# Pi's Irrationality Using a TI84 Calculator

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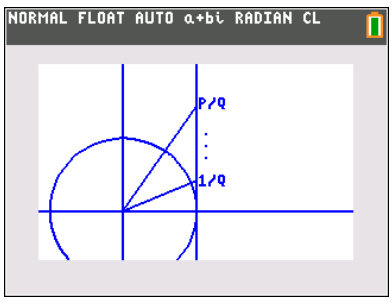
**Abstract**

We use a TI-84 program to show $\pi$'s rationality implies that a radius at 90 degrees must have a defined slope, a contradiction.

## Arc lengths and slopes

Looking at Figure 1, every rational arc length, $P/Q$ can be used to form a line with a defined slope. There is thus a one-to-one correspondence between rational numbers given by the tick mark $P/Q$ and arc lengths given by intersections with a circle. We can say that every rational arc length has a line with a defined rational slope. As a vertical line, the positive y-axis, that radius has no slope, it has no rational arc length. Therefore $\pi/2$ is irrational.




```
001 ClrDraw
002 Circle(-3,-2,3)
003 Line(-3,-2,.75cos(-1.5),.75sin(-1.5))
004 Line(-3,-2,0,2.5sin(2))
005 Vertical 0
006 Vertical -3
007 Horizontal -2
008 Text(90,135,"1/Q")
009 Text(67,140,".")
010 Text(57,140,".")
011 Text(47,140,".")
012 Text(25,135,"P/Q")
013 DispGraph
```

Figure 1: Left: Any rational $P/Q$ generates a line with a defined slope and arc length. Right: Code for program.

# Series

A limiting process is needed for rational numbers to converge to $\pi/2$. The limiting process (additions) of an infinite series will work provided it doesn't converge to a rational number; if it did that would again be a single rational number giving a line with a defined slope and corresponding arc. The series implied by the decimal representation of $\pi$ will work: as $\pi$ is a real number it has such a representation and by our reasoning it must converge to an irrational number.

# Conclusion

This is a geometric proof of $\pi$'s irrationality. Hardy gives a geometric proof of the irrationality of the square root of $5$ [2]. Sondow more recently gave a geometric proof of the irrationality of $e$ [5]. Curiously the proof given here seems to be the simplest in this list.

# References


[1] R. Courant, H. Robbins, *What is Mathematics*, Oxford Univ. Press, London, 1948.

[2] Hardy, G. H., Wright, E. M., Heath-Brown, R. , Silverman, J. , Wiles, A. (2008). *An Introduction to the Theory of Numbers*, 6th ed. London: Oxford Univ. Press.

[3] I. Niven, A simple proof that $\pi$ is irrational, *Bull. Amer. Math. Soc.* **53** (1947) 509.

[4] _____, *Irrational Numbers*, Carus Mathematical Monographs, no. 11, Mathematical Association of America, Washington, DC, 1985.

[5] Sondow, J. (2006). A geometric proof that e is irrational and a new measure of its irrationality. *Amer. Math. Monthly* 113(7): 637–641.