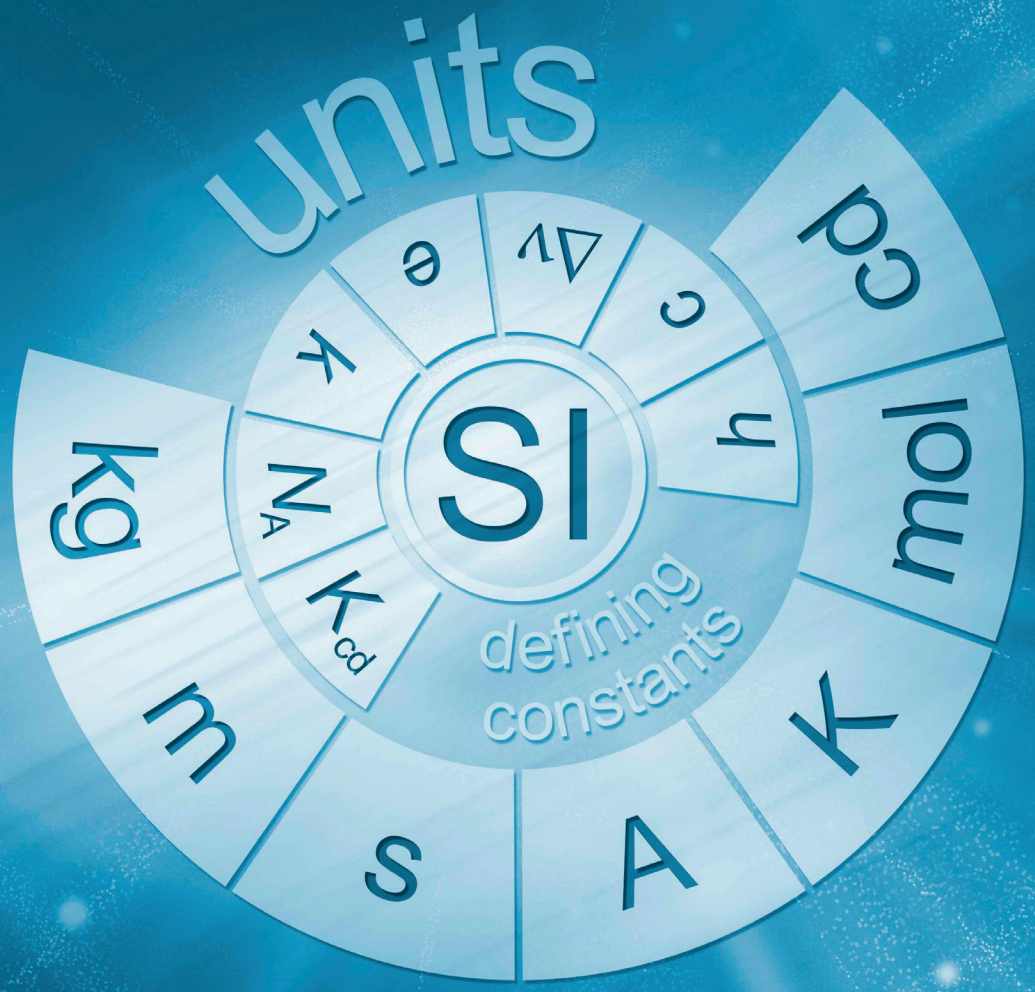
# Infographics:
# The International System of Units (SI)

To be used for specific audiences

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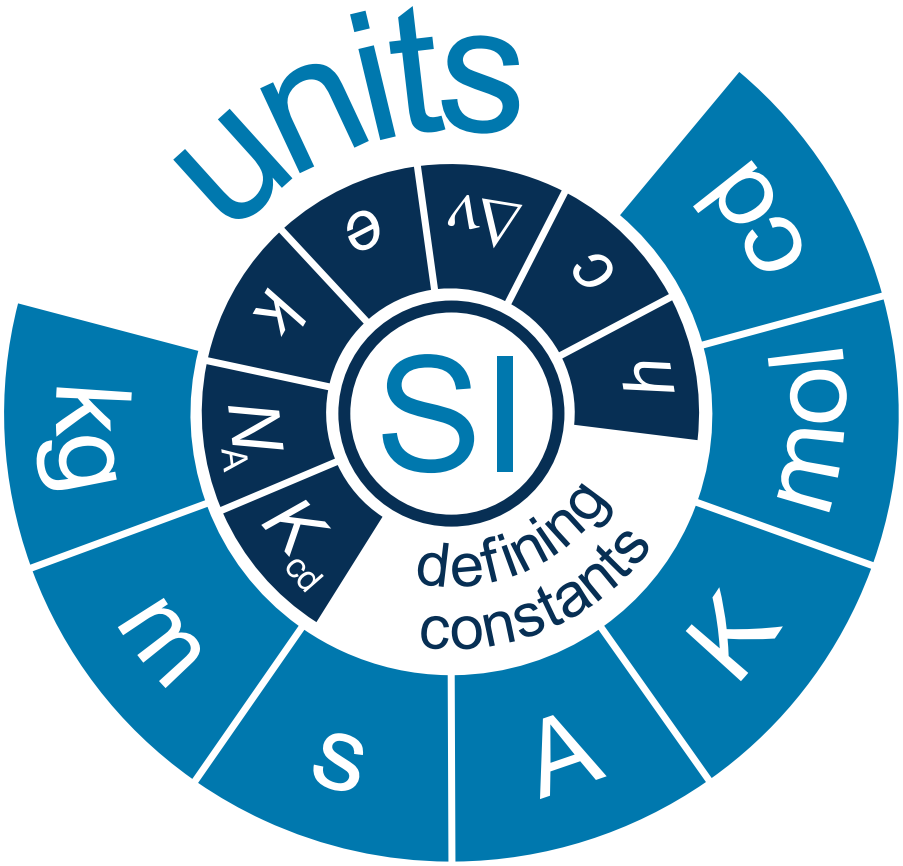


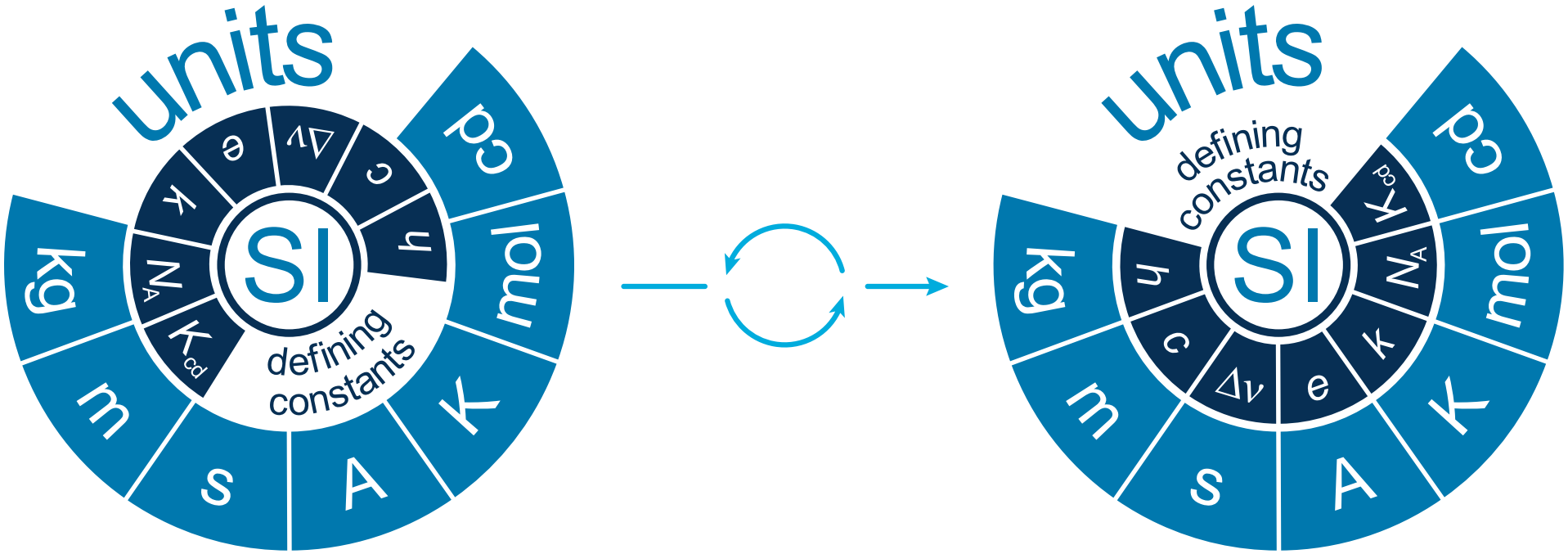

## Revising the system

In the system that comprises the units currently in use, the values of the fundamental constants are determined. This is how we have defined what a kilogram is, and we use this unit to determine the mass of a proton, of an electron or of other elementary particles. This leads to the remarkable situation that the values of the fundamental constants are in a permanent state of flux, since our measurement capabilities are reflected in these values. There is even a group of experts, the "CODATA Task Group on Fundamental Constants" in the United States, whose task it is to assess the values of fundamental constants measured in physics laboratories throughout the world and to bring them in line with one another. Every four years, the charge of an electron, to name one example, is assigned a new numerical value although – in reality – the charge itself has not changed at all. What has changed is merely our proficiency at the art of measuring and thus our knowledge of the world.

By revising the system of units, the tables will be turned: in the new system, it will be possible to express any velocity as a function of the speed of light, or each electric charge as a function of the elementary charge of an electron. This means that, in the new system, the units are no longer set in stone but are calculated on the basis of the specified fundamental constants. However, it would be preferable, for example, for 37 °C to remain the body temperature of a healthy human being or for us not to have to worry about the new definition of the kilogram while we are standing on our bathroom scale. For this reason (i.e., to ensure a smooth transition from the old system to the new system), metrology laboratories are trying to measure the constants in question one last time with the best possible accuracy. These experiments are being conducted in the form of a cooperative competition between the national metrology institutes. And eventually, besides the already defined "clock frequency" in the cesium atom and the speed of light, the following constants will also be assigned fixed values: Planck's quantum of action (or Planck's constant) $h$, the Avogadro constant $N_A$, the Boltzmann constant $k_B$ and the elementary charge $e$.

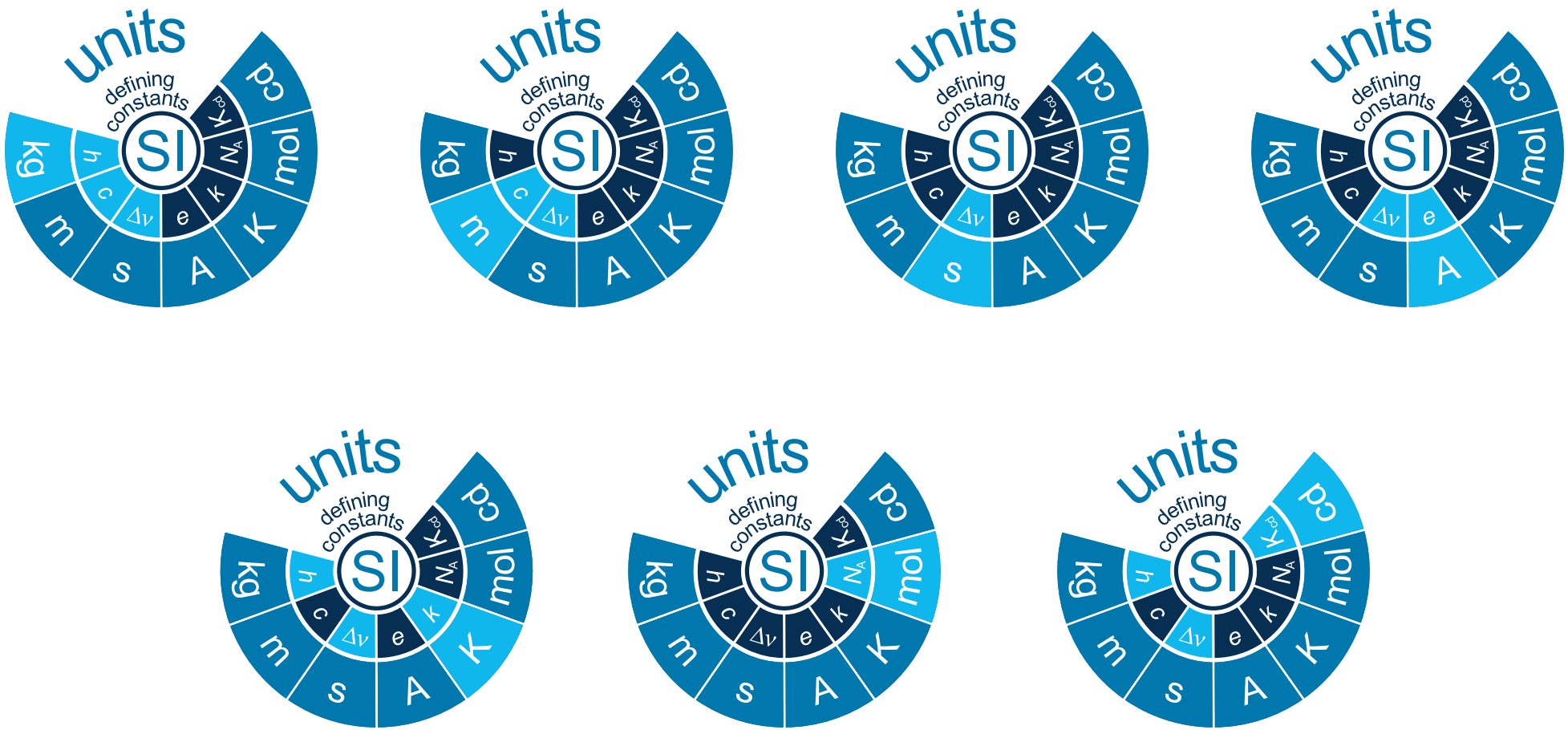
# A milestone

The new system of units represents a milestone in the history of science. By being based on fundamental constants, the definitions of the units become, in principle, universal. For science, this is a tremendous progress, alone from a systematic point of view. “Systematic” refers to the scope of application of the SI and at the same time represents its inner logics. In the new SI, the differentiation into base units and derived units, for example, is no longer needed. All units are instead “derived” from fundamental constants; against this background, they are all equivalent.



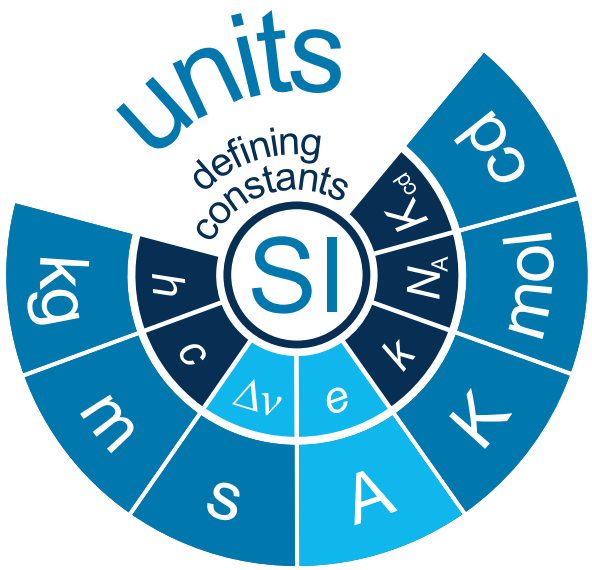
# Units and defining constants

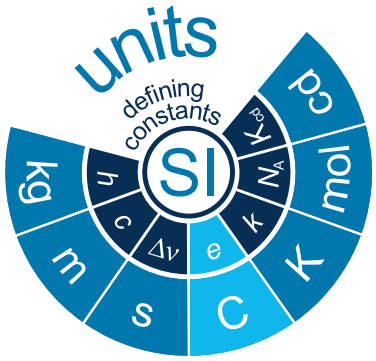
The new SI is much more abstract. In this system, each unit is obtained via fundamental constants that, by means of multiplication, are coupled with each other. In most cases, several fundamental constants are indeed necessary in order to realize a unit. The meter, for instance, needs two constants; the kilogram needs three.

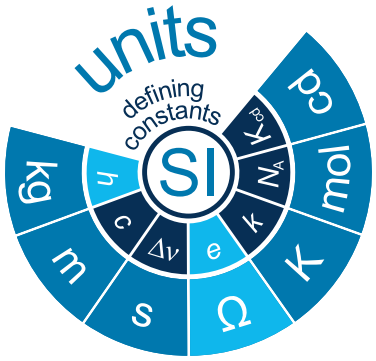


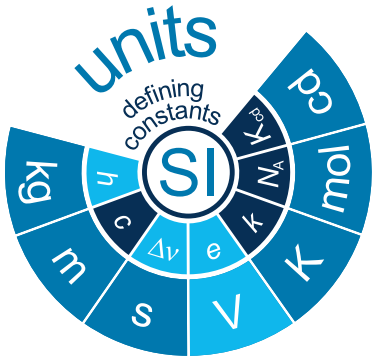
# Electrical units and their constants

One of the numerous advantages of the new SI is that the realization of the electrical units once again conforms with the system. Since the volt and the ohm used to be based on quantum effects with well-defined values for the Josephson constant and the von Klitzing constant, they formed a kind of parallel system of units outside the SI. The new SI does away with this parallel universe due to the fact that all electrical units can be derived from the set of given fundamental constants. The coulomb (C) needs only one constant; the ohm (Ω) needs two, and the volt (V) three.



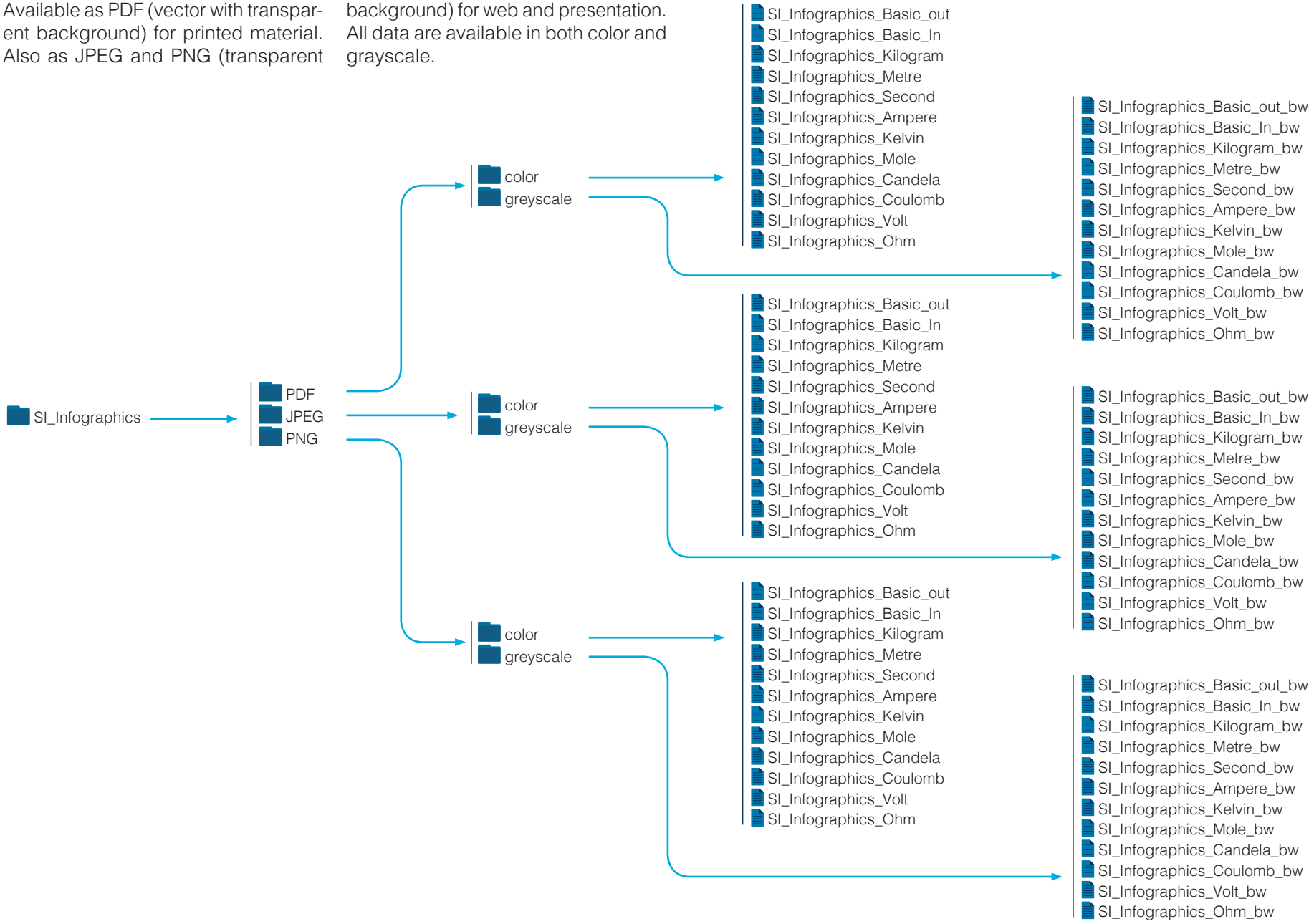



# Data

Available as PDF (vector with transparent background) for printed material. Also as JPEG and PNG (transparent background) for web and presentation. All data are available in both color and grayscale.



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