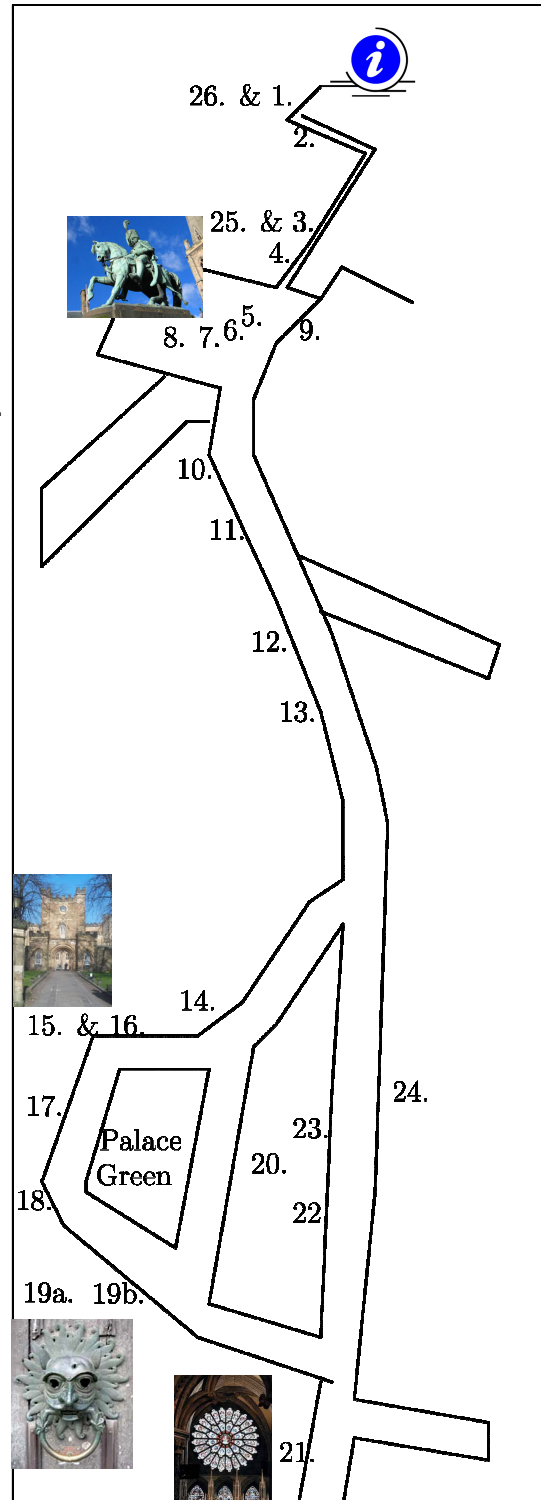
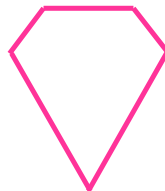
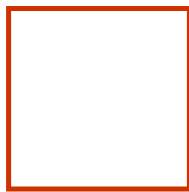
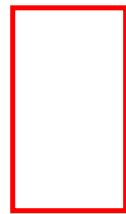
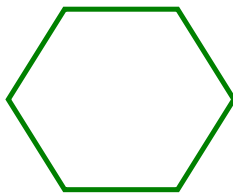
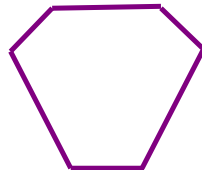
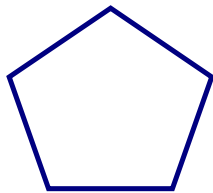


# The Hidden Beauty Within Durham City: A Mathematics Trail for All Ages



The trail begins in Millennium Square outside Durham Tourist Information. You must agree with the conditions of use at the bottom of this page before starting. Typically directions are printed in **brown**.

Throughout this trail keep an eagle eye open for burglar alarm boxes. Put a tick inside the shape once you find it and draw any different shapes you find in the box provided.



The designers of this trail accept no responsibility for or liability from any claim, loss, injury or inconvenience caused as a result of following this Mathematics Trail. By taking part in the trail you agree to do so at your own risk.

1. Outside Durham Tourist Information on your right there is an arrangement of square paving slab on the ground.

a) How many square paving slabs can you see? -----

b) Using all of the shapes you can see on the ground (squares and rectangles) make a different symmetrical pattern which fits into this square:



2. Outside the Library in Millennium Square you will see some bicycle racks.

a) Given that the height of a hoop from the floor is 70cm, what is the maximum circumference (in centimetres) of a tyre that could fit exactly under the hoop? *Hint:* The circumference of a circle is approximately  $22/7$  times its diameter.  
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b) Suppose you decide to cycle 4400cm from the bike rack to the information board for the Gala Theatre. How many full revolutions will the tyre for part (a) have made?  
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3. **Walk out of Millennium Square and turn right towards the Market Place.** Just across the bridge you will see a blue National Cycle Route Sign (just in-front of the street-sign "Walkergate") indicating routes and distances. Estimate the angles in degrees between the following destinations (note: there are 360 degrees in a circle)

a) Consett and Cathedral -----

b) Cathedral and Sunderland -----

c) Sunderland and Consett -----

4. In front of you is the congestion zone and the charge barrier is on your left. On your right is St. Nicholas' church. Above the doorways are some interesting geometrical shapes. Choose one of the shapes and draw it in this box. How many lines of reflectional symmetry does the shape have? -----



5. In front of you are the traffic lights in the Market Place which stay on green for 40 seconds and red (or amber) for 50 seconds.

a) If five cars go through every time on green, how many cars get through the traffic light between 10am and 12 noon? \_ \_ \_ \_ \_  
\_ \_ \_ \_ \_

b) If all these cars have to pay the congestion charge, about £2, how much revenue is generated for Durham City Council?  
\_ \_ \_ \_ \_

6. **Walk into the Market Place** and find Charles William Vane Stewart (3<sup>rd</sup> Marquis of Londonderry)

When was he born? \_ \_ \_ \_ \_

When did he die? \_ \_ \_ \_ \_

How old was he when he died? \_ \_ \_ \_ \_



7. Next to Neptune's statue and close to the signpost in the centre of the market square you will find the large compass.

- ❖ Begin by standing at the Western point facing away from the centre of the compass.
- ❖ Walk to the nearest large round bollard, counting your steps as you go. Make a note of your steps \_ \_ \_ \_ \_ and in the remaining parts of this question always use the same number of steps when asked to *walk*.
- ❖ Find the old lamp on the wall to the right of the entrance to the Market Hall and *walk* towards it.
- ❖ Find the lamp post with two monkeys sitting on it and *walk* towards it.
- ❖ Find the plaque on the side of the plinth for the 3<sup>rd</sup> Marquis of Londonderry and *walk* towards it.
- ❖ Turn toward the nearest traffic light and *walk* towards it.
- ❖ Finally, turn back to the Western point of the compass (where you started) and *walk* to it.

a) Can you draw the shape you traced out on the ground?

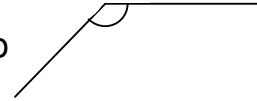
b) What regular shape did you draw?

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c) What are the internal angles of this shape?

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(Hint: To work out the angles it might help to split the shape into triangles)



d) How many sets of parallel lines does your shape have?

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8. Look for the six red telephone boxes. How many letter 'E's are there in total?

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9. Look at the black pattern on the wall high above the main entrance to Boots. Ignoring the central circular part what is the order of rotation of the pattern?

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10. Leave the Market Place in the direction of Saddler Street in the direction of Bimbis. On the door of Bimbis you will find the opening times. If it is 9.27a.m. on a Saturday, how many minutes do I need to wait until opening?



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11. Further along and opposite the entrance for the High Street on your right you will find a giant tea pot suspended high above a shop. If a regular tea pot has a 10cm base and makes four mugs, estimate how many mugs of tea the giant tea pot will make.

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12. **Continue walking up Saddler Street.** Opposite the Shakespeare pub is Saddlers restaurant.

a) What number Saddler Street is it? \_\_\_\_\_

b) Circle the three *special properties* this number has:

Prime                  Even                  Odd                  Square                  Triangular

*Hints:*

Square numbers are: 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, ...

Prime numbers are: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, ...

Even numbers are: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, ...

Triangular: 1, 3, 6, 10, 15, 21, 28, 36, 45, 55, 66, 78, 91, 105, ...

c) Give examples of other numbers with only two (not all three) of these *special properties*. Finding numbers will all three *special properties* is one for later.

\_\_\_\_\_

13. **Further along** look on your left for the lane where “The Muffin Man” lives. Above the entrance to the lane you will find two numbers. Rewrite both numbers in reverse order. Make a note of what you notice.

\_\_\_\_\_

14. **Follow the road up towards the Cathedral and take the right fork up Owen-gate onto Palace Green where you will find the Cathedral.** On your trail around Durham, you will be sure to hear its ten mighty bells. They are more than 300 years old and the largest weighs more than a car, so no wonder they can be heard for miles around! The cathedral bells ring out every fifteen minutes, day and night. There are 4, 8 and 12 chimes at 15, 30 and 45 minutes past the hour. On the hour there are 16 chimes plus the same number of chimes as the hour. How many chimes will there be from 10am to 11am inclusive?

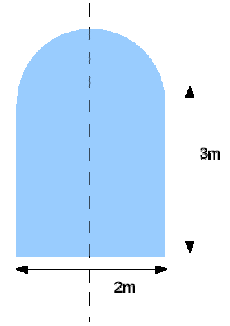
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15. **Turning towards the entrance of the Castle** there are two stone pillars with turrets on top.

a) How many sides does each pillar have? \_\_\_\_\_

b) What are these shapes called? \_\_\_\_\_

16. The entrance to the court yard of the Castle is through a gatehouse. At night, the gatehouse is secured by two large black doors which together make a rectangle and a semicircle. Given that the entrance is 2 metres wide and the straight part of the side is 3 metres, what is the area of one door?  
*Hint: The area of a circle is roughly  $22/7$  times its radius.*

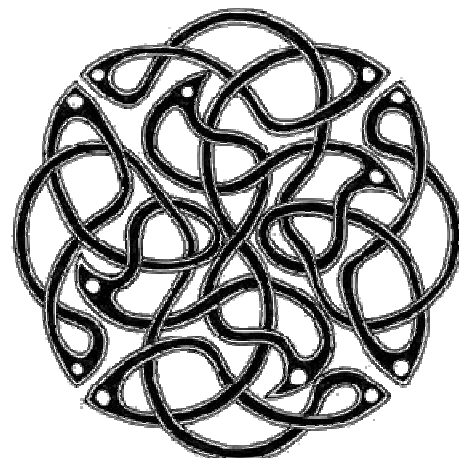


17. You will find lots of parked cars on Palace Green. Survey the registration plates of *all* the cars by making a note of the last digit of the number on the plate

0	1	2	3	4	5	6	7	8	9

18. **Walk towards the Cathedral.** On the grass bank next to the Cathedral entrance you will find a variety of gravestones and the Durham Light Infantry memorial.

- From the gravestones pick out your favourite Celtic knot and draw it in the box below without taking your pen off the paper.
- Sketch over the Celtic knot illustrated on the right without taking your pen off the paper.



19. To the right of the main door of the Cathedral you will find two arches at ground level.

a) Estimate the height of one of the arches.

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b) Use the estimate in part a) to estimate the height of the largest glass window which faces onto Palace Green.

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20. **Carry on walking around Palace Green.** Above the entrance to the Almshouses you will notice the roman numerals MDCLXVI. Using the code below, work out what number the roman numerals represent.

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M = 1,000, D = 500, C = 100, L=50, X = 10, V=5 and I = 1.

21. **Turn around and leave Palace Green on the cobbled road at the corner following the small blue sign for the Heritage Centre and Museum. Stop opposite the Heritage Centre.** Turning around you will see the magnificent rose window in the Cathedral. If there are 360 degrees in a circle, what is the angle in each segment of the rose window?

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22. **Turn back and walk along North Bailey towards the Market Place. On your left you will find number 38 (the Classics Department).** This building has nine windows.

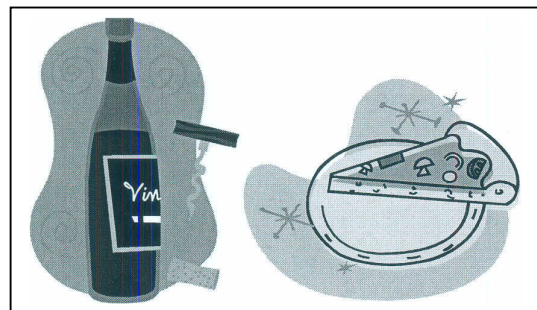
a) What fraction of these windows has twelve panes of glass?

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b) Can you express this as a decimal?

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23. **Continue walking down North Bailey and stop when you find the two restaurants ("Shaheen's Indian Bistro" and "Ristorante San Marco").** Find the price for a bottle of House White Wine from each restaurant, and round the prices to the nearest pound. Also make a note of the volume of wine in the bottle. Find the cost per litre for the two bottles.



24. **Walk back down to Tourist Information** and count the number of bollards that you see along the way.

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25. **Pass back out through the Market Place** and just after the congestion charge bollard you will notice a number of decorative lampposts looking like the one pictured below.



a) How many are there?

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b) Multiply this number by itself and add 1.

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c) Your answer to part (b) should be a 3-digit number. Take the “factorial” of each digit separately and add these 3 factorials together (for instance 4 “factorial” is  $[1 \times 2 \times 3 \times 4]$ , 1 “factorial” is  $[1]$  and 5 “factorial” is  $[1 \times 2 \times 3 \times 4 \times 5]$  so if the answer to part (b) was 415 then you would calculate the answer to be as  $[1 \times 2 \times 3 \times 4] + [1] + [1 \times 2 \times 3 \times 4 \times 5]$  ). What do you notice about the answer?

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26. **Now walk back to Millennium Square.** We revisit the first question of this trail.

a) Find as many different ways as you can for counting the number of square paving slabs used in the arrangement outside Tourist Information and put it in the box below.

b) The County Council wants to double the area of this pattern while recycling the existing slabs. They need to find out how many new slabs to buy, can you help?