

# The Curious Quest

Issue Number 11

Centre for Mathematical Outreach, MAX

*“A mathematician, like a painter or poet, is a maker of patterns. If his patterns are more permanent than theirs, it is because they are made with ideas.”*

– G.H Hardy

## § Reader’s Delight

### The Pioneer of Indivisibles and Forerunner of Integral Calculus

In the 17th century Italy, Bonaventura Cavalieri (1598–1647) was an Italian mathematician who developed a method of indivisibles which became a factor in the development of integral calculus. He is known for his work on the problems of optics and motion, work on indivisibles, the precursors of infinitesimal calculus, and the introduction of logarithms to Italy. Cavalieri’s principle in geometry partially anticipated integral calculus. It states that if two solids have equal heights and the areas of their cross-sections at every height are equal, then their volumes are equal. So, it applies similarly for plane figures: equal widths at every height mean equal areas. He published tables of logarithms, emphasizing their practical use in the fields of astronomy and geography.

Cavalieri blended numbers, invention, and teaching into a life’s work and the ideas he shaped still speak to the very heart of mathematics centuries later.



Figure 1: Bonaventura Cavalieri

“Bonaventura Cavalieri.” *MacTutor History of Mathematics Archive*, School of Mathematics and Statistics, University of St Andrews.

## § The Problem Arena

### Problem 1

Find

$$\lim_{n \rightarrow \infty} \frac{(1^2 + 2^2 + \dots + n^2)(1^3 + 2^3 + \dots + n^3)(1^4 + 2^4 + 3^4 + \dots + n^4)}{(1 + 2^5 + \dots + n^5)^2}$$



**Problem 2**

Find the area of the region

$$\{(x, y) : 0 \leq x \leq \frac{9}{4}, 0 \leq y \leq 1, x \geq 3y, x + y \geq 2\}$$

**Problem 3**

Suppose  $f : \mathbb{R} \rightarrow \mathbb{R}$  is a function given by

$$f(x) = \begin{cases} 1, & \text{if } x = 1, \\ \frac{1}{e^{(x^{10}-1)} + (x-1)^2 \sin\left(\frac{1}{x-1}\right)}, & \text{if } x \neq 1 \end{cases}$$

i) Find  $f'(1)$

ii) Evaluate  $\lim_{u \rightarrow \infty} \left[ 100u - u \sum_{k=1}^{100} f\left(1 + \frac{k}{u}\right) \right]$

**§ The Enigma Box****Ramsey at Recess**

Students A, B, C, D and E are on a playground such that no three of them are collinear. Although a line can join every pair of them, say, with colours red and blue. In how many ways can we colour these lines with the given colours such that no three points form a triangle with lines of the same colour?

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We do not claim to be the creators of any questions shared in *The Curious Quest*, unless specified otherwise.

If you have any questions, puzzles, or stories that you want to share, kindly mail them to [centre.math.outreach@gmail.com](mailto:centre.math.outreach@gmail.com)!

**§ Hints & Solutions - Previous Issue**

As mentioned in the *Special Edition of The Curious Quest*, no hints or solutions will be provided!

