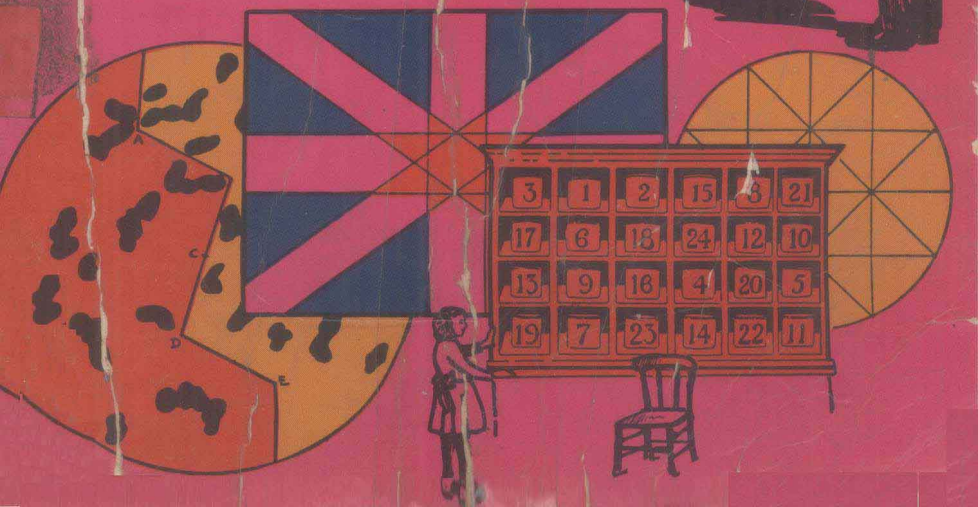


AMUSEMENTS IN MATHEMATICS

H. E. DUDENEY



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15	9	16	4	20	5
19	7	23	14	22	11

AMUSEMENTS IN MATHEMATICS

by

HENRY ERNEST DUDENEY

In Mathematicks he was greater
Than Tycho Brahe or Erra Pater :
For he, by geometrick scale,
Could take the size of pots of ale ;
Resolve, by sines and tangents, straight,
If bread or butter wanted weight ;
And wisely tell what hour o' th' day
The clock does strike by algebra.

BUTLER'S *Hudibras*.

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Henry E. Dudeney

1847 – 1930

with the hope that it will keep alive for many years his
remarkable contributions to intellectual and mathematical
recreations.

PREFACE

IN issuing this volume of my Mathematical Puzzles, of which some have appeared in periodicals and others are given here for the first time, I must acknowledge the encouragement that I have received from many unknown correspondents, at home and abroad, who have expressed a desire to have the problems in a collected form, with some of the solutions given at greater length than is possible in magazines and newspapers. Though I have included a few old puzzles that have interested the world for generations, where I felt that there was something new to be said about them, the problems are in the main original. It is true that some of these have become widely known through the press, and it is possible that the reader may be glad to know their source.

On the question of Mathematical Puzzles in general there is, perhaps, little more to be said than I have written elsewhere. The history of the subject entails nothing short of the actual story of the beginnings and development of exact thinking in man. The historian must start from the time when man first succeeded in counting his ten fingers and in dividing an apple into two approximately equal parts. Every puzzle that is worthy of consideration can be referred to mathematics and logic. Every man, woman, and child who tries to "reason out" the answer to the simplest puzzle is working, though not of necessity consciously, on mathematical lines. Even those puzzles that we have no way of attacking except by haphazard attempts can be brought under a method of what has been called "glorified trial"—a system of shortening our labours by avoiding or eliminating what our reason tells us is useless. It is, in fact, not easy to say sometimes where the "empirical" begins and where it ends.

When a man says, "I have never solved a puzzle in my life," it is difficult to know exactly what he means, for every intelligent individual is doing it every day. The unfortunate inmates of our lunatic asylums are sent there expressly because they cannot solve puzzles—because they have lost their powers of reason. If there were no puzzles to solve, there would be no questions to ask; and if there were no questions to be asked, what a world it would be! We should all be equally omniscient, and conversation would be useless and idle.

It is possible that some few exceedingly sober-minded mathematicians, who are impatient of any terminology in their favourite science but the academic, and who object to the elusive x and y appearing under any other names, will have wished that various problems

had been presented in a less popular dress and introduced with a less flippant phraseology. I can only refer them to the first word of my title and remind them that we are primarily out to be amused—not, it is true, without some hope of picking up morsels of knowledge by the way. If the manner is light, I can only say, in the words of Touchstone, that it is “an ill-favoured thing, sir, but my own; a poor humour of mine, sir.”

As for the question of difficulty, some of the puzzles, especially in the Arithmetical and Algebraical category, are quite easy. Yet some of those examples that look the simplest should not be passed over without a little consideration, for now and again it will be found that there is some more or less subtle pitfall or trap into which the reader may be apt to fall. It is good exercise to cultivate the habit of being very wary over the exact wording of a puzzle. It teaches exactitude and caution. But some of the problems are very hard nuts indeed, and not unworthy of the attention of the advanced mathematician. Readers will doubtless select according to their individual tastes.

In many cases only the mere answers are given. This leaves the beginner something to do on his own behalf in working out the method of solution, and saves space that would be wasted from the point of view of the advanced student. On the other hand, in particular cases where it seemed likely to interest, I have given rather extensive solutions and treated problems in a general manner. It will often be found that the notes on one problem will serve to elucidate a good many others in the book; so that the reader's difficulties will sometimes be found cleared up as he advances. Where it is possible to say a thing in a manner that may be “understood of the people” generally, I prefer to use this simple phraseology, and so engage the attention and interest of a larger public. The mathematician will in such cases have no difficulty in expressing the matter under consideration in terms of his familiar symbols.

I have taken the greatest care in reading the proofs, and trust that any errors that may have crept in are very few. If any such should occur, I can only plead, in the words of Horace, that “good Homer sometimes nods,” or, as the bishop put it, “Not even the youngest curate in my diocese is infallible.”

I have to express my thanks in particular to the proprietors of *The Strand Magazine*, *Cassell's Magazine*, *The Queen*, *Tit-Bits*, and *The Weekly Dispatch* for their courtesy in allowing me to reprint some of the puzzles that have appeared in their pages.

A Note on British Coins and Stamps

SEVERAL of Dudeney's puzzles are based upon British money, which might not be familiar to the American reader. The basic unit is the pound, which contains twenty shillings; the shilling in turn contains twelve pence (pennies). The symbol for pound is £, which is placed before the number like our dollar sign. The symbols for shilling and pence are, respectively, s. and d., which are placed, like our cent sign, after the number. In place notation these symbols are sometimes omitted. Common ways of writing British prices are:

£2-6-6	Two pounds, six shillings, six pence
2 6 6	Two pounds, six shillings, six pence
7/6 or 7-6	or 7 s. 6 d., seven shillings and six pence.

Just as in American money one does not write down 101¢, but \$1.01, in British notation one writes down twenty-five shillings as £1 5 s.; eighteen pence as 1 s. 6 d.; and twelve pence as 1 s.

At the time that Dudeney wrote his books British coinage was not exactly the same as it is today. These coins could have been available to his readers:

<i>Name</i>	<i>Notation</i>	<i>Value</i>
Farthing	$\frac{1}{4}$ d.	One quarter of a penny
Half penny	$\frac{1}{2}$ d.	One half of a penny
Penny	1 d.	
Two pence	2 d.	Two pence ($\frac{1}{6}$ th of a shilling)
Three pence	3 d.	Three pence ($\frac{1}{4}$ th of a shilling)
Four pence	4 d.	Four pence ($\frac{1}{3}$ rd of a shilling)
Six pence	6 d.	Six pence ($\frac{1}{2}$ of a shilling)

<i>Name</i>	<i>Notation</i>	<i>Value</i>
Shilling	1 s.	Twelve pence
Florin	2 s.	Two shillings
Half crown	2 s. 6 d.	Two shillings and six pence
Double florin	4 s.	Four shillings
Crown	5 s.	Five shillings
Half sovereign	10 s.	Ten shillings (half a pound)
Sovereign	£1	Twenty shillings or one pound
Guinea	£1 1 s.	Twenty-one shillings

Many of these coins are no longer in circulation. The guinea, even though the coin itself is no longer in circulation, is still used as a value term for £1 1 s., and its exact multiples. £5 5 s., for example, is still spoken of as five guineas.

The postal stamps in circulation in Dudeney's time were of the following denominations: $\frac{1}{2}$ d., 1 d., $1\frac{1}{2}$ d., 2 d., $2\frac{1}{2}$ d., 3 d., 4 d., 5 d., 6 d., 9 d., 10 d., 1 s., 2 s. 6 d., 5 s., 10 s., £1, £5.

A Note on the Game of Cricket

A few comments may make Puzzles 387 and 388 easier for Americans who do not understand cricket.

CRICKET is played on a field at the centre of which two "wickets" are set 22 yards apart. Each wicket consists of three "stumps," wooden sticks 28" high and 9" apart, on top of which are lightly balanced two smaller sticks called "bails." A line is marked on either side of the wicket (the "bowling crease") and another (the "popping crease") 4' in front.

The game is played between two teams of 11 men each. The defending or "fielding" side are in the field all at once; two "batsmen" from the opposite ("batting") side must also be in the field. One of the latter (the "striker") stands with one foot inside the popping crease at one end of the pitch, and at the other a member of the fielding side (the "bowler") delivers the ball, with a straight-armed action (bowls it), having one foot behind the bowling crease at his own end. His aim is to put the batsman out by knocking down the wicket, or by having the ball caught by a member of the fielding side after the batsman has hit it, or by having one of the batsmen trapped in the zone between the popping creases when a fieldsman knocks down the nearer wicket. (There are other ways of putting a batsman out, which are not relevant.)

The batsman endeavours to score "runs," primarily by hitting the ball far enough away from any fieldsman to enable him and his partner to change ends. To score, the two batsmen *must* step over, or put their bats over, the popping creases at the ends opposite to where they were when the ball was bowled.

A change of ends constitutes "one run." If, however, one or other batsman omits to comply with the rule about crossing the popping crease, the run cannot be scored. This is why the umpires in puzzle

387 call "three short"—in their haste, Messrs. Dumkins and Podder both failed to observe the rule. Similarly, in the second innings, they call "two short."

The question arising, therefore, is simply: which, if either, pair of batsmen succeeded in accomplishing a legal change of ends.

For puzzle 388, the American reader should remember that there must always be *two* batsmen in play; therefore, when ten men of the 11 in the side have been put out, the surviving player cannot continue by himself and is spoken of as "not out" or as having "carried his bat."

"Drawing stumps" is the conclusion of the day's play. The "duck's egg" (more commonly just "duck") is, of course, zero.

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