

248. The Solution of the "Christmas Cake" Problem

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248. [C. 2. j.] *The Solution of the "Christmas Cake" Problem.*

The problem of dividing a circular cake in the manner suggested in *Nature* for December 20, so that the areas of the portions eaten on three consecutive days shall be equal, is easily solved correct to any required number of decimal places by the following or some such method :

Let x be the ratio of the thickness of the first slice to the diameter of the cake, then since the area of the first slice is one third of that of the cake, we easily obtain

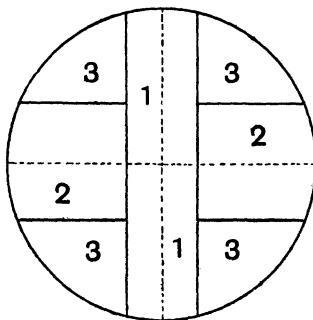
$$\frac{\pi}{12} = \frac{x\sqrt{1-x^2}}{2} + \frac{1}{2}\sin^{-1}x = \int_0^x \sqrt{1-x^2} dx.$$

Since x is a proper fraction, the easiest plan is to use the second form and expand the quantity under the integral in a convergent series, giving, for x , the equation,

$$\frac{\pi}{12} = x - \frac{1}{2} \frac{x^3}{3} - \frac{1.1}{2.4} \frac{x^5}{5} - \frac{1.1.3}{2.4.6} \frac{x^7}{7} \dots$$

or

$$3.14159\dots - 12x + 2x^3 + 0.3x^5 + 0.103\dots x^7 + \dots = 0.$$



This is easily solved by Horner's method. The trial divisor gives immediately the first digit 2.

To find the ratio of the breadth of the second pair of slices to the diameter of the cake, we notice that the height of the slices has to be diminished by the portion removed in the first operation. If x_1 is the root of the previous equation, we must subtract x_1x from the right-hand side of the first equation, and we get as our new equation for x ,

$$3.14159\dots - 12(1-x_1)x_2 + 2x_2^3 + 0.3x_2^5 + \dots = 0.$$

The results I obtain are $x_1 = .26407420\dots$ and $x_2 = .367180\dots$, which might easily be checked by recalculation, as the working is simple.

G. H. BRYAN.

QUERIES.

(15) Where shall I find the best treatment of "Linkages" suitable for boys of 15-16? "Linkages" is set as part of the London University Syllabus for Applied Mathematics, Inter-Sci. A.

(16) Given a curve in which each abscissa represents the space described from a given time by a moving particle under the action of forces represented by the corresponding ordinates; how may the change in kinetic energy of the particle be expressed geometrically? δ K.E.

(17) Under what conditions may the locus of the corners of a quadrilateral, circumscribed to an ellipse E , consist of two ellipses confocal with E ? STUDENT.