What is a Moment

What is a day? 24 hours, 60 minutes, 60 seconds.

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In today's world, the most widely used numeral system is decimal (base 10), a system that probably originated because it made it easy for humans to count using their fingers. The civilizations that first divided the day into smaller parts, however, used different numeral systems, specifically duodecimal (base 12) and sexagesimal (base 60).

Thanks to documented evidence of the Egyptians' use of sundials, most historians credit them with being the first civilization to divide the day into smaller parts. The first sundials were simply stakes placed in the ground that indicated time by the length and direction of the resulting shadow. As early as 1500 B.C., the Egyptians had developed a more advanced sundial. A T-shaped bar placed in the ground, this instrument was calibrated to divide the interval between sunrise and sunset into 12 parts. This division reflected Egypt's use of the duodecimal system--the importance of the number 12 is typically attributed either to the fact that it equals the number of lunar cycles in a year or the number of finger joints on each hand (three in each of the four fingers, excluding the thumb), making it possible to count to 12 with the thumb. The next-generation sundial likely formed the first representation of what we now call the hour. Although the hours within a given day were approximately equal, their lengths varied during the year, with summer hours being much longer than winter hours.

Without artificial light, humans of this time period regarded sunlit and dark periods as two opposing realms rather than as part of the same day. Without the aid of sundials, dividing the dark interval between sunset and sunrise was more complex than dividing the sunlit period. During the era when sundials were first used, however, Egyptian astronomers also first observed a set of 36 stars that divided the circle of the heavens into equal parts. The passage of night could be marked by the appearance of 18 of these stars, three of which were assigned to each of the two twilight periods when the stars were difficult to view. The period of total darkness was marked by the remaining 12 stars, again resulting in 12 divisions of night (another nod to the duodecimal system). During the New Kingdom (1550 to 1070 B.C.), this measuring system was simplified to use a set of 24 stars, 12 of which marked the passage of the night. The clepsydra, or water clock, was also used to record time during the night, and was perhaps the most accurate timekeeping device of the ancient world. The timepiece--a specimen of which, found at the Temple of Ammon in Karnak, dated back to 1400 B.C.--was a vessel with slanted interior surfaces to allow for decreasing water pressure, inscribed with scales that marked the division of the night into 12 parts during various months.

Once both the light and dark hours were divided into 12 parts, the concept of a 24-hour day was in place. The concept of fixed-length hours, however, did not originate until the Hellenistic period, when Greek astronomers began using such a system for their theoretical calculations. Hipparchus, whose work primarily took place between 147 and 127 B.C., proposed dividing the day into 24 equinoctial hours, based on the 12 hours of daylight and 12 hours of darkness observed on equinox days. Despite this suggestion, laypeople continued to use seasonally varying hours for many centuries. (Hours of fixed length became commonplace only after mechanical clocks first appeared in Europe during the 14th century.)

Hipparchus and other Greek astronomers employed astronomical techniques that were previously developed by the Babylonians, who resided in Mesopotamia. The Babylonians made astronomical calculations in the sexagesimal (base 60) system they inherited from the Sumerians, who developed it around 2000 B.C. Although it is unknown why 60 was chosen, it is notably convenient for expressing fractions, since 60 is the smallest number divisible by the first six counting numbers as well as by 10, 12, 15, 20 and 30.

Although it is no longer used for general computation, the sexagesimal system is still used to measure angles, geographic coordinates and time. In fact, both the circular face of a clock and the sphere of a globe owe their divisions to a 4,000-year-old numeric system of the Babylonians.

The Greek astronomer Eratosthenes (who lived circa 276 to 194 B.C.) used a sexagesimal system to divide a circle into 60 parts in order to devise an early geographic system of latitude, with the horizontal lines running through well-known places on the earth at the time. A century later, Hipparchus normalized the lines of latitude, making them parallel and obedient to the earth's geometry. He also devised a system of longitude lines that encompassed 360 degrees and that ran north to south, from pole to pole. In his treatise *Almagest* (circa A.D. 150), Claudius Ptolemy explained and expanded on Hipparchus' work by subdividing each of the 360 degrees of latitude and longitude into smaller segments. Each degree was divided into 60 parts, each of which was again subdivided into 60 smaller parts. The first division, *partes minutae primae,* or first minute, became known simply as the "minute." The second segmentation, *partes minutae secundae,* or "second minute," became known as the second.

Minutes and seconds, however, were not used for everyday timekeeping until many centuries after the *Almagest.* Clock displays divided the hour into halves, thirds, quarters and sometimes even 12 parts, but never by 60. In fact, the hour was not commonly understood to be the duration of 60 minutes. It was not practical for the general public to consider minutes until the first mechanical clocks that displayed minutes appeared near the end of the 16th century. Even today, many clocks and wristwatches have a resolution of only one minute and do not display seconds.

Thanks to the ancient civilizations that defined and preserved the divisions of time, modern society still conceives of a day of 24 hours, an hour of 60 minutes and a minute of 60 seconds. Advances in the science of timekeeping, however, have changed how these units are defined. Seconds were once derived by dividing astronomical events into smaller parts, with the International System of Units (SI) at one time defining the second as a fraction of the mean solar day and later relating it to the tropical year. This changed in 1967, when the second was redefined as the duration of 9,192,631,770 energy transitions of the cesium atom. This re-characterization ushered in the era of atomic timekeeping and Coordinated Universal Time (UTC).

Interestingly, in order to keep atomic time in agreement with astronomical time, leap seconds occasionally must be added to UTC. Thus, not all minutes contain 60 seconds. A few rare minutes, occurring at a rate of about eight per decade, actually contain 61.

And What about the second…

second, fundamental unit of time, now defined in terms of the ***radiation (***see, below***)*** frequency at which atoms of the element cesium change from one state to another.

The second was formerly defined as 1/86,400 of the mean solar day—i.e., the average period of rotation of the Earth on its axis relative to the Sun. In the mid-20th century this definition became inadequate because of the need for increased precision in timekeeping. In 1956 the second was redefined by the International Committee on Weights and Measures as 1/31,556,925.9747 of the length of the tropical (seasonal) year 1900. In 1967 the 13th General Conference on Weights and Measures provisionally defined the second as 9,192,631,770 cycles of radiation associated with the transition between the two hyperfine levels of the ground state of the cesium-133 atom (*see* ***atomic time***). The number of cycles of radiation was chosen to make the length of the defined second correspond as closely as possible to that of the now obsolete astronomically determined second of Ephemeris Time (defined as the fraction of the tropical year given above). As the rate of rotation of the Earth constantly changes, it is necessary to occasionally add (or theoretically to subtract) a second during the year to ensure the atomic timescale Coordinated Universal Time (UTC) stays in synchronization with nature. This represents the sole definition of the second in the International System of Units (SI).

Radiation

radiation measurement, technique for detecting the intensity and characteristics of ionizing radiation, such as alpha, beta, and gamma rays or neutrons, for the purpose of measurement. The term ionizing radiation refers to those subatomic particles and photons whose energy is sufficient to cause ionization in the matter with which they interact. The ionization process consists of removing an electron from an initially neutral atom or molecule. For many materials, the minimum energy required for this process is about 10 electron volts (eV), and this can be taken as the lower limit of the range of ionizing radiation energies.

And Finally, the Moment

Max Planck and the smallest unit of time, length, mass and temperature

What is a “moment”?

1. The smallest natural unit of measure of time as experienced in our physical universe.
2. A unit of perceivable time experienced in the sentient mind.

The concept of natural units was introduced in 1874, when George Johnstone Stoney, noting that electric charge is quantized, derived units of length, time, and mass, now named Stoney units in his honor. Stoney chose his units so that G, c, and the electron charge e would be numerically equal to 1.

In 1899, one year before the advent of quantum theory, ***Max Planck*** introduced what became later known as the Planck constant. At the end of the paper, he proposed the base units that were later named in his honor. The Planck units are based on the quantum of action, now usually known as the Planck constant, which appeared in the Wien approximation for black-body radiation. Planck underlined the universality of the new unit system, writing:

> *... die Möglichkeit gegeben ist, Einheiten für Länge, Masse, Zeit und Temperatur aufzustellen, welche, unabhängig von speciellen Körpern oder Substanzen, ihre Bedeutung für alle Zeiten und für alle, auch*

ausserirdische und aussermenschliche Culturen nothwendig behalten und welche daher als »natürliche Maasseinheiten - bezeichnet werden können.

In English;

... it is possible to set up units for length, mass, time and temperature, which are independent of special bodies or substances, necessarily retaining their meaning for all times and for all civilizations, including extraterrestrial and non-human ones, which can be called "natural units of measure".

Table 1: Modern values for Planck's original choice of quantities

Name	Dimension	Expression	Value (SI units)
Planck length	length (L)	$l_P = \sqrt{\frac{\hbar G}{c^3}}$	1.616 255(18) × 10^{-35} m[7]
Planck mass	mass (M)	$m_P = \sqrt{\frac{\hbar c}{G}}$	2.176 434(24) × 10^{-8} kg[8]
Planck time	time (T)	$t_P = \sqrt{\frac{\hbar G}{c^5}}$	5.391 247(60) × 10^{-44} s[9]
Planck temperature	temperature (Θ)	$T_P = \sqrt{\frac{\hbar c^5}{G k_B^2}}$	1.416 784(16) × 10^{32} K[10]

For our purpose of trying to perceive the "length" of a moment of "time", the above number or units for the smallest possible unit of time is a decimal point followed by 43 zeros and then 5391247.

What does this mean? Well, it means that it would take Trillions upon Trillions of these "***Planck moments***" to amount to a single second of our attention.

With this knowledge we can begin to imagine the 3000 Realms in a single thought moment of life, and the unfathomable, the incalculable number of "Realms" manifesting influence on our experienced reality in each moment of our existence. The idea that we can "perceive" or experience any single realm in one second of thought is so delusional that is untenable and futile.

More useful for our practice and enlightenment is to train diligently our Buddha-mind-state to stay alert and omnipresent (***awakened***) so as to influence and guide this vast stream of moments and incalculable realms toward Life Affirming, Compassionate and Loving thoughts and actions of all type.

Moments, though too inconceivably brief, are another term in Buddhism to fathom the depth of forces we challenge in our daily practice of awakening. It is important to stay confident in our deep capacity for enlightenment and not discouraged by the sometimes overwhelming concepts of Buddhist thought. It is sufficient to understand that moments are very powerful "actors" in our life. All the more incentive then to remain aware and in a Buddha mind-state.