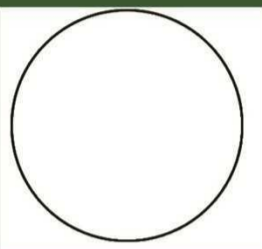
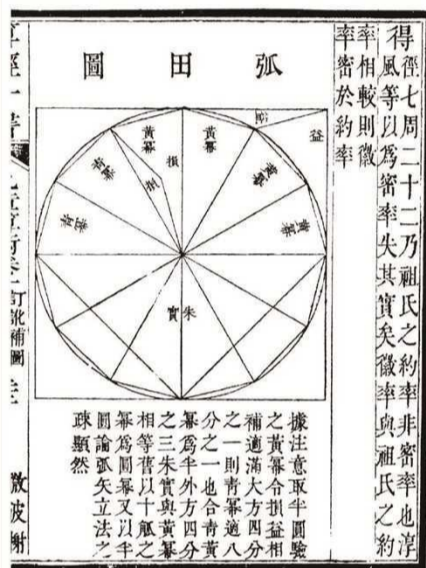


This Is Not a Circle: The Extraordinary Algorithm of Liu Hui



Is it a circle? **No, it is a polygon.**
Look at it again! It has 192 sides.



Can you see it now?

With no calculators or modern tools, ancient mathematicians used polygons like this 192-sided polygon to find an approximation for pi (π). In fact, Liu Hui (劉徽) (3rd century AD) was the first Chinese mathematician to provide an exact algorithm to calculate the value of π . Liu Hui himself calculated it with a 96-gon, and reached an accuracy of five digits: $\pi \approx 3.1416$. Liu Hui noticed that if the perimeter of a regular polygon is known, it is relatively easy to calculate the perimeter of a regular polygon with twice the number of sides. This operation can be repeated to obtain the perimeter of a polygon with four times as many sides. Then eight, sixteen, and so on. A regular polygon with many sides is nearly identical to a circle, so its perimeter-to-diameter ratio will be very close to π .

Here, let's see some algebra.

Since $(1-d)^2 + \left(\frac{a}{2}\right)^2 = 1$ and $\left(\frac{a}{2}\right)^2 + d^2 = b^2$, so we have $b^2 = 2d$ and $a^2 = 4b^2 - b^4$.

That means $b^2 = 2 - \sqrt{4 - a^2}$.

Using the above results, Liu showed that if a_n is a side of an n -sided polygon, then:

$$(a_6)^2 = 1$$

$$(a_{12})^2 = 2 - \sqrt{3}$$

$$(a_{24})^2 = 2 - \sqrt{2 + \sqrt{3}}$$

$$(a_{48})^2 = 2 - \sqrt{2 + \sqrt{2 + \sqrt{3}}}$$

$$(a_{96})^2 = 2 - \sqrt{2 + \sqrt{2 + \sqrt{2 + \sqrt{3}}}}$$

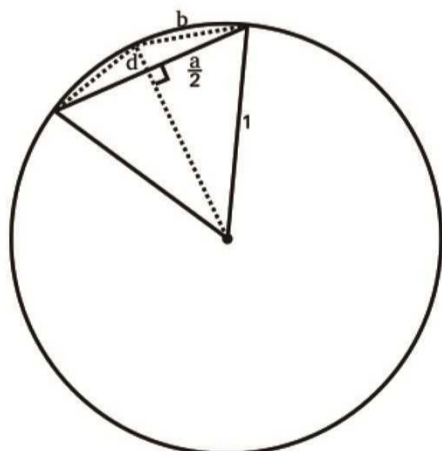
$$(a_{192})^2 = 2 - \sqrt{2 + \sqrt{2 + \sqrt{2 + \sqrt{2 + \sqrt{3}}}}}$$

So on and on...

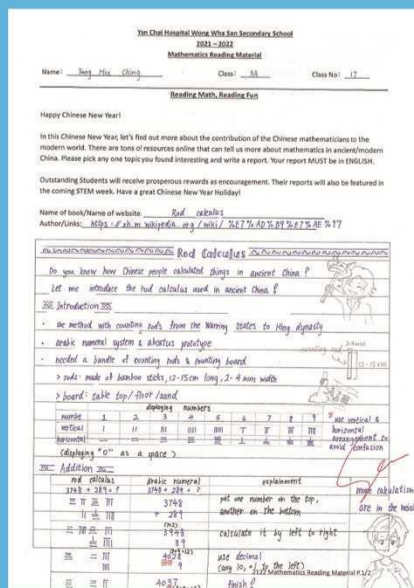
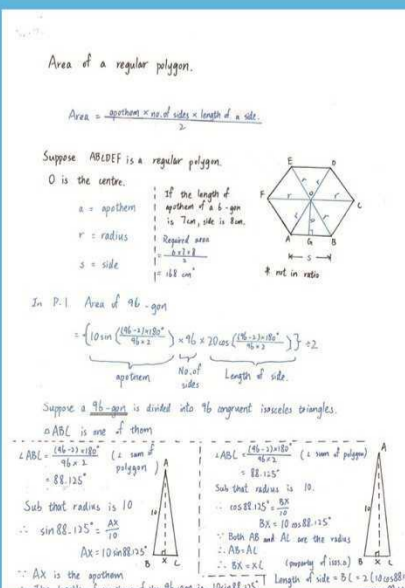
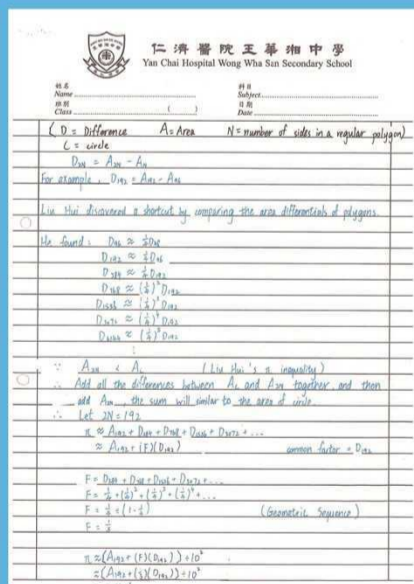
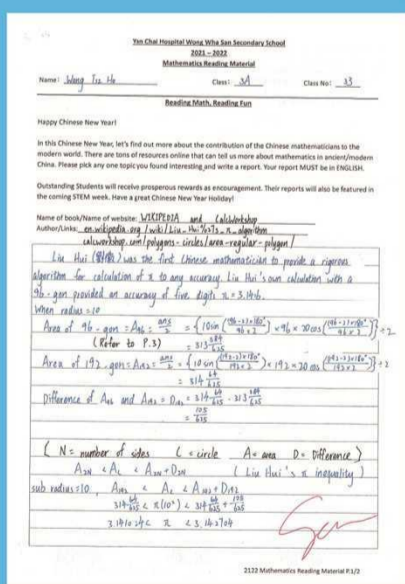
Therefore, the perimeter of a 192-sided polygon is $192a_{192}$ and we get an approximation of π :

$$\pi \approx \frac{192a_{192}}{2} = 96\sqrt{2 - \sqrt{2 + \sqrt{2 + \sqrt{2 + \sqrt{2 + \sqrt{3}}}}}}$$

It is so beautiful!



The editors would like to thank
2122 3A Tang Miu Ching and Wong Tsz Ho
for giving us inspiration for this article.
You can see their original work here:



Interview with our New Math Teacher and former Whasanian, Miss Chen Shujun



Miss CHEN Shujun is a former Whasanian and returned to YCHWWSSS after graduation.

Q: Does your experience and background as a former Whasanian help you understand students' life and learning?

A: Yes, to a certain extent, but not entirely. Education system in my time was different from the current one. We studied for the A-level exam, while you are studying for the DSE. This has led to differences in the course content and required different study approaches.

Q: Have you applied your own experience as a student to your teaching?

A: Yes, I have. For instance, in terms of learning, I would not only rely on the techniques and approaches taught by my teachers but also explore ways that worked best for me. This allowed me to have a better understanding of the subject matter and enabled me to solve problems more efficiently during exams. However, I do not directly teach my students my own methods; instead, I encourage them to find their own ways of learning to suit their individual needs and styles.

Q: What do you think are the differences between math education during your time as a student and now?

A: The main differences lie in two aspects: the education system and the scope of the curriculum. In terms of the education system, there is not much difference between DSE and A-level exam, as both are diploma exams. However, in the past, students had fewer subject options, with limited choices in arts, science, and business subjects. Now, students have more flexible options, with fewer restrictions, and can opt for a combination of different subjects. Moreover, the scope of the curriculum has changed, with the difficulty level of math subjects being lowered in the DSE exam. The curriculum is also more applicable to real-life situations, and students who enjoy math have an advantage, as the M1 and M2 courses are adjusted to be less difficult than A-level math subjects.

Q: Do you think math education is helpful for students' future development?

A: I believe that math education is beneficial for the society as a whole. However, for individual students, it largely depends on their career paths. Some fields may not require extensive use of math, or may only require a basic proficiency in math, such as Music, History and other humanities or arts related subjects. But for those related to some science, technology, engineering, and math (STEM), a strong aptitude for math or a strong ability to apply math concepts is necessary, such as Economics, Actuarial Science, Accounting and Architecture. Therefore, it is hard to make such a generalization.

Thank Miss CHEN for her precious time.

Fillomino

1. Divide the grid into groups.
2. Every square must contain a number, and the number indicates how many squares are in that group.
3. Squares in groups are only linked horizontally and vertically.

Example :

	1			1	
		1			
			1		
	1				1

Solution :

3	1	4	4	1	2
3	3	4	4	6	2
4	4	1	6	6	6
6	4	4	2	1	6
6	6	6	2	3	6
6	6	1	3	3	1

Let's try !

						6	
7	7	7	1			6	
					8	1	
8		1	2	4			6
	1		1			4	1
		5			1		3
	1		1			3	
3		1					8

					1	3	1		4	
1				1	2			1		1
4		1		8	3	1	4		4	1
1										2
	1	5	5		1			9		
3	3					8	8	1	6	
		1	3			1			7	1
1				1			6			2
		7				1	6		4	4
	5	1	2	1		5		8		
	1			2		5	5		1	1
		3	1		1					3

Answers :

3	3	8	8	8	8	1	2	1	3	5	5
1	1	8	5	5	5	2	3	3	5	1	3
4	4	1	8	8	8	5	1	2	5	5	4
2	4	4	7	6	6	1	6	7	7	7	4
2	7	7	7	6	6	1	7	7	1	7	2
1	6	1	7	8	8	1	3	3	7	7	1
6	6	6	1	8	8	8	3	3	3	3	6
6	6	6	6	9	9	1	5	5	1	3	6
2	9	9	9	9	9	3	3	5	5	5	1
1	2	4	4	1	3	3	1	4	4	4	1
4	4	1	2	2	8	8	8	8	8	8	4
4	4	1	3	1	2	8	8	8	8	8	4

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