the metre was only provisionally defined as part of the distance from the North Pole to the equator.
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- 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).
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- These variable measurements were finally replaced with the international prototype kilogram (IKP), used today, which is a **metal** cast from a mixture of platinum and iridium 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.
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- This made the kilogram to be the only base unit in the SI still defined by a physical object.
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- Six Copies of the IKP are transported across the world to ensure all participating countries use the same standard.
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- But although this metal is stored in a highly controlled environment, its

weight can change by tiny amounts as wear and tear 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 constant measurements 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.
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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, Planck's constant (h).
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- Planck's constant will be defined as 6.62607015×10−34 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.
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- The constant is usually measured in joule seconds but this can also be expressed as **kilogram** square **metres** per **second**.
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- 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.
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- This became the basis of all measures of time, and is used in atomic clocks.
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- The SI unit of the metre is also based on another universal constant, namely the speed of light.
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- The metre is defined as the distance travelled by light in vacuum in 1/299,792,458 of a second (which is already defined).
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- 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.
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- 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.
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- But some of these changes will mean practical advantages for scientists making very precise measurements.
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- 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.
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Source: The Indian Express, The Wire

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