

# W.H.S Mathematics Presentation

Think about Mathematics and Physics naturally

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## Notation, Formulas, and Equations

Notation should be pretty standard complex analysis notation<sup>1</sup>. The space of complex numbers is denoted  $\mathbb{C}$ , by convention, the variable used to denote a function of a complex variable the letter  $z$  is used.

$$z := x + iy, \forall z \in \mathbb{C}; \quad \Re z = x; \quad \Im z = y; \quad \|z\| = \sqrt{x^2 + y^2};$$

Polar representation of complex numbers requires information about the angle a complex number  $z$  makes with the positive  $\mathbb{R}$ -axis, for this discussion. The angle  $\theta$  a complex number  $z$  makes is called the argument of the number  $z$ :

$$\text{Arg } z = \theta = \arccos \frac{\Re z}{\|z\|} = \arcsin \frac{\Im z}{\|z\|} = \arctan \frac{\Im z}{\Re z} + \gamma;$$

where  $\gamma$ :

$$\begin{aligned} \gamma &\iff \pi, \{x < 0, y > 0\}, \quad \text{or} \quad \{x < 0, y < 0\}; \\ \gamma &\iff 2\pi, \{x > 0, y < 0\}; \end{aligned}$$

The complete polar representation of a complex number  $z$  below:

$$r = \|z\|; \quad \text{cis } \theta = \cos \theta + i \sin \theta; \quad z = r \text{cis } \theta;$$

These tools are used in the presentation for the proof outlined.

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<sup>1</sup>Actual notation used comes from this book: Joseph Bak, Donald J. Newman, 'Complex Analysis', 3rd ed.

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# 1 Introduction

Physics uses mathematical descriptions to model events in the physical world. Consequentially, a firm foundation in mathematics is useful to the modern physicist. Today I am here to explain another way to think about mathematics to facilitate learning how to solve much more difficult problems.

# 2 Roots of Complex Numbers