SHORT CIRCUIT

Newsletter of the Canberra Mathematical Association INC

VOLUME 13 NUMBER 3 MARCH 2022

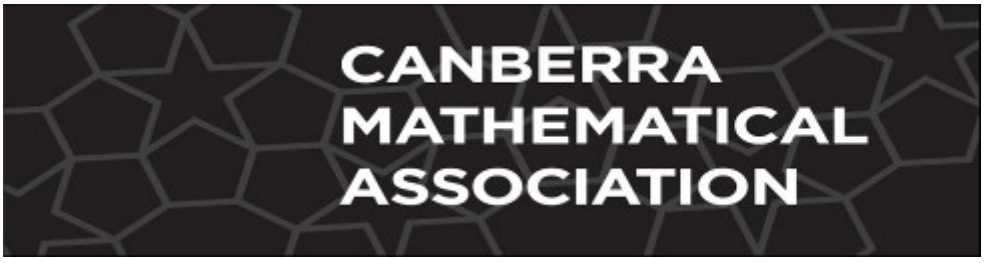
NEWS AND COMMENT

Contributors have exceeded expectations this month, providing enough material for eight pages plus a few more articles left over. This is an excellent trend. Long may it continue.

Pi-day is coming up. We have a two-and-a-half page spread of ideas for it, collected by Valerie Barker. There is an unusual kind of sudoku puzzle in the collection for which we will publish a solution next month. There is also a pi trivia quiz that includes a question closely related to Heather Wardrop's article on page 3. Here we see that phenomenon in statistical experiments where there is a correlation but not a causal relationship.

The International Mathematical Modeling Challenge, administered by ACER, is open for team registrations.

Teachers of suitably inclined year 11/12 students might like to consider the free Actuarial Science course offered by ANU. See page 2.



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Coming Events:

2022 CMA conference

Wednesday Workshops:

Check for notices sent separately.

MEMBERSHIP

Memberships run from 1 Jan to 31 Dec. each year. Membership forms can be accessed from the CMA website: http://www.canberramaths.org.au

Membership of CMA includes affiliation with the Australian Association of Mathematics Teachers and a subscription to one of two AAMT journals.

As a member, you are entitled to attractive rates for the CMA annual conference and CMA professional development events.

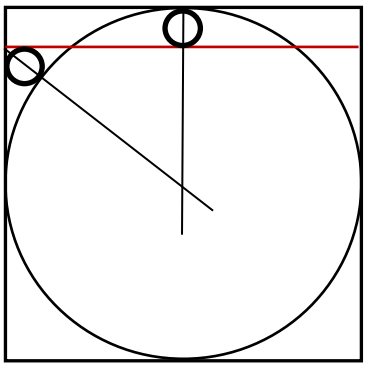
CMA members may attend conferences of the AAMT affiliates in other states, MAV, MANSW, etc. at member rates.

PUZZLE

1. **A constant**

From Colin McAllister.

In the diagram, there is a large circle inscribed in a square and two smaller circles with equal diameters that are tangent to sides of the square and to the large circle and to a uniquely positioned line parallel to and below the top of the square.



What is the ratio of the diameter of the large circle to that of a small circle?

ACTUARIAL SCIENCE

The Australian National University (ANU) is running its popular Introduction to Actuarial Science course for Year 11/12 students in Australia. The purpose of the course is to provide students considering an actuarial career with an interactive introduction to the profession. As such, it is a perfect fit for high school students who are strong in maths to find out if an actuarial degree would be good university program choice for them. The course is FREE for all students.

Click here for more information and to register interest

RAMANUJAN'S MAGIC SQUARE

A frequent contributor, Ed Staples, came across a remarkable magic square invented by Srinivasa Ramanujan.

The 4×4 grid starts with Ramanujan's birth date, 22 December 1887, in the first row. Then, every row and every column has the sum, 139, as do the main diagonals. Astonishingly, the four 2×2 squares at the corners, all three 2×2 central squares, and the 4 corner squares also have this sum.

22	12	18	87
88	17	9	25
10	24	89	16
19	86	23	11

At first sight, this looks miraculous, but there is a scheme involved and, in fact, it is possible to apply Ramanujan's scheme to anyone's birthdate and come up with a personalised magic square.

For example, Ed's square with row sum 103 looks like the following picture on the left, and mine with row sum 87 is the one on the right.:

25	3	19	56
57	18 (22)	0	28
1	18	58	26
20 (18)	55	26	2

16	4	19	48
49	18 (22)	1	19
2	18	50	17
20	47	17	3

Luckily, the scheme works for Ramanujan's birthdate and most others. However, for people born in January or February, their square will contain negative numbers.

Ed devised a spreadsheet that automatically creates the magic square belonging to any birthday. To do this he needed an abstract representation of the cell entries in the 4×4 grid. If you can find such a representation, you will have understood what is going on!

Happy birthday, Ed, later this month!

MY FAVOURITE LESSONS

From Heather Wardrop

I would like to encourage readers to submit their favourite lessons to this journal so that other mathematics teachers can use them.

I will kick this off with a simple investigation that has a surprising result. It is suitable for students who know how to find the circumference of a circle and can solve simple equations. It could be done by a year 8 class but I have found it stimulates curiosity in years 11 and 12 students too. It is from the MCTP books by Lovitt and Clarke. These books have remained my favourite teaching resource over my 44 years of teaching.

Belt Around the Earth

Imagine that a steel belt circles the earth, measuring 40 000Km and fitting tightly. If I add 6 metres to this belt it will ease a little and may be raised a bit. After this addition will you be able to:

Slip a sheet of paper under it?
Crawl under it? OR
Walk under it?

Let the students guess an answer and then work on it for a while. Some will convert both to metres and then solve for the circumferences $2\pi R = 40\,000\,006$ and $2\pi r = 40\,000\,000$. Where R is the radius of the earth with the 6 metres added, and r is the radius of the earth.

The more elegant solution is to express the problem as $2\pi R - 2\pi r = 6$, factorise and then solve $2\pi(R - r) = 6$.

Since 2π is about 6, when we divide both sides by 2π we see that $R - r$ is approximately 1 metre.

You can crawl under it!

AAMT – TEXTHELP

AAMT has announced a 'partnership' with Ed Tech company, texthelp. The company claims, *Our products support literacy, numeracy and accessibility in the classroom and the workplace.*

In particular, *texthelp* has a product called EquatIO that can create mathematical text - expressions and formulae - from speech, handwriting or from typing at a keyboard. It also does things with chemistry formulae and with diagrams and graphs.

The advertising pitch on their website says the program is free for teachers. However, we note that it is not free for students (after a 30-day trial).

Teachers and students will no doubt appreciate the benefits of such software but the Noble Society of Pedants, of which I am a member, and indeed the entire Greek diaspora in this country, will object strenuously to the product's logo.

The name EquatIO is rendered ignorantly as 'ΣquatIO', using the letter *sigma* as though it sounded like an English E. While the company claims to support literacy, and so on, its marketing department appears to be working to a contrary purpose.

PT

VALE PETER NEUMANN

Dr Peter Neumann, son of CMA founders Bernhard and Hanna Neumann, has died. His death occurred in December 2021 in the UK just short of his 80th birthday. Years ago, Dr Neumann attended CMA conferences with his father.

There is an obituary written by Dr Peter Neumann's son, David Neumann, in The Guardian and pieces from several other writers can be found with an internet search.

Readers may be interested in a long interview from 1998 with Dr Neumann's father, Bernhard Neumann, on the Australian Academy of Science website.

NEWSLETTER OF THE CANBERRA MATHEMATICAL ASSOCIATION INC

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We're on the Web!
http://www.canberramaths.org.au/

ABOUT THE CMA

The Canberra Mathematical Association (Inc.) is the representative body of professional educators of mathematics in Canberra, Australia.
It was established by, among others, the late Professor Bernhard Neumann in 1963. It continues to run - as it began - purely on a volunteer basis.

Its aims include

* the promotion of mathematical education to government through lobbying,
* the development, application and dissemination of mathematical knowledge within Canberra through in-service opportunities, and
* facilitating effective cooperation and collaboration between mathematics teachers and their colleagues in Canberra.

THE 2022 CMA COMMITTEE

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	Joe Williams	

Theresa Shellshear is CMA's COACTEA representative.

Sue Wilson is CMA's AAMT representative.

Joe Wilson is the website manager.

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Find us on Facebook

http://www.facebook.com/pages/Canberra-Mathematical-Association/110629419011275

CAREERS IN MATHEMATICS

From Frances Moore

This is the first article in a series.

Mathematics is in every job - we all know that but do our students? We will explore a different job and the mathematical activities involving this job from the website On the Job.

Let's look firstly at the **Logistics Analyst**. This is a job that evaluates the supply chain. Detailed information about the Logistics Analyst can be found here: Logistics Analyst - Transport - On The Job

Context and relevance:

In January 2022, fresh food supplies to northern South Australia and parts of the Northern Territory have been disrupted due to roads being washed away and damaged railway lines. The supply chain was broken. The Logistics Analyst had to work out the best and most efficient way to get fresh food to the people in these areas.

Activities for the Classroom:
https://onthejob.education/classhome_activities/transport/logistics_analyst.htm

Activity 1: The Geography of Mandarins: Where do they come from?

Primary Middle

The class is going to examine the labels of mandarins for 1- 4 weeks. The students will start an Excel spreadsheet to add the data. They will compare and contrast the data collected by Citrus Australia. The class will also note down the number of mandarins consumed over the month. In the end, they are to graph their knowledge about mandarins and where they come from across Australia.

Activity 2: Logistics, Global Trade and the Suez Canal

Middle High (9 – 12)

Students are to read articles from The Conversation about the Suez Canal disaster in March 2021 using the Expert Jigsaw Strategy. They are to write up any facts and figures relating to these articles, the cost of the blockage, and, the effects on global trade. Students are to imagine they are a seafarer on the *Even Given* ship as well as write about the importance and problems of the Suez Canal to Global Trade. As a class, the students are to discuss the sustainability of the canal.

Activity 3: How do COVID-19 vaccines get from the factory to your local pharmacy?

High (9 – 12)

Students are to plot the production of vaccines from an ABC News article and create a timeline. They are to investigate the AstraZeneca "starter" getting from Oxford to Broadmeadows, Melbourne. As a group they are to read and add to their timeline. They are to estimate how long it would

IN CELEBRATION OF PI DAY

Can I have a small container of coffee?

Do you notice anything special about that? The numbers of letters per word are 31415926. Looks familiar? Pi (π) is 3.14159 26535 89793 23846 26433 83279 50288 41971 69399 37510 58209…

This sort of sentence is a pi-mnemonic, i.e. an aid to remembering the decimal digits of pi. Why stop with sentences? People have created poems, jokes, even dramas based on the digits of pi in many languages.

See, I have a rhyme assisting
My feeble brain
Its tasks sometimes resisting

How I like a drink, alcoholic of course, after the heavy lectures involving quantum mechanics.

1. Monday 14th March is Pi Day, using American date notation. While this will be a public holiday in the ACT, you might like to celebrate this special number with some of the following activities. These have all been tried and tested in ACT classrooms over many years, and are classics of their kind!

2. Writing a πku (a pi-ku), that is, **a pi-haiku**

There are three lines in these; however the number of syllables do not follow the traditional Japanese pattern (5-7-5), but rather *piku* are composed of 3-, 1- and 4-syllable lines, often in celebration of pi.

Beautiful,
Rare,
Mysterious.

I love you,
Pi,
You complete me.

I love pie,
Pi,
and my cat Pye.

3. What is a πEM (a piem)?

A **PI-POEM**, of course!

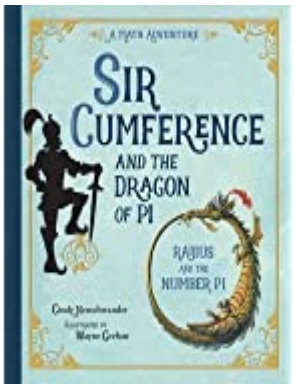
How *(3)*
I wish *(1)* *(4)*
I could calculate pi
(1) *(5)* *(9)* *(2)*

There once was a fellow from Greece,
Who forgot pi's last decimal piece.
So he used electronics
To collect pi mnemonics…
Now he's hooked, and there is no release.

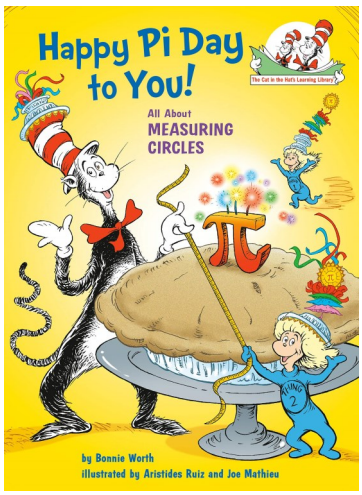
Michael P. Masterston-Gibbons

Could we call this a **pimerick**?

4. Some books to read – these will be suitable for upper primary students in particular.



Sir Cumference,
Lady Di of Ameter, and Rajius
in one of their several adventures in this series.



This is from the *Cat in the Hat's Learning Library* series.

5. Recite Pi. How many digits can your students recite from memory…or 'play' on an instrument (perhaps using the first 10 notes of the C Major scale?)

6. Cooking. Enjoy a pie or two, pikelets (piped with a pi!), pizza, pineapple (pieces) and more.

7. A Pi Day Sudoku

		1	5	4			1		9
1			3					1	3
	4			3		8			2
		1			9	2	5		
9			5			5			
8	1			9			3		6
5		8			2			5	5
			5			6			1
		5	1	5			5		
6			4		1			3	
5	1					5			5
5		4			3	1	6		

Rules: Each row, column and jigsaw region must contain exactly the first twelve digits of pi, including repeats:
3.14159265358

Notice that each region will contain two 1s, two 3s, three 5s and no (zero) 7s.

8. One Mile of Pi? What would that look like?

The team from Think Maths (that's Matt Parker's group) and Numberphile decided to create this! Check out the following video.
https://www.numberphile.com/videos/mile-of-pi

Some of these - and lots more - *Pi Day* activities are also described at the following site.
https://www.weareteachers.com/pi-day-activities/

9. A Pi Trivia Quiz

1. Who, in 1706, first gave the Greek letter "pi" its current mathematical definition?

a. Albert Einstein
b. William Jones
c. Attila the Hun
d. Archimedes
e. Napoleon Bonaparte

2. Pi is transcendental. What does this mean in mathematics?

a. It is equal to the ratio of two integers
b. Its square root is imaginary
c. It cannot be expressed as an integer, or as a root or quotient of roots
d. It was Ralph Waldo Emerson's favourite number.

3. What is the earliest known reference to pi in history?

a. The Rosetta Stone, approx. 200 BC
b. The Bible
c. An Egyptian papyrus scroll, written approx. 1650 BC by Ahmes the Scribe
d. Euclid's Elements, written in the 3rd century BC

4. If you calculated the circumference of a circle the size of the known universe, requiring that the answer be accurate to within the radius of one proton, how many decimal places of pi would you need to use? (i.e 3.14, or 3.1415, or 3.1415926 etc.)?

a. two million
b. 39
c. 48,000
d. 6 billion

5. People tried for centuries to "square the circle". What were they trying to do?

a. Construct a square that perfectly circumscribes (surrounds) a given circle
b. Determine the value of pi squared
c. Multiply a circle by itself
d. Use a straightedge and compass to construct a square exactly equal in area to a given circle
e. Alter a recipe intended for a round pan so that it would fit exactly into a square pan

6. Some people became mentally deranged when trying to "square the circle". What was this illness named?

a. Impossibilius Fittus
b. Morbus Cyclometricus
c. Repetitionatis Decimalus

7. Are pi's digits periodic? In other words, do the digits ever repeat themselves in any pattern?

a. Yes. The digits repeat themselves every 6,000,000 decimal places
b. No. Every periodic number is rational, but pi is irrational
c. Yes. Every infinitely long number repeats itself
d. Perhaps. Not enough digits of pi have been calculated to know yet

8. Pi is an irrational number. What does that really mean?

a. Its digits cannot be rationed out evenly
b. Nobody with sound judgement has anything to do with it
c. It is a real number, but can't be expressed as a ratio of two integers

9. Among the digits of pi currently known, the concentration of each of the digits 0-9 are pretty close to equal. However, in the first 30 places of pi's decimal expansion, which digit is completely missing?

a. 7
b. 2
c. 0
d. 8

10. What is the "formal" definition of pi?

a. The surface area of a sphere of diameter 22/7
b. 3.1415926
c. The radius of a circle
d. A delicious dessert
e. The ratio of a circle's circumference to its diameter

11. Imagine if you wrapped a rope tightly around the earth at the equator. How much longer would you have to make the rope if you wanted it to be exactly one foot above the surface all the way around? [NB a 'foot' is an imperial measurement approximately equal to 30cm]

a. 2π feet
b. $2\pi r$ feet, where r is the radius of the earth
c. πr^2 feet

12. What is the current world record for the memorisation of the decimal places of pi?

a. 4400 places, by Chris Lyons
b. 10 980 places, by Gaurav Raja
c. 42 195places, by Hiroyuki Goto
d. 70 030 places, by Suresh Kumar Sharma
e. 83 245 places by Alfred E. Neuman

PUZZLE SOLUTIONS from Vol 13 No 2

1. Devilish

Given that p and q are integers, find a square of the form $(p/q)^2$, that remains a rational square when decreased or increased by 5.

We must have $(p/q)^2 + 5 = (s/q)^2$ and $(p/q)^2 - 5 = (t/q)^2$, so that $p^2 + 5q^2 = s^2$ and $p^2 - 5q^2 = t^2$. In effect we will need to look for two squares, s^2 and t^2, whose average is a square and that differ by 10 times a square.

By experiment, Fibonacci found $p = 41$, $q = 12$. Thus, $(41/12)^2 + 5 = (49/12)^2$ and $(41/12)^2 - 5 = (31/12)^2$.

The puzzle prompts further questions: 'Are there other solutions?' and 'Could a number other than 5 be the amount of the increase and decrease?'.

2. Not quite so devilish

If $a^2 = b + c$, $b^2 = c + a$ and $c^2 = a + b$, then what value(s) can be taken by $1/(a + 1) + 1/(b + 1) + 1/(c + 1)$?

One could argue from the given conditions that $a^2 + a = a + b + c$. Also, $b^2 + b = c^2 + c = a + b + c$. Then, $a + 1 = (a + b + c)/a$, $b + 1 = (a + b + c)/b$, and $c + 1 = (a + b + c)/c$. The question asks for the sum of the reciprocals of these amounts, which is clearly 1.

In another approach, the symmetry of the given relations suggests that $a = b = c$ so that we have an equation $x^2 = 2x$ with roots 0 and 2.

When $x = 2$, the expression has the value 1 which was the one already found. But when $x = 0$, the expression has the further value, 3.

The first approach assumes implicitly that none of a, b, c are zero, and so the second possible value of the expression is missed.