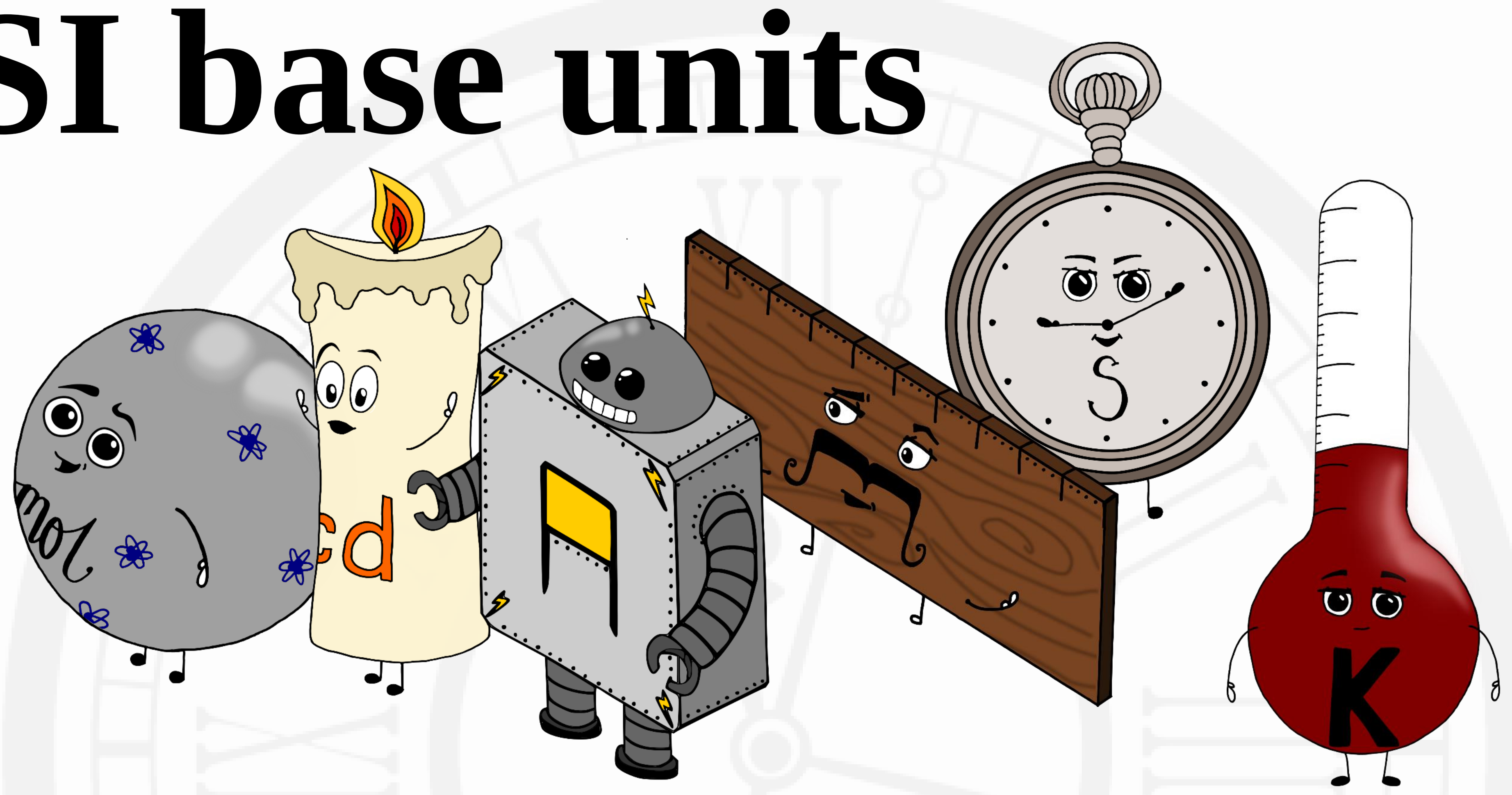
Revision of the SI base units



Did you know that we have been revised?

Revised? But why?

You first need to understand where the SI units came from.

As a consequence of there being many different units in use around the world, in 1875 a number of countries agreed to the "Convention of the Metre" which declared a standard set of units for length, time, and mass, the so called Metric System. Units for electric current, temperature, luminosity, and amount of substance were introduced in later years to form the International System of Units (SI).

metre

second

kilogram

ampere

kelvin

candela

mole

Some of the units used to have reference to physical artefacts, the most famous being the International Prototype of the Kilogram (IPK), which was held in a vault in Paris.
The problem with using a physical artefact to define the unit, is that it is subject to changes in properties over time. Since the creation of the IPK in 1889 variations in environmental conditions caused the mass to change, so the definition of the kilogram was linked to something that was unstable over long periods of time.

In the revised SI the new definitions are based on seven of the most important fundamental constants of nature, which are now known to a very high precision. Each of the constants is linked to one or more of the seven SI base units.

$\Delta\nu$ (^{133}Cs) = 9 192 631 770 **s**$^{-1}$ (Hz)
unperturbed ground state hyperfine transition frequency of the caesium-133 atom

c = 299 792 458 **m** s^{-1}
speed of light in vacuum

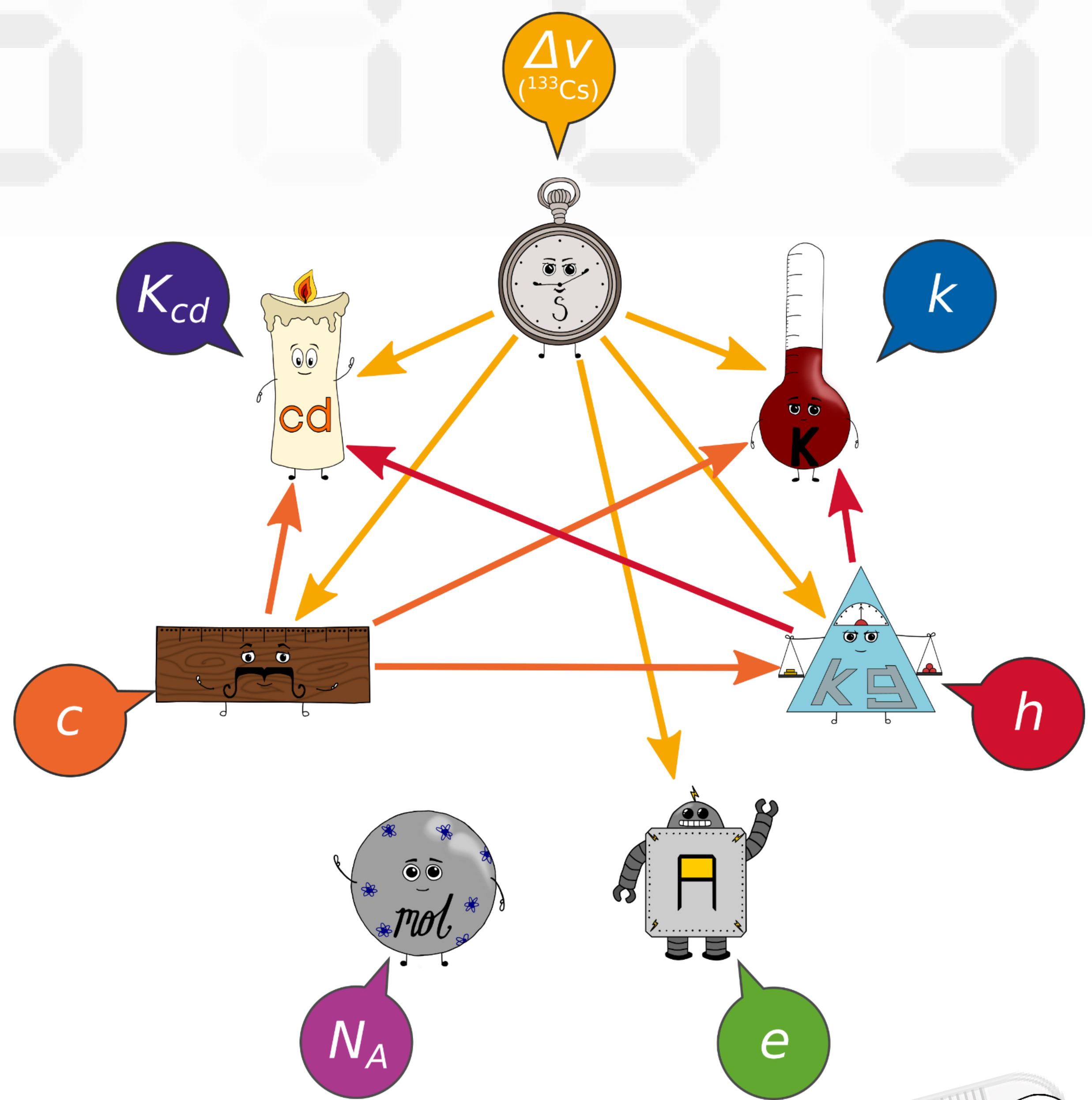
h = 6.626 070 15 × 10^{-34} **kg** m^2 s^{-1} (J s)
Planck constant

k = 1.380 649 × 10^{-23} kg m^2 **K**$^{-1}$ s^{-2} (J K^{-1})
Boltzmann constant

e = 1.602 176 634 × 10^{-19} **A** s (C)
elementary charge

K_{cd} = 683 **cd** kg^{-1} m^{-2} s^3 (lm/W)
luminous efficacy of monochromatic radiation of frequency 540 × 10^{12} Hz

N_A = 6.022 140 76 × 10^{23} **mol**$^{-1}$
Avogadro constant



Scientists can now measure the seven SI base units with ever increasing accuracy and precision, as more advanced experiments and technologies are designed.

Practical measurement in every aspect of our lives, from everyday activities, to science and engineering to medicine, to trade and industry, all of it, now has reference to a scale defined by nature, through the fundamental constants.

The famous physicist Max Planck made this extraordinary statement in 1927 about linking the measurement units to constants of nature, that "they will necessarily retain their validity for all times and cultures, even extra-terrestrial and nonhuman."

nmisa
National Metrology Institute of South Africa

MeASURe
Metrological and Applied Sciences University Research Unit

DEPARTMENT OF PHYSICS
UNIVERSITY OF CAPE TOWN