# Correspondence

DEAR EDITOR,

I have derived the general solution to Canon Eperson's second conjecture in terms of four parameters $t, f, g, h$ (one or three of which must be odd). The solution, up to a common multiplier, is as follows: If

$$2y + 1 = t^2 + f^2 + g^2 + h^2,$$

$$2u + 1 = t^2 + f^2 - g^2 - h^2 + 2(g - h)t + 2(g + h)f,$$

$$2v + 1 = t^2 - f^2 + g^2 - h^2 + 2(h - f)t + 2(h + f)g,$$

$$2w + 1 = t^2 - f^2 - g^2 + h^2 + 2(f - g)t + 2(f + g)h,$$

then

$$(2u + 1)^2 + (2v + 1)^2 + (2w + 1)^2 = 3(2y + 1)^2,$$

the sufficiency of which can be checked by using *DERIVE*. For the present purpose a proof of the necessity is not required.

As any positive integer can be represented as the sum of four squares, [1, pp. 302-303] all one has to do, for a given odd integer $2y + 1$, is to find a four square representation of it, and the values of $t, f, g, h$ and hence those of $u, v, w$ follow at once. For example

$$39 = 5^2 + 3^2 + 2^2 + 1^2,$$

then taking $t = 5, f = 3, g = 2, h = 1$ one obtains

$$3 \times 39^2 = 57^2 + 15^2 + 33^2.$$

Whether this is deemed to be elementary is a matter of definition, but as the general solution depends on the representation of integers as the sum of four squares (or three triangular numbers) it is doubtful that any solution will be more elementary than this.

*Reference*

1. G. H. Hardy and E. M. Wright, *An introduction to the theory of numbers*, Oxford University Press (Fourth edition. 1960).

Yours sincerely,

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DEAR EDITOR,

I write with reference to the article by Harold Williams in *The Mathematical Gazette* **82** (July 1998), entitled The Mathematics of Flat Green Bowling. From his disparaging remarks about my mathematical model of bowling I gather that he did not bother to look at the references

https://doi.org/10.1017/S0025557200208292 Published online by Cambridge University Press

(repeated below) quoted in my article in *Math. Gaz.* **80** (November 1996) entitled A Mathematician's View of Bowling. Had he done so, he would have learned from [1] that Professor Bolt and I did not attempt to predict the total length of the path from the initial velocity, something which would indeed have required introducing air resistance. We actually measured the length and running time, and used them to estimate the resistance of the green. We were then able to find the equation of the bowl path, without recourse to a computer. This enabled us to predict the path and end position of the bowl with great accuracy, on greens of various speeds and on two bowls test tables. Our model also predicted accurately the total angle of precession of the bowl. The infinity which arises in Mr Williams' work (which he regards as 'no embarrassment'!) stems from the inadequacy of his model of a bowl as a sphere with an offset weight inside it, a model long discarded as unsuitable by serious bowls analysts.

Mr Williams writes at length about a bowl running with tilt. From [2] he would learn that the tilted bowl is a myth. Any bowl delivered with tilt becomes just a wobbling bowl as soon as it starts to roll. [2] includes calculations of the effect of wobble (and hence of initial tilt) on the end position of a bowl.

*References*

1. M. N. Brearley and B. A. Bolt, The dynamics of a bowl, *Quart. J. Mech. Appl. Maths.* **11** (1958) pp. 351-363.
2. M. N. Brearley, The motion of a biased bowl with perturbing projection conditions, *Proc. Camb. Phil. Soc.* **57** Pt 1 (1961), pp. 131-151.

Yours sincerely,

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DEAR EDITOR,

Back in March 1994 you published a pair of articles by Robert Pargeter and me about barcodes – we both concentrated on EAN13, the commonest system seen in supermarkets.

Since then I have continued my interest in things of this nature but have not come across anything of particular note until recently, when I noticed that more and more mail order firms and other organisations are using a system of which this is a typical example:

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