

JOHNNY BALL

BALL OF

Confusion

With a
Foreword by
**ZOE
BALL**

Puzzles,
Problems
& PERPLEXING
Posers

As
heard on
ZOE'S
BBC RADIO 2
SHOW

AS HEARD ON
BBC
RADIO

2

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Confusion
PUZZLES, PROBLEMS & PERPLEXING POSERS



ICON BOOKS

Published in the UK in 2011
by Icon Books Ltd, Omnibus Business Centre,
39-41 North Road, London N7 9DP
email: info@iconbooks.co.uk
www.iconbooks.co.uk

This electronic edition published in the UK in 2011 by Icon
Books Ltd

ISBN: 978-1-84831-349-1 (ePub format)
ISBN: 978-1-84831-350-7 (Adobe ebook format)

Printed edition (ISBN 978-1-84831-348-4) sold in the UK,
Europe, South Africa and Asia by Faber & Faber Ltd,
Bloomsbury House, 74-77 Great Russell Street, London
WC1B 3DA or their agents

Printed edition distributed in the UK, Europe, South Africa
and Asia by TBS Ltd, TBS Distribution Centre, Colchester
Road, Frating Green, Colchester CO7 7DW

Printed edition published in Australia in 2011 by Allen &
Unwin Pty Ltd,
PO Box 8500, 83 Alexander Street,
Crows Nest, NSW 2065

Printed edition distributed in Canada by Penguin Books
Canada,
90 Eglinton Avenue East, Suite 700,
Toronto, Ontario M4P 2YE

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Typeset by Marie Doherty

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*For Four Grandchildren Woody, Ronnie, Nelly May and
Albie*

Just like your Grandad – life is always a bit of a puzzle!

Foreword

If I had a pound for every time someone had told me how my Dad's television shows had made science and maths a joy for them when they were a kid, which in turn had encouraged them to follow a career in engineering or medicine or some other clever vocation ... well then, I'd have a ridiculously enormous pot full of coins!

Exactly how many coins would be in that pot would take some figuring out – it might involve some guess work, perhaps some logical thinking. Of course you could just empty the pot and count the coins but that would be far too obvious. At this point my Dad would wade in and give a fantabulous explanation of averages and probability.

With my heritage you'd think I'd be good with numbers, a natural. Sadly this is not the case. The thirst for scientific knowledge and understanding of all things numerical is, apparently, not handed down in the genes. One might even argue that when it came to me the intelligence gene skipped a generation. I was an average maths student. I was only really good with digits when it involved remembering boys' telephone numbers. 'But you have the best teacher in the world right there in your Dad!' people would say. Yes, occasionally I would ask for some help with my algebra homework and my Dad would ooze enthused explanations about the Egyptians' weighing systems and Pythagoras' theorem which, although fascinating, still didn't explain to *me* why $x^2 + y^2 = z^2$.

It's true, my Dad knows an awful lot about a huge number of things. What he doesn't know about the history of science and mathematics is probably not worth knowing. His mind is like an Escher drawing; a never-ending maze of facts and figures about everything from Archimedes, Roman road building, gravity and trigonometry to Johannes Kepler, pi, space exploration, the universe ... I could go on.

The best bit is that it's all self-taught - he went to grammar school but never to university. He just read books - great books. He's written a few good ones himself. He loves learning about how things work, how men and women have made such invaluable discoveries and how there is maths behind everything around us. Dad believes maths and sciences are terrific, important subjects and enormously fun to learn if taught with enthusiasm and energy.

Family gatherings in our house can be great fun - heated debates about who were better, the Egyptians or the Romans, arguments about global warming or over which is the most valuable number. The grandkids in the family quite rightly think Granddad knows everything - a taxi driver recently joked with me, 'Most people have Google, your kids have Granddad.'

I'm so proud of my Dad and all that he's done for the sciences and for education. He's a very clever, brilliant chap, so it's an absolute pleasure to share him with everyone. This especially includes the people who listen to my radio show, where we do a weekly feature called Ball of Confusion in which Dad sets puzzles. I, of course, rarely get them right but when I do it's such a thrill - I even surprise myself. I do hope you and your family enjoy this collection of some of the best.

Zoe Ball
Summer 2011

How *Ball of Confusion* was born ...

When my daughter Zoe began the BBC Radio 2 Saturday Morning Breakfast Show in 2008, her producer asked for ideas for special features. Zoe asked me if I could do a puzzle of some kind on each show. I would set the puzzle in the first hour and give the answer and explanation an hour or so later.

At first, I was worried that I wouldn't be able to find enough puzzles that would work on radio, but I soon found that there was really no problem at all. Radio is such a wonderful medium, in that you can paint an image or set a scene in just a few words.

Zoe and I have now delivered well over 100 puzzles together and I am amazed to find that I am still nowhere near to running out of ideas. I have all my puzzle experience, which began at school, as well as my many old books on all things mathematical to thank for that.

I should mention that on the show, Zoe very seldom comes up with the answer to a puzzle. Now, that could be because she is really quite stupid at puzzles, but it isn't that way at all.

When the show is transmitted the listener has an hour to deliberate and try to solve the problem before we give the answer. But for Zoe, there is no thinking time at all. For one thing, she has the rest of the show to do!

But more importantly, the puzzles are all pre-recorded. Otherwise I would be making a trip into the London studios every Saturday morning before dawn, for five minutes work. So about three times a year, we record a whole bunch of puzzles and for each, I deliver the question, and then almost instantly I launch into the answer and explanation. So Zoe really is allowed no thinking time at all.

She is actually quite good at puzzles – where she gets it from, I don't know. Just like me, though, she is often slow to show confidence. However, given time and encouragement, she is pretty good at everything she sets her mind to. But I would say that wouldn't I? I'm her Dad.

Hey, that's an idea for my next book – 'Ball of Compliments!'

Johnny Ball
Summer 2011

Introduction

When I was a comedian, it soon became apparent that there was no such thing as an original joke. Whatever the wise-crack, pun, witticism, tall tale, spoonerism, one-liner, play on words, rudeism or gag, it could always be proved to be a newer version of something that had been said before.

So it is with puzzles. If you want an early comic puzzle, try this! Why, in an Egyptian tomb did someone long ago inscribe the words (or rather hieroglyphs) that said, 'Can I borrow your washing line? Someone's spread jam on mine!' It is clearly a joke, but the puzzle is who thought of it and chose to record it for posterity?

Almost all the puzzles in this book, though re-set or juggled about by me, were created by people in the past who revelled in puzzles. As with any good joke, there are always people wanting to pass puzzles on for others to enjoy.

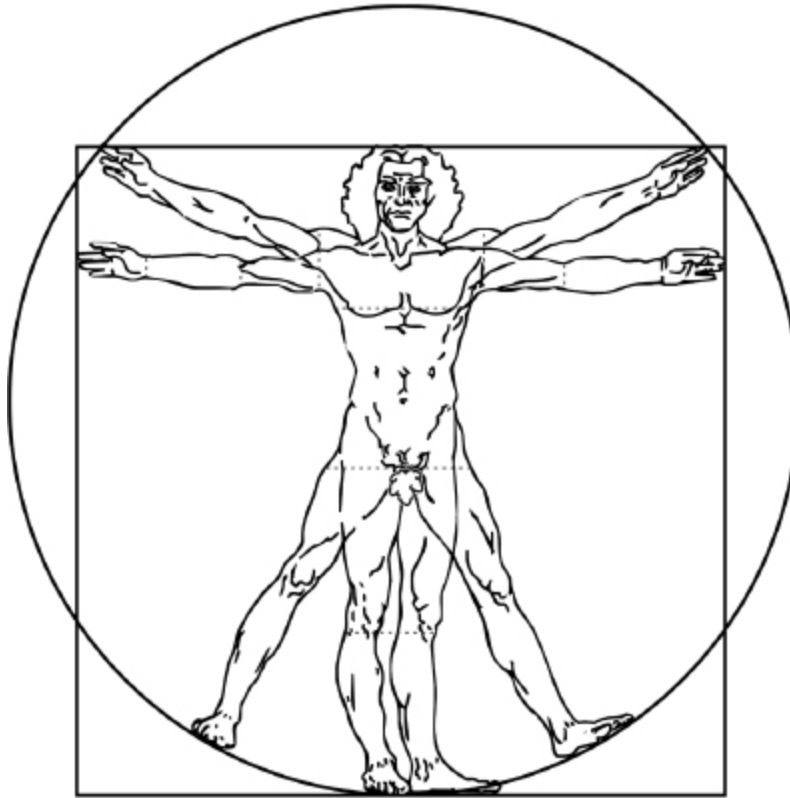
Unlike most puzzle books, you will often find my solutions longer and more multi-faceted than the basic answer. This is because puzzles are to be understood, solved and learned from – that is, and always was, their purpose. To set a question and then, on a later page, give the answer as a single word or number would be of no use in helping a puzzled puzzler, who did not understand the question in the first place, to understand how that answer was arrived at.

So I have indulged myself and my love of puzzles by trying, in most cases, to extend the basic idea with mathematical

thoughts that take the puzzler a step further and into a deeper realm of puzzle understanding. On occasion, as with the jug pouring puzzles, which I love, I will say, 'If you liked that puzzle, then here are a few more in the same vein.' Why? Because when a basic understanding dawns on a puzzler, they need to extend that understanding, to broaden their knowledge and appreciation of the variations on each particular theme. This is why people get hooked on Sudoku.

Sometimes I will credit the originator of a puzzle, because from my researches, I happen to know just who that person was. But on many occasions there will be no credit, even though I may have first encountered a puzzle in a book written by someone with a knowledge of puzzles far greater than my own. The reason I feel I can repeat the puzzle without giving them credit is that I am pretty certain they *also* found it written by someone who had gone before *them*.

In my modern day maths lectures I often open with a slide showing the Vitruvian Man, as drawn by Leonardo da Vinci. It shows a man set in a square with his arms outstretched, demonstrating that a man's height is almost always the same as the distance his fingers can reach sideways. The Romans called both distances a man's 'stature'. The Vitruvian Man is also set in a circle, with a second set of arms reaching higher, to the very edge of that circle.



Have a look at the picture, then cover it and ask yourself, 'What point is half way up the human body?' Well? In my lectures, I invariably find that almost everyone will say, 'Your waist, belly button or navel!'

But they are all totally wrong. Half way up your body is your pubic bone, at the point near the bottom of your torso, just above where your body starts to get interesting. The navel or belly button is about a span higher – the distance between little finger and thumb when a hand is outstretched.

Look at the Vitruvian Man and you will see that the navel is at the centre of the circle, not the square. This point is one span higher than half way up your body. If you reach either arm straight up above your head you will reach a point one cubit or two spans higher than your height. So the

Vitruvian square is eight spans high by eight spans wide, but the circle has a radius of five spans and a diameter of ten.

But by far the most important thing about Leonardo's Vitruvian Man is that from it we can understand exactly what learning is all about. Where did Leonardo, this man of a genius hardly even equalled in the past 2000 years, get the idea for the drawing? Simple - he nicked it from the architect Vitruvius, who designed the Roman Colosseum 1500 years before Leonardo was born. Sadly, the Colosseum itself eventually went broke - the lions ate all the prophets.

The tale of Leonardo and Vitruvius explains that all learning is theft. Almost all top sportsmen and women talk of the idols that inspired them when they were young. They learned to copy their idols until eventually they became just as good, if not better - it is the natural way the whole of mankind has developed and improved over time.

A child should never be allowed to be worried or doubtful about their ability to learn. In their first two years of life, they mastered an incredibly complex language and learned to mimic every aspect of the everyday antics, accents and actions of their parents. So, it is in our nature to steal the ideas of those who have gone before and build upon them.

This book is full of stolen ideas, as I know that those who taught me learned in the same way I did, and learning is arguably the only thing absolutely worthwhile in all our lives, including our learning how to love and be loved.

I love people and I love puzzles. Hopefully I will be able to blend those two loves in the following pages by helping you, dear reader, to love puzzles and puzzling and to love learning and acquiring knowledge. Doing so will broaden your mind, your understanding, and eventually your whole outlook and personality.

How bright do you need to be to enjoy puzzles? Well, let me tell you a little about my own education. I was born in Bristol to parents who loved games which involved counting and calculating, so I was naturally very good in primary school and always top in maths, passing my '11 plus' with ease.

About that time my parents moved to Bolton in Lancashire – but I found them and I moved too. I was accepted into Bolton County Grammar School and to reflect my success at primary school, I was placed in form 2B for the first year. Then in subsequent years, they placed me in form 3C, then in 4D, then in Lower 5E and finally in 5E, because they didn't have a 5F. I had always been top in maths but I left school a failure, with O Levels in just two subjects, one of course was maths – the other one wasn't.

So I joined an illustrious list of school failures including Winston Churchill, Richard Branson and a German lad whose teacher declared he would 'never make anything of himself'. Luckily his engineer uncle showed him the maths puzzles that I was to discover 60 years later, many of which feature in this book.

This activity trained and readied the lad's mind for the path ahead, where in just one year – 1904 – he produced three scientific papers explaining to the world for the very first time:

1. How energy creates all light;
2. That molecules constantly crash into each other in a liquid;
3. His very Special Theory of Relativity.

This puzzle-loving lad became the greatest scientist of all time – Albert Einstein.

So, becoming a puzzle lover might place you in very illustrious company indeed.

But the aim of this book of puzzles, old and new, is simply to help you discover the fun of exercising that brain of yours, which makes you the totally unique individual that you are. Enjoy.

Johnny Ball
Summer 2011

1

Kitchen Capers and Domestic Problems

Many of the puzzles in this book are versions of puzzles which were thought up and amusing people long before TV and even radio were invented. In those days, people were nowhere near as worldly as we are today. Many people never strayed far from their home town or village in their entire lives.

People in those days made their own entertainment from the things that surrounded them in everyday life and the things that they thought they knew about. Just like today, much of their fun and humour was all about playing tricks on their family and those around them.

So, in this chapter the puzzles are all about things that even today, you might link to everyday home and social life.

1. Bun fun with Mum

As an Easter treat Mum has made 27 hot cross buns. As a surprise, she put a £2 coin inside one of them.

Unfortunately, she can't remember which one – except that it is clearly heavier than the rest. The odd bun is not heavy enough to detect the difference by hand, though! You have a simple set of balance scales, but no weights. Can you find

which is the heaviest bun (and so snaffle the £2) in just three weighs?

[Answer on page 117](#)

2. The sands of time

You have a couple of glass sand timers. One takes 7 minutes for the sand to trickle through and the other takes 11 minutes for the sand to trickle through. Using these two, can you time a 15-minute passage of time, exactly?

[Answer on page 117](#)

3. One green bottle

Bottles usually have a circular base and a tapered neck.

You can work out the cross sectional area, as it is πr^2 .

If, for example, the wine bottle is 7 cm across, its internal width will be about 6 cm across. The internal radius is $6 \div 2 = 3$. Its cross sectional area is $3 \times 3 \times 22 \div 7 = 28.28 \text{ cm}^2$.

But for simplicity, let's say we know a bottle's cross sectional area to be 30 cm^2 .

If it were a cylinder, with no tapered neck, the volume of the bottle would be easy to find: height $\times 30 \text{ cm}^2$.

But it does have a tapered neck. It also has some wine in it. How can you work out the volume of the bottle?

[Answer on page 118](#)

4. A toast to toast

Isn't making toast a bind if you haven't got a toaster? You only have a grill and space for 2 pieces of bread under it. So it takes 4 toasting to do 3 slices on both sides. Or does it?

Can you toast 3 pieces of bread on both sides in less than 4 toasting?

[Answer on page 119](#)

5. Time on his hands

Let's go back to the days before we had telephones and mobiles phones – oh bliss! A chap forgot to wind his only clock and it stopped. He knew his pal had a clock that always told the right time. So, he walked to his mate's house, where he stopped and had a chat and a cup of tea. He then walked back home, went straight in and set his clock to the right time. But how did he manage to do this?

[Answer on page 119](#)

6. Draw your own conclusions

In the playroom, I have just put an elastic band around a bundle of coloured pencils. The bundle now forms a perfect hexagon. Counting around the outside of the bundle, there are 18 pencils. How many pencils are there in the bundle?

[Answer on page 120](#)

7. Sock it and see

I have 3 pairs of socks. I actually have a few more, but that has nothing to do with the puzzle. I have a blue pair, a green pair and a red pair. I want to hang them on a washing line, but in a puzzling mathematical way. I want to hang them so that:

There is 1 sock between the blues
There are 2 socks between the greens
There are 3 socks between the reds.

In what order along the washing line should I place them?

Tip: start with the biggest numbers!

[Answer on page 121](#)

8. Put a sock in it

Here is a similar puzzle but with 4 pairs of socks.

You have 4 pairs of socks, blue, green, red and yellow.
Hang them on the line so that:

There is 1 sock between the blues
There are 2 socks between the greens
There are 3 socks between the reds
And there are 4 socks between the yellows.

[Answer on page 121](#)

9. A sucker born every minute

You have 5 sweets and you suck one every 10 minutes. How long will it be before you have none left?

[Answer on page 122](#)

10. An eggs-acting question

Mary sets up her egg stall at the side of a country road and waits for her customers.

Anne arrives first and buys half the entire egg stock, plus half an egg.

Betty turns up and buys half the remaining eggs, plus half an egg.

Celia then buys half the eggs that are left, plus half an egg.

Now Daisy arrives and, while Mary isn't looking, steals half the eggs and half an egg.

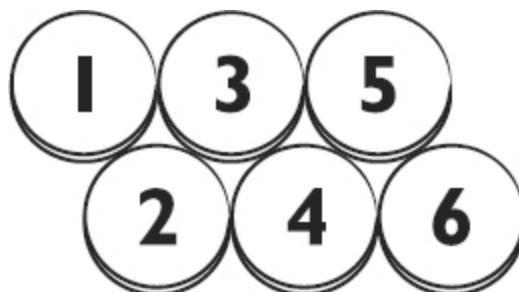
Mary looks round to find she has no eggs left at all! Mary leaves her egg stall empty handed and eggsasperated.

Not one egg was broken. So, how many eggs did Mary start with?

[Answer on page 122](#)

11. Put your money where your mouth is

Here are 6 identical touching coins.



Can you, in just 3 moves, change their position so that they form a hexagonal circle around a single coin sized space? It's easy in 4 moves, but can you do it in 3? The secret is in finding the first correct move.

[Answer on page 123](#)

12. Fumbling in the dark

The lights have gone out – I said we should never trust wind farms – and I have to search my wardrobe in the dark for a pair of shoes and socks.

I have 3 pairs of shoes, 12 pairs of black and 12 pairs of brown socks.

How many of each do I need to take, to be sure I have a matching pair of each to wear?

[Answer on page 124](#)

13. Animal farm

I was once looking for work and I met a farmer. I said, 'Can you use me on the land?'

He replied, 'Well, not really. We use special stuff for that.'

A farmer has 20 goats, 30 cows and 50 horses. How many horses would he have if you called the cows 'horses'?

[Answer on page 124](#)

14. The weight of the matter