Radian is equal to

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Radians Most of the time we measure angles in degrees. For example, there are 360° in a full circle or one cycle of a sine wave, and sin(30°) = 0.5 and cos(90°) = 0. But it turns out that a more natural measure for angles, at least in mathematics, is in radians. An angle measured in radians is the ratio of the arc length of a circle subtended by that angle, divided by the radius of the circle. To put that mouth full of words into a diagram, the figure below shows an angle of 90°, the arc length L subtended by that angle, and the radius r of the circle. The circumference of the entire circle is (2 π r); the arc length of the 1/4 of that circle subtended by this angle is L = (2 π r) / 4 = (π r) / 2; and the ratio of that arc length L to the radius r is π / 2. So 90° = π / 2 radians. We usually suppress the unit of measurement "radians" since it is understood if no other units for angles is specified. Also, since an angle in radians is defined as the ratio of two lengths, L/r, it is dimensionless. Since 90° = π / 2 radians, to four significant figures, one radian equals 180°/ π = 57.30°. There are 2π radians in a full circle. (So 2π radians should equal 360°. Check it out by multiplying 57.30° by 2π = 6.283. You should get 360° to four significant figures.) 30°, which is 1/12 of a full circle, therefore equals 2π/12 = π/6 radians and sin(π/6) = 0.5 90°, which is 1/4 of a full circle, therefore equals 2π/4 =π/2 radians, and cos(π/2) = 0 So when I wrote s(t) = sin(2 π 3000 t) to express one of the signals in our discussion with angles measured in radians, I could instead have written s(t) = sin(1,080,000° t) which is the equivalent expression when angles are measured in degrees. That's because there are 360° in a cycle (a full circle) so 3000 cycles per second equals 3000 cycles/sec x 360°/cycle = 1,080,000°/sec. Why are radians more natural than degrees? Comparing the first and second above expressions for s(t), it is easier to see that the frequency is 3 kHz (3000 cycles per second) when angles are measured in radians – provided I leave the 2π factor as an explicit multiplier, which mathematicians and engineers always do. A second, more fundamental reason that radians are more natural can be seen from the "power series" for sine and cosine. These are infinite series that converge to the sine and cosine functions. If angles are measured in radians then sin(x) = x - x3/3! + x5/5! - x7/7! + x9/9! ... and cos(x) = 1 - x2/2! + x4/4! - x6/6! + x8/8! ... The same power series would be less "elegant" (a favorite word of mathematicians) if angles are measured in degrees: sin(x) = (π x / 180) - (π x / 180)3 / 3! + (π x / 180)5 / 5! - (π x / 180) x7 / 7! + π x9 / 9! ... and cos(x) = 1 - (π x / 180)2 / 2! + (π x / 180)4 / 4! - (π x / 180)6/ 6! + (π x / 180)8 / 8! ... As an exercise, you may want to take the power series for sin(x) where x is in radians, substitute x = π/6 = 0.5236 and see how close it comes to 0.5, the correct value for sin(30°) as you vary the number of terms. [Hint: It takes so few terms that you can do it easily on a non-programmable pocket calculator.] If you liked that first exercise, you may want to try the power series for cos(x) with x = π/2 = 1.5708 and see how fast it converges to 0. While this computation, too, can be done on a non-programmable pocket calculator, it requires a few more terms and you might want to use a spreadsheet program to help. Radians, like degrees, are a way of measuring angles. One radian is equal to the angle formed when the arc opposite the angle is equal to the radius of the circle. So in the above diagram, the angle ø is equal to one radian since the arc AB is the same length as the radius of the circle. Now, the circumference of the circle is 2 PI r, where r is the radius of the circle. So the circumference of a circle is 2 PI larger than its radius. This means that in any circle, there are 2 PI radians. Therefore 360º = 2 PI radians. Therefore 180º = PI radians. So one radian = 180/ PI degrees and one degree = PI /180 radians. Therefore to convert a certain number of degrees in to radians, multiply the number of degrees by PI /180 (for example, 90º = 90 × PI /180 radians = PI /2). To convert a certain number of radians into degrees, multiply the number of radians by 180/ PI . Arc Length The length of an arc of a circle is equal to ∅, where ∅ is the angle, in radians, subtended by the arc at the centre of the circle (see below diagram if you don't understand). So in the below diagram, s = r∅ . Area of Sector The area of a sector of a circle is ½ r^2 ∅, where r is the radius and ∅ the angle in radians subtended by the arc at the centre of the circle. So in the below diagram, the shaded area is equal to ½ r^2 ∅ . See the video below for more information on how to convert radians and degrees 1 Know that π radians is equal to 180 degrees. Before you begin the conversion process, you have to know that π radians = 180°, which is equivalent to going halfway around a circle. This is important because you'll be using 180/π as a conversion metric. This is because 1 radians is equal to 180/π degrees.[1] 2 Multiply the radians by 180/π to convert to degrees. It's that simple. Let's say you're working with π/12 radians. Then, you've got to multiply it by 180/π and simplify when necessary. Here's how you do it:[2] π/12 x 180/π = 180π/12π ÷ 12π/12π = 15° π/12 radians = 15° Advertisement 3 Practice with a few examples. If you really want to get the hang of it, then try converting from radians to degrees with a few more examples. Here are some other problems you can do: Example 1: 1/3π radians = π/3 x 180/π = 180π/3π ÷ 3π/3π = 60° Example 2: 7/4π radians = 7π/4 x 180/π = 1260π/4π ÷ 4π/4π = 315° Example 3: 1/2π radians = π /2 x 180/π = 180π /2π ÷ 2π/2π = 90° 4 Remember that there's a difference between "radians" and "π radians." If you say 2π radians or 2 radians, you are not using the same terms. As you know, 2π radians is equal to 360 degrees, but if you're working with 2 radians, then if you want to convert it to degrees, you will have to calculate 2 x 180/π. You will get 360/π, or 114.5°. This is a different answer because, if you're not working with π radians, the π does not cancel out in the equation and results in a different value.[3] Advertisement Add New Question Question Convert 1.03 radians to degrees. We know from working with the numbers in the article above that one radian is equivalent to approximately 57.3 degrees. Therefore, you would multiply 57.3 by 1.03 to find the number of degrees you're looking for. Question How do I convert degrees into radians? The easiest way to do it is to recognize that 180° equals π radians, or 3.14 radians. Then determine what fraction (or percentage) of 180° the angle you're concerned with is, and multiply that fraction by 3.14 radians. For example, to convert 60° to radians, divide 60° by 180°. That's 1/3. Then multiply 1/3 by 3.14: that's 1.05 radians. Question How do I convert 11/16 of a radian to degrees? Since 1 radian is approximately 57.3 degrees, 11/16 of a radian is (11/16)(57.3°) = 39.39°. See more answers Ask a Question Advertisement Thanks! Thanks! Advertisement Pen or Pencil Paper Calculator wikiHow is a "wiki," similar to Wikipedia, which means that many of our articles are co-written by multiple authors. To create this article, 15 people, some anonymous, worked to edit and improve it over time. This article has been viewed 692,174 times. Co-authors: 15 Updated: July 8, 2022 Views: 692,174 Categories: Trigonometry Article SummaryXRadians and degrees are both units that you can use to measure an angle. Converting radians to degrees is pretty easy. First, remember that π radians is equal to 180 degrees, or half the number of degrees in a circle. That means that 1 radian is equal to 180 degrees divided by π. So, in order to convert radians to degrees, all you have to do is multiply the number of radians by 180 divided by π. For instance, let's say you have to convert 1/2 π radians into degrees. Simply multiply π/2 by 180/ π to get 90 degrees. Be careful though, because while radians are usually written as multiples of π, this isn't always the case. When you're solving a problem where you have to convert radians to degrees, look at the numbers closely. Make sure, for example, that you don't mix up 2 π radians with 2 radians. 2 π radians equals 360 degrees, or the number of degrees in a circle. However, 2 radians is equal to only about 114.6 degrees. For more examples of converting radians to degrees, read on! Print Send fan mail to authors Thanks to all authors for creating a page that has been read 692,174 times. "This article helped me a lot to study for my exam. It explained for me every single bit of the subject. Thanks really, thanks to you."..." more Share your story SI derived unit of angle For the measure of ionizing radiation, see Rad (unit). For other uses, see Radian (disambiguation). RadianAn arc of a circle with the same length as the radius of that circle subtends an angle of 1 radian. The circumference subtends an angle of 2π radians.General informationUnit systemSIUnit ofAngleSymbolrad, c or rConversions 1 rad in ...... is equal to ... milliradians 1000 mrad turns 1/2π turn degrees 180°/π ≈ 57.296° gradians 200g/π ≈ 63.662g The radian, denoted by the symbol rad, is the unit of angle in the International System of Units (SI), and is the standard unit of angular measure used in many areas of mathematics. The unit was formerly an SI supplementary unit (before that category was abolished in 1995).[1] The radian is defined in the SI as being a dimensionless unit with 1 rad = 1.[2] Its symbol is accordingly often omitted, especially in mathematical writing. Definition One radian is defined as the angle subtended from the center of a circle which intercepts an arc equal in length to the radius of the circle.[3] More generally, the magnitude in radians of a subtended angle is equal to the ratio of the arc length to the radius of the circle; that is, θ = s/r, where θ is the subtended angle in radians, s is arc length, and r is radius. A right angle is exactly π/2 radians.[4] The magnitude in radians of one complete revolution (360 degrees) is the length of the entire circumference divided by the radius, or 2πr / r, or 2π. Thus 2π radians is equal to 360 degrees, meaning that one radian is equal to 180/π degrees ≈ 57.295779513082320876... degrees.[5] The relation 2π rad = 360° can be derived using the formula for arc length, ℓ arc = 2 π r (θ 360 ∘) {\textstyle \ell _{\text{arc}}=2\pi r\left({\tfrac {\theta }{360^{\circ }}}\right)} . Since radian is the measure of an angle that subtends an arc of a length equal to the radius of the circle, 1 = 2 π (1 rad 360 ∘) {\textstyle 1=2\pi \left({\tfrac {1{\text{ rad}}}{360^{\circ }}}\right)} . This can be further simplified to 1 = 2 π rad 360 ∘ {\textstyle 1={\tfrac {2\pi {\text{ rad}}}{360^{\circ }}}} . Multiplying both sides by 360° gives 360° = 2π rad. Unit symbol The International Bureau of Weights and Measures[4] and International Organization for Standardization[6] specify rad as the symbol for the radian. Alternative symbols that were in use in 1909 are c (the superscript letter c, for "circular measure"), the letter r, or a superscript R,[7] but these variants are infrequently used, as they may be mistaken for a degree symbol (°) or a radius (r). Hence a value of 1.2 radians would be written today as 1.2 rad; archaic notations could include 1.2 r, 1.2rad, 1.2c, or 1.2R. In mathematical writing, the symbol "rad" is often omitted. When quantifying an angle in the absence of any symbol, radians are assumed, and when degrees are meant, the degree sign ° is used. Dimensional analysis The radian is defined as θ = s/r, where θ is the subtended angle in radians, s is arc length, and r is radius. One radian corresponds to the angle for which s=r, hence 1 radian = 1 m/m.[8] However, r a d {\displaystyle \mathrm {rad} } is only to be used to express angles, not to express ratios of lengths in general.[4] A similar calculation using the area of a circular sector θ = 2A/r2 gives 1 radian as 1 m2/m2.[9] The key fact is that the radian is a dimensionless unit equal to 1. In SI 2019, the radian is defined accordingly as 1 rad = 1.[10] It is a long-established practice in mathematics and across all areas of science to make use of r a d = 1 {\displaystyle \mathrm {rad} =1} .[11][12] In 1993 the AAPT Metric Committee specified that the radian should explicitly appear in quantities only when different numerical values would be obtained when other angle measures were used, such as in the quantities of angle measure (rad), angular speed (rad/s), angular acceleration (rad/s2), and torsional stiffness (N⋅m/rad), and not in the quantities of torque (N⋅m) and angular momentum (kg⋅m2/s).[13] Giacomo Prando says "the current state of affairs leads inevitably to ghostly appearances and disappearances of the radian in the dimensional analysis of physical equations."[14] For example, a mass hanging by a string from a pulley will rise or drop by y=rθ centimeters, where r is the radius of the pulley in centimeters and θ is the angle the pulley turns in radians. When multiplying r by θ the unit of radians of disappears from the result. Similarly in the formula for the angular velocity of a rolling wheel, ω=v/r, radians appear in the units of ω but not on the right hand side.[15] Anthony French calls this phenomenon "a perennial problem in the teaching of mechanics".[16] Oberhofer says that the typical advice of ignoring radians during dimensional analysis and adding or removing radians in units according to convention and contextual knowledge is "pedagogically unsatisfying".[17] At least a dozen scientists have made proposals to treat the radian as a base unit of measure defining its own dimension of "angle", as early as 1936 and as recently as 2022.[18][19][20] Quincey's review of proposals outlines two classes of proposal. The first option changes the unit of a radius to meters per radian, but this is incompatible with dimensional analysis for the area of a circle, πr2. The other option is to introduce a dimensional constant. According to Quincey this approach is "logically rigorous" compared to SI, but requires "the modification of many familiar mathematical and physical equations".[21] In particular Quincey identifies Torrens' proposal, to introduces a constant η equal to 1 inverse radian (1 rad−1) in a fashion similar to the introduction of the constant ε0.[21][22] With this change the formula for the angle subtended at the center of a circle, s = rθ, is modified to become s = ηrθ, and the Taylor series for the sine of an angle θ becomes:[20][23] Sin θ = sin rad (η θ) = η θ − (η θ) 3 3 ! + (η θ) 5 5 ! − (η θ) 7 7 ! + ⋯ . {\displaystyle \operatorname {Sin} \theta =\sin _{\text{rad}}(\eta \theta)=\eta \theta -{\frac {(\eta \theta)^{3}}{3!}}+{\frac {(\eta \theta)^{5}}{5!}}-{\frac {(\eta \theta)^{7}}{7!}}+\cdots .} The capitalized function Sin {\displaystyle \operatorname {Sin} } is the "complete" function that takes an argument with a dimension of angle and is independent of the units expressed,[23] while sin rad {\displaystyle \sin _{\text{rad}}} is the traditional function on pure numbers which assumes its argument is in radians.[24] Sin {\displaystyle \operatorname {Sin} } can be denoted sin {\displaystyle \sin } if it is clear that the complete form is meant.[20][25] SI can be considered relative to this framework as a natural unit system where the equation η = 1 is assumed to hold, or similarly 1 rad = 1. This radian convention allows the omission of η in mathematical formulas.[26] A dimensional constant for angle is "rather strange" and the difficulty of modifying equations to add the dimensional constant is likely to preclude widespread use.[20] Defining radian as a base unit may be useful for software, where the disadvantage of longer equations is minimal.[27] For example, the Boost units library defines angle units with a plane_angle dimension,[28] and Mathematica's unit system similarly considers angles to have an angle dimension.[29][30] Conversions Conversion of common angles Turns Radians Degrees Gradians 0 turn 0 rad 0° 0g 1/24 turn π/12 rad 15° 16+2/3g 1/16 turn π/8 rad 22.5° 25g 1/12 turn π/6 rad 30° 33+1/3g 1/10 turn π/5 rad 36° 40g 1/8 turn π/4 rad 45° 50g 1/2π turn 1 rad c. 57.3° c. 63.7g 1/6 turn π/3 rad 60° 66+2/3g 1/5 turn 2π/5 rad 72° 80g 1/4 turn π/2 rad 90° 100g 1/3 turn 2π/3 rad 120° 133+1/3g 2/5 turn 4π/5 rad 144° 160g 1/2 turn π rad 180° 200g 3/4 turn 3π/2 rad 270° 300g 1 turn 2π rad 360° 400g Between degrees As stated, one radian is equal to 180 ∘ / π {\displaystyle {180^{\circ }}/{\pi }} . Thus, to convert from radians to degrees, multiply by 180 ∘ / π {\displaystyle {180^{\circ }}/{\pi }} . angle in degrees = angle in radians ⋅ 180 ∘ π {\displaystyle {\text{angle in degrees}}={\text{angle in radians}}\cdot {\frac {180^{\circ }}{\pi }}} For example: 1 rad = 1 ⋅ 180 ∘ π ≈ 57.2958 ∘ {\displaystyle 1{\text{ rad}}=1\cdot {\frac {180^{\circ }}{\pi }}\approx 57.2958^{\circ }} 2.5 rad = 2.5 ⋅ 180 ∘ π ≈ 143.2394 ∘ {\displaystyle 2.5{\text{ rad}}=2.5\cdot {\frac {180^{\circ }}{\pi }}\approx 143.2394^{\circ }} π 3 rad = π 3 ⋅ 180 ∘ π = 60 ∘ {\displaystyle {\frac {\pi }{3}}{\text{ rad}}={\frac {\pi }{3}}\cdot {\frac {180^{\circ }}{\pi }}=60^{\circ }} Conversely, to convert from degrees to radians, multiply by π / 180 ∘ {\displaystyle {\pi }/{180^{\circ }}} . angle in radians = angle in degrees ⋅ π 180 ∘ {\displaystyle {\text{angle in radians}}={\text{angle in degrees}}\cdot {\frac {\pi }{180^{\circ }}}} For example: 1 ∘ = 1 ∘ ⋅ π 180 ∘ ≈ 0.0175 rad {\displaystyle 1^{\circ }=1^{\circ }\cdot {\frac {\pi }{180^{\circ }}}\approx 0.0175{\text{ rad}}} 23 ∘ = 23 ∘ ⋅ π 180 ∘ ≈ 0.4014 rad {\displaystyle 23^{\circ }=23^{\circ }\cdot {\frac {\pi }{180^{\circ }}}\approx 0.4014{\text{ rad}}} Radians can be converted to turns (complete revolutions) by dividing the number of radians by 2π. Between gradians 2 π {\displaystyle 2\pi } radians equals one turn, which is by definition 400 gradians (400 gons or 400g). So, to convert from radians to gradians multiply by 200 g / π {\displaystyle 200^{\text{g}}/\pi } , and to convert from gradians to radians multiply by π / 200 g {\displaystyle \pi /200^{\text{g}}} . For example, 1.2 rad = 1.2 ⋅ 200 g π ≈ 76.3944 g {\displaystyle 1.2{\text{ rad}}=1.2\cdot {\frac {200^{\text{g}}}{\pi }}\approx 76.3944^{\text{g}}} 50 g = 50 g ⋅ π 200 g ≈ 0.7854 rad {\displaystyle 50^{\text{g}}=50^{\text{g}}\cdot {\frac {\pi }{200^{\text{g}}}}\approx 0.7854{\text{ rad}}} Usage Mathematics Some common angles, measured in radians. All the large polygons in this diagram are regular polygons. In calculus and most other branches of mathematics beyond practical geometry, angles are universally measured in radians. This is because radians have a mathematical "naturalness" that leads to a more elegant formulation of a number of important results. Most notably, results in analysis involving trigonometric functions can be elegantly stated, when the functions' arguments are expressed in radians. For example, the use of radians leads to the simple limit formula lim h → 0 sin h h = 1 , {\displaystyle \lim _{h\rightarrow 0}{\frac {\sin h}{h}}=1,} which is the basis of many other identities in mathematics, including d d x sin x = cos x {\displaystyle {\frac {d}{dx}}\sin x=\cos x} [5] d 2 d x 2 sin x = − sin x . {\displaystyle {\frac {d^{2}}{dx^{2}}}\sin x=-\sin x.} Because of these and other properties, the trigonometric functions appear in solutions to mathematical problems that are not obviously related to the functions' geometrical meanings (for example, the solutions to the differential equation d 2 y d x 2 = − y {\displaystyle {\tfrac {d^{2}y}{dx^{2}}}=-y} , the evaluation of the integral ∫ d x 1 + x 2 , {\displaystyle \textstyle \int {\frac {dx}{1+x^{2}}},} and so on). In all such cases, it is found that the arguments to the functions are most naturally written in the form that corresponds, in geometrical contexts, to the radian measurement of angles. The trigonometric functions also have simple and elegant series expansions when radians are used. For example, when x is in radians, the Taylor series for sin x becomes: sin x = x − x 3 3 ! + x 5 5 ! − x 7 7 ! + ⋯ . {\displaystyle \sin x=x-{\frac {x^{3}}{3!}}+{\frac {x^{5}}{5!}}-{\frac {x^{7}}{7!}}+\cdots .} If x were expressed in degrees, then the series would contain messy factors involving powers of π/180: if x is the number of degrees, the number of radians is y = πx / 180, so sin x d e g = sin y r a d = π 180 x − (π 180) 3 x 3 3 ! + (π 180) 5 x 5 5 ! − (π 180) 7 x 7 7 ! + ⋯ . {\displaystyle \sin x_{\mathrm {deg} }=\sin y_{\mathrm {rad} }={\frac {\pi }{180}}x-\left({\frac {\pi }{180}}\right)^{3}\ {\frac {x^{3}}{3!}}+\left({\frac {\pi }{180}}\right)^{5}\ {\frac {x^{5}}{5!}}-\left({\frac {\pi }{180}}\right)^{7}\ {\frac {x^{7}}{7!}}+\cdots .} In a similar spirit, mathematically important relationships between the sine and cosine functions and the exponential function (see, for example, Euler's formula) can be elegantly stated, when the functions' arguments are in radians (and messy otherwise). Physics The radian is widely used in physics when angular measurements are required. For example, angular velocity is typically measured in radians per second (rad/s). One revolution per second is equal to 2π radians per second. Similarly, angular acceleration is often measured in radians per second per second (rad/s2). For the purpose of dimensional analysis, the units of angular velocity and angular acceleration are s−1 and s−2 respectively. Likewise, the phase difference of two waves can also be measured in radians. For example, if the phase difference of two waves is (n⋅2π) radians, where n is an integer, they are considered in phase, whilst if the phase difference of two waves is (n⋅2π + π), where n is an integer, they are considered in antiphase. Prefixes and variants Metric prefixes for submultiples are used with radians. A milliradian (mrad) is a thousandth of a radian (0.001 rad), i.e. 1 rad = 103 mrad. There are 2π × 1000 milliradians (≈ 6283.185 mrad) in a circle. So a milliradian is just under 1/6283 of the angle subtended by a full circle. This unit of angular measurement of a circle is in common use by telescopic sight manufacturers using (stadiametric) rangefinding in reticles. The divergence of laser beams is also usually measured in milliradians. The angular mil is an approximation of the milliradian used by NATO and other military organizations in gunnery and targeting. Each angular mil represents 1/6400 of a circle and is 15/8% or 1.875% smaller than the milliradian. For the small angles typically found in targeting work, the convenience of using the number 6400 in calculation outweighs the small mathematical errors it introduces. In the past, other gunnery systems have used different approximations to 1/2000π; for example Sweden used the 1/6300 streck and the USSR used 1/6000. Being based on the milliradian, the NATO mil subtends roughly 1 m at a range of 1000 m (at such small angles, the curvature is negligible). Prefixes smaller than milli- are useful in measuring extremely small angles. Microradians (μrad, 10−6 rad) and nanoradians (nrad, 10−9 rad) are used in astronomy, and can also be used to measure the beam quality of lasers with ultra-low divergence. More common is the arc second, which is π/648,000 rad (around 4.8481 microradians). History Pre-20th century The idea of measuring angles by the length of the arc was in use by mathematicians quite early. For example, al-Kashi (c. 1400) used so-called diameter parts as units, where one diameter part was 1/60 radian. They also used sexagesimal subunits of the diameter part.[31] Newton in 1672 spoke of "the angular quantity of a body's circular motion", but used it only as a relative measure to develop an astronomical algorithm.[32] The concept of the radian measure is normally credited to Roger Cotes, who died in 1716. By 1722, his cousin Robert Smith had collected and published Cotes' mathematical writings in a book, Harmonia mensurarum.[33] In a chapter of editorial comments, Smith gave what is probably the first published calculation of one radian in degrees, citing a note of Cotes that has not survived. Smith described the radian in everything but name, and recognized its naturalness as a unit of angular measure.[34][35] In 1765, Leonhard Euler implicitly adopted the radian as the angle unit for all equations involving rotation.[32] Specifically, Euler defined angular velocity as "The angular speed in rotational motion is the speed of that point, the distance of which from the axis of gyration is expressed by one."[36] Euler was probably the first to adopt this convention, referred to as the radian convention, which gives the simple formula for angular velocity ω= v/r. As discussed in § Dimensional analysis, the radian convention has been widely adopted, and other conventions have the drawback of requiring a dimensional constant, for example ω = v/(ηr).[26] Prior to the term radian becoming widespread, the unit was commonly called circular measure of an angle.[37] The term radian first appeared in print on 5 June 1873, in examination questions set by James Thomson (brother of Lord Kelvin) at Queen's College, Belfast. He had used the term as early as 1871, while in 1869, Thomas Muir, then of the University of St Andrews, vacillated between the terms rad, radial, and radian. In 1874, after a consultation with James Thomson, Muir adopted radian.[38][39][40] The name radian was not universally adopted for some time after this. Longmans' School Trigonometry still called the radian circular measure when published in 1890.[41] As a SI unit As Paul Quincey et al. writes, "the status of angles within the International System of Units (SI) has long been a source of controversy and confusion."[42] In 1960, the CGPM established the SI and the radian was classified as a "supplementary unit" along with the steradian. This special class was officially regarded "either as base units or as derived units", as the CGPM could not reach a decision on whether the radian was a base unit or a derived unit.[43] Richard Nelson writes "This ambiguity [in the classification of the supplemental units] prompted a spirited discussion over their proper interpretation."[44] In May 1980 the Consultative Committee for Units (CCU) considered a proposal for making radians an SI base unit, using a constant α0 = 1 rad,[45][26] but turned it down to avoid an upheaval to current practice.[26] In October 1980 the CGPM decided that supplementary units were dimensionless derived units for which the CGPM allowed the freedom of using them or not using them in expressions for SI derived units,[44] on the basis that "[no formalism] exists which is at the same time coherent and convenient and in which the quantities plane angle and solid angle might be considered as base quantities" and that "[the possibility of treating the radian and steradian as SI base units] compromises the internal coherence of the SI based on only seven base units".[46] In 1995 the CGPM eliminated the class of supplementary units and defined the radian and the steradian as "dimensionless derived units, the names and symbols of which may, but need not, be used in expressions for other SI derived units, as is convenient".[47] Mikhail Kalinin writing in 2019 has criticized the 1980 CGPM decision as "unfounded" and says that the 1995 CGPM decision used inconsistent arguments and introduced "numerous discrepancies, inconsistencies, and contradictions in the wordings of the SI".[48] At the 2013 meeting of the CCU, Peter Mohr gave a presentation on alleged inconsistencies arising from defining the radian as a dimensionless unit rather than a base unit. CCU President Ian M. Mills declared this to be a "formidable problem" and the CCU Working Group on Angles and Dimensionless Quantities in the SI was established.[49] The CCU met most recently in 2021,[update] but did not reach a consensus. A small number of members argued strongly that the radian should be a base unit, but the majority felt the status quo was acceptable or that the change would cause more problems than it would solve. A task group was established to "review the historical use of SI supplementary units and consider whether reintroduction would be of benefit", among other activities.[50][51] See also Angular frequency Minute and second of arc Steradian, a higher-dimensional analog of the radian which measures solid angle Trigonometry References

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Similiter in Canone Trigonometrico finuum & tangentium, exhibetur Systema quoddam menfurarum numeralium, quæ Gradus appellantur: atque hujus systematis Modulus is est Numerus Graduum, qui metitur Angulum Modularem modo definitun, hoc est, qui continetur in arcu Radio æquali. Eft autem hic Numerus ad Gradus 180 ut Circuli Radius ad Semicircuinferentiam, hoc eft ut 1 ad 3.141592653589 &c. Unde Modulus Canonis Trigonometrici prodibit 57.2957795130 &c. Cujus Reciprocus eft 0.0174532925 &c. Hujus moduli subsidio (quem in chartula quadam Auctoris manu descriptum inveni) commodissime computabis mensuras angulares, queinadmodum oftendam in Nota III. [In the Logarithmic Canon there is presented a certain system of numerical measures called Logarithms: and the Modulus of this system is the Logarithm, which measures the Modular Ratio as defined in Corollary 6. Similarly, in the Trigonometrical Canon of sines and tangents, there is presented a certain system of numerical measures called Degrees: and the Modulus of this system is the Number of Degrees which measures the Modular Angle defined in the manner defined, that is, which is contained in an equal Radius arc. Now this Number is equal to 180 Degrees as the Radius of a Circle to the Semicircumference, this is as 1 to 3.141592653589 &c. Hence the Modulus of the Trigonometric Canon will be 57.2957795130 &c. Whose Reciprocal is 0.0174532925 &c. With the help of this modulus (which I found described in a note in the hand of the Author) you will most conveniently calculate the angular measures, as mentioned in Note III.] ^ Gowing, Ronald (27 June 2002). Roger Cotes - Natural Philosopher. Cambridge University Press. ISBN 978-0-521-52649-4. ^ Euler, Leonhard. Theoria Motus Corporum Solidorum seu Rigidorum [Theory of the motion of solid or rigid bodies] (PDF) (in Latin). Translated by Bruce, Ian. 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