Map of Mathematics: Resource Document

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1 Introduction

This is the resource document for the lecture 1 of the CEIA Leaving Cert Maths Lectures. In the same folder as this document, you'll find my PowerPoint slides. Each section of these notes will go through things that I covered in the lecture that you may want to revise, or read into in more detail.

If you have any questions, you can email me at 120317406@umail.ucc.ie (my student email).

2 General Learning Resources

Here are some free-to-access resources that aren't tied to any one topic in particular, but that I find very useful in my studies, so they might be useful to you too.

2.1 Websites Apps

Desmos (desmos.com) is a free online graphing calcualtor. It has phenomenal functionality, can can help you visualise any function you could possibly think of.

Khan Academy (khanacademy.org) has free online courses on pretty much anything you could think of. It covers the entire leaving cert syllabus, and considerably more. The calibre of education available is extraordinarily high quality.

Borrowbox (borrowbox.com) is a free app you can download. To log in, you need a library card (if you don't already have a library card, this is your sign to get one). Through the app, you can access free ebooks, audiobooks and epress.

YouTube is genuinely one of the best learning resources I've ever used. If it exists, someone has made a tutorial for it. Here are some of my favourite maths youtubers:

2.2 YouTubers

- **3Blue1Brown** is the undeniable king of mathstube. His schtick is visualising complex maths topics to make them easy to understand.

- **Stand-up Maths** is run by maths teacher/ stand-up comedian Matt Parker, where he essentially turns maths lectures into stand-up comedy routines. Has a penchant for pi.

- **Tibees** is run by mathematical physicist Toby Hendy, who has been described as "the Bob Ross of maths".

- **Numberphile** is a part of a series of educational channels created by educational videographer and journalist Brady Haran. Anything Brady makes is guaranteed to be a gem. In each episode of Numberphile, he interviews a maths specialist about a particular maths topic.

- **Ellie Sleightholm** is a Cambridge maths graduate who makes both maths explainers, and gives you a glimpse into life as a maths student. Especially valuable for those interested in what college life is like.

- **TomRocksMaths** is run by the surprisingly punk-rock Oxford mathematics professor, Dr. Tom Crawford. He actually has a video where he goes through a Leaving Cert maths paper, which is worth checking out.

- **Welsh Labs** covers videos across maths, physics and computer science, and all are excellent. I will be referencing this channel heavily when we get to complex numbers, since Welsh labs has a fantastic series on the subject.

2.3 Books

In the lecture, I reference the I came across this puzzle in Sarah Flannery's autobiography, *In Code* (ISBN 9780761123842). Sarah Flannery is a mathematician from Cork (fun fact: I went to the same secondary school as her).

Sarah Flannery got it from Arthur Keostler's book, "The Act of Creation".

Another great Irish maths writer is Peter Lynch. I would highly recommend his book "That's Maths" (ISBN 0717169553).

Not a maths recommendation, but a physics one. I would be remiss to give a lecture on mathematical beauty and not plug Carlo Rovelli, my personal favourite author of all time. Rovelli is a gravitational quantum physicist who writes about physics like it's poetry. To start, I would recommend "Seven Brief Lessons In Physics" (9780241235966).

As I'm at it, go read/watch anything ever done by Carl Sagan. That man is the crown jewel of physics exposition.

3 Past Paper Example: HL Paper 1, 2019 Q9 (a)

You can access the original question in my powerpoint sides, or on the SEC website for past papers. Here, we will go through the solution as I go through it in the lecture.

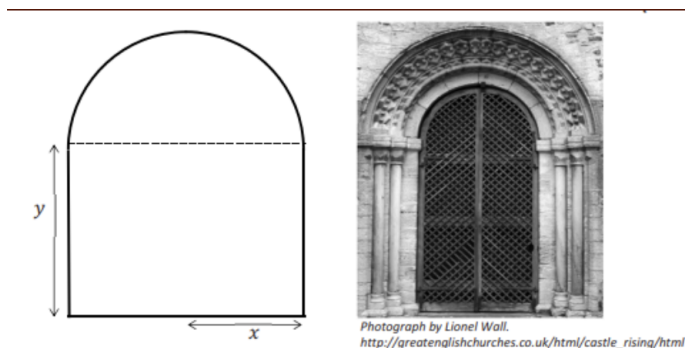We are given the following image of a window:

Figure 1: HL 2019 Q9 Setup

3.1 (i)

We are asked to find the perimeter P of the Norman window.

We can decompose the window into two shapes: a square, and a semicircle. If we find the perimeter of each of these shapes individually, and add them together, we can find the total area of the window.

When we find the perimeter of the square, we aren't counting the top line, since that's not actually a part of the window.

The perimeter of the square is (without the top bit):

$$2x + y + y = 2x + 2y \tag{1}$$

The circumference of the semi circle is (half the circumference of a circle of radius x):

$$\frac{1}{2}(2\pi x) = \pi x \tag{2}$$

Therefore, the total perimeter is:

$$2x + 2y + \pi x \tag{3}$$

3.2   (ii)

Now, we are told that the perimeter is 12m.

Show that:
$$y = \frac{12 - x(2 + \pi)}{2} \tag{4}$$

for
$$0 \le x \le \frac{12}{2 + \pi} \tag{5}$$

In (i), we found an expression for the perimeter. Let's set that equal to 12, and then try to isolate y.

$$2x + 2y + \pi x = 12 \tag{6}$$

Get y on it's own on one side:
$$2y = 12 - 2x - \pi x \tag{7}$$

Divide across by 2 to get y on it's own. Also, factor out x to get the desired form.

$$y = \frac{12 - x(2 + \pi)}{2} \tag{8}$$

3.3   What does this result mean?

Look at the limits given on the question:
$$0 \le x \le \frac{12}{2 + \pi} \tag{9}$$

What would it mean for x to be outside these limits?

If x was less than or equal to zero, it would be physically confusing, since x is supposed to be a length. Negative length doesn't really make sense.

If $x \ge \frac{12}{2+\pi}$, we would end up with a zero or negative y value. This doesn't make sense for the same reason.