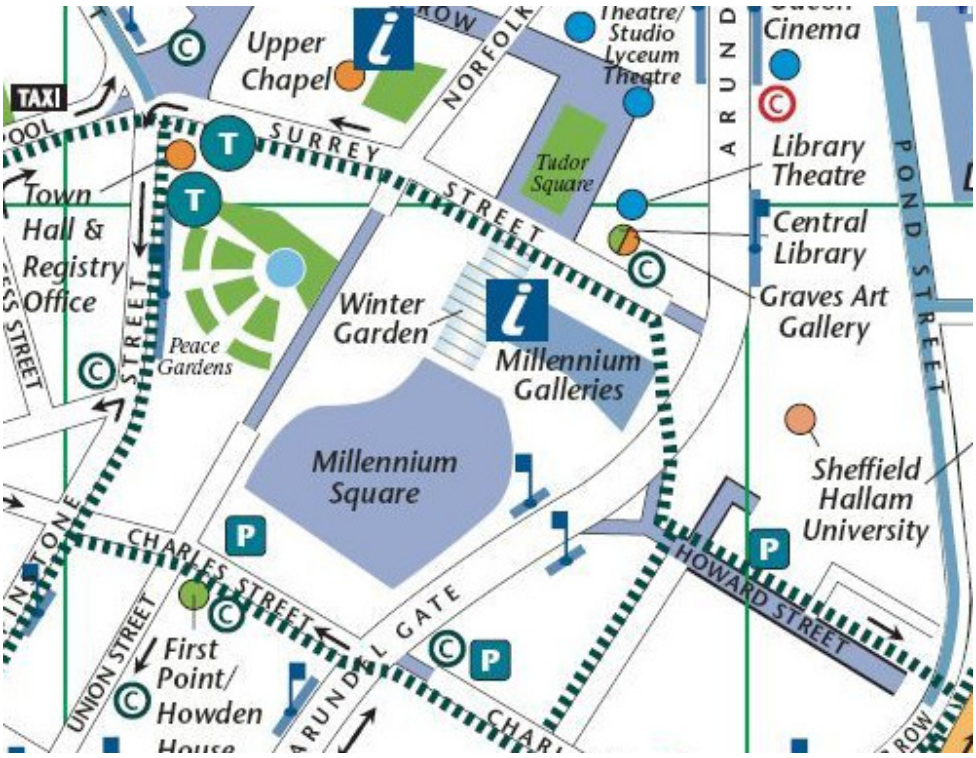
SHEFFIELD HALLAM UNIVERSITY
MATHS EDUCATION CENTRE
CITY CENTRE MATHEMATICS TRAIL

The trail takes friends, families or school groups around the area near City Campus making use of the dramatic new skyline, architecture and public spaces in central Sheffield. In the course of the trail children and adults will develop and discuss puzzles and mathematical ideas and stimulate their thinking together in an exciting way. They will answer some questions en route, and explore more challenging problems at home or in the classroom, later.

The trail is devised by the Maths Education Centre staff, who have considerable experience in working in innovative and engaging ways with local children and schools ( Magic Maths circus, gifted and talented days, Further Maths centre, taster days, CPD, curriculum development , Cre8ate Maths Project and others.) The trail includes questions accessible to young children and questions that are challenging to adults and older children, without assuming any particular mathematical knowledge base.

Trail leaflets have been included in mailings to all schools this year and can be freely photocopied and adapted. Individual copies (paper or electronic) are available from the Maths Education Centre. This year we will also be producing a booklet with some answers and suggestions for exploring the questions and ideas further in a classroom context. This will be useful for teachers who want to use the trail as a starting point for investigative mathematics work, or who are thinking of devising a similar trail around their own school area. Please contact us for copies.

Jo Tomalin and Keith Marsden j.tomalin@shu.ac.uk k.marsden@shu.ac.uk
Maths Education Centre, Sheffield Hallam University, Room 947, Owen Building, City Campus, Howard St, S1 1WB



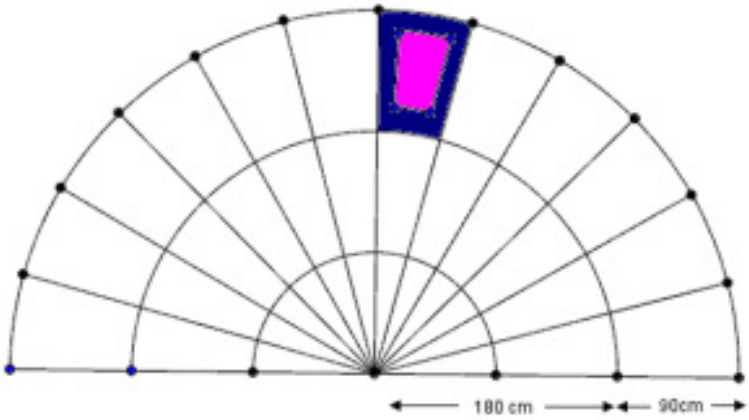

**NOTE: The dotted line on the map is not the route of the trail!**

# NEW CITY CENTRE MATHEMATICS TRAIL

**Phase 1 (Owen Building, Sheffield Hallam University)**
*Proceed from the reception into the Atrium of the Owen Building:*

1. The spiral staircase going down has several landing stages. Name as many shapes as you can see on these landing stages (which are visible from the Student and Academic Services sign).

2.




On the landing stage what is the area of the 'curved trapezium' (shaded blue and pink here); given as fraction of the semi-circle? (HARD)

3. There are some white railings above the top 'landing stage'.

(Partly shown in this photo - we're only interested in the ones at the front.)

How many different kinds of quadrilaterals can you find within the white railings? List them.

4. How many triangles (of any type ) are there here altogether?

*Exit the building back through Reception:*

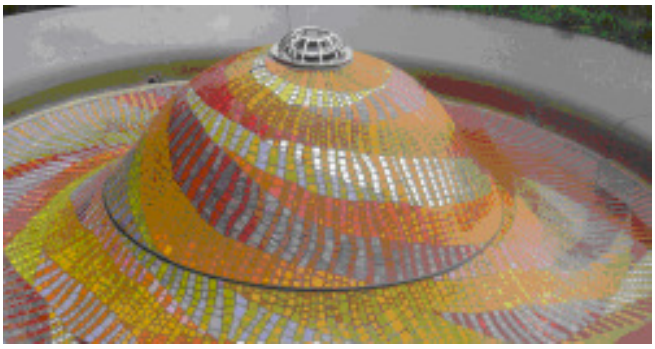
**Phase 2 Around Howard St**

5. (a) Immediately outside the building there are 4 parking bays. If 4 cars (eg. a red one, a blue one, a green one and a yellow one) all park facing forwards, how many different ways could they do this?

(b) What would the answer be if there were 6 bays (but still only 4 cars)?

*Proceeding down Howard St.....*

6. Look at the fountain.



If a small fish comes out of the fountain, how far will it travel before it goes down the drain? How long will it take?

(PLEASE DO NOT PUT ANYTHING IN THE FOUNTAIN THAT MIGHT BLOCK THE DRAIN!)

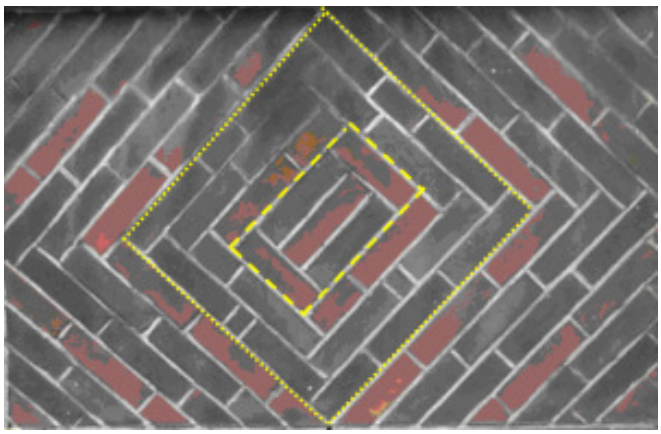
*Proceeding down Howard St look up at the Owen building on your left:*

7. What if you look up? Poetry! What if you add the digits of the year when it was written? It is a number which you can find on the downhill diagonal of a times table grid.

(a)When will this happen next?

(b) And then when?

8. Look at the brick patterns on the wall of the Globe pub.



(a)How many different ways could the marked inner rectangle be made with five whole bricks of this size?

(b)The builders have chosen not to use whole bricks outside this. Can you show a way that they could have made the marked outer rectangle with whole bricks of the same size of those in the inner rectangle?

(c)How many ways altogether for the outer rectangle with whole bricks? (HARD!)

*Proceeding up Howard St to the top:*

9. On the side of a building something is watching you.

Each of the 4 vultures' eyes is made of bricks!

(a) How many bricks have been used altogether for vultures' eyes?

(b) If you have this many eye bricks, how many ways can you divide up the bricks between four vultures? It doesn't matter what order the vultures are in, but each vulture should have at least one eye, and each eye should use no more than three bricks.

(c) Now how many ways can you divide them up between the vultures' eyes so each vulture has at least one eye, and each eye uses 1, 2 or 3 bricks? (It doesn't matter what order the vultures or their eyes are in.) (HARD!)

*Walk back up to Arundel Gate, and turn to your right, towards the pedestrian crossing:*

10. Look back at the steps down by the university.
The first set of steps has four steps.
If you can go down steps either one at a time or two at a time, how many different ways could you go down? (For example, a flight of three stairs could be done in 3 ways:
1 then 1 then 1 ***or*** 1 then 2 ***or*** 2 then 1.)

11. Before you cross the road, look at the NOVOTEL sign across the road.
Using just those letters, how many other possible names for new hotel chains could you make which alternate consonants and vowels?
(For example TENOLOV.)

*Cross the road at the crossing:*

**Phase 3 Millennium Galleries and Winter Garden**

12. Which is the nearest power of 2 to a millennium?

*Proceed up to the Winter Gardens:*

13. In the Winter Gardens - how many panes of glass are there in the arches? (Only count panes inside the gardens, above the perimeter lighting and part of the arches - so not the vertical panes between the arches or at the ends.)

14. The gardens were opened by the Queen and Duke of Edinburgh. When were they opened? Is this number prime?

*Exit to Millennium Square:*

**Phase 4 Millennium Square**

15. The balls in the square are by an artist called Colin Rose. They are called 'Rain'.

(a) In the square (in some clusters) the largest ball is approximately twice as tall as the smallest. How many times bigger is its volume?

(b) There are nine balls of different sizes. If they were all the same size how many more would you need to stack them in a triangular based pyramid?

(c) How many balls in total would you need for the next biggest pyramid?

*Proceed from here towards the Peace Gardens:*

**Phase 5 Peace Gardens**

16. Can you find out who Samuel Holbery is?
How long (from what you can tell) did he live?
This number is a 'perfect' number (ie its factors, other than itself, add up to the same as itself).
(a) Which is the first perfect number greater than 1?
(b) Are there any more perfect numbers between these?

17.

(a) How many jets of water in the fountains coming up out of the ground?

(b) Draw a rough diagram of the birds-eye view of all the jets.

(c) How many lines of symmetry does this have?

(d) What order is its rotational symmetry (if you rotated the pattern, how many ways would it fit exactly over itself)?

(e) What if you had space to build a bigger fountain in this pattern that was 12 fountains across at the widest point and still had the same symmetries? Can you sketch this?
How many jets of water in the fountain then?

(f) How many jets would be in the next biggest pattern after this?

(g) How many jets if you wanted the pattern to be 100 fountains across at the widest part? (HARD)

18. The fountains around the edges of the gardens have eight steps.

(a) If you could walk up them either one or two steps at a time, how many ways could you do this? (HARD)

(b) How many steps on the steps next to these fountains? How many ways of walking up these one or two steps at a time? (HARD)

*Now go up the steps and turn right towards the Town Hall:*

## Phase 6 Around the Town Hall

19. The walk of fame has five pointed star plaques for famous 'Sheffielders'.


There is at least one for each recent consecutive year.
The sum of the digits of each of these numbers are also consecutive.
(a)Which is the first year that will break the sequence?

(b) Investigate what happens with consecutive years giving consecutive digit sums (for the rest of the century)

20. Going up the steps 1 or 2 steps at a time, how many ways are there of climbing the town hall (outside) steps?

21. When the town hall clock says 9.00 in the morning the hands are at right angles to each other. This is also true at 3.00 in the afternoon.

a) How many times in between are the hands at right angles to each other?
b) What are these times exactly? (HARD)

c) The clock face is over a pattern made of six identical quadrilaterals.
What is the name of this quadrilateral?
d) What are its angles?

*Turn onto Surrey St:*

## Phase 7 Surrey St

22.

If you look above the Yorkshire bank - what is the angle between the directions that adjacent griffins are looking?

23. There is an old police box on Surrey St.
(a) What date were police boxes like this first used?
(b) What is the product of this number's digits?
(c) If you can choose any 2 of these digits to make a 2 digit number how many different numbers can you make?
(d) Which of these are divisible by 4?

24. If you are a man how much would it cost if you were in town all day (on a weekday) and needed to change your baby every hour and a half? (Do the first change as soon as possible just to be safe!)

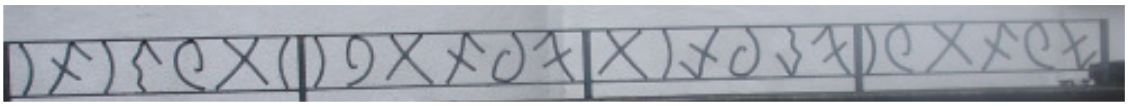
25. 1830 is last time you can do what on Surrey St?

26. The Wicker Herbalists!
How do you know its opening date is not prime?

*Enter Tudor Square:*

**Phase 8 Tudor Square and back to start**

27. One of the shops has some interesting railings!



They seem kind of mathematical.

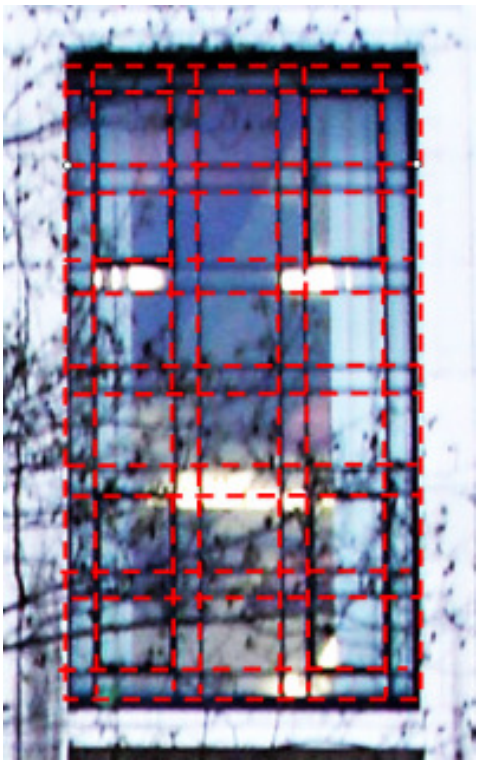
With a bit of imagination we can see possibly 4 numbers and 3 or 4 mathematical symbols! Using these, can you make the numbers?:

(a) 3 (b) 95 (c) 24

(d) You could use the symbols to make the algebraic expression $\sqrt{(7x - 6)}$.

What values of x would make this a whole number?
Can you make any of these with the symbols here?

28.



(a) How many different sizes of square can be seen in the pane of one of the library first floor windows?

(b) How many are there of each size?

(c) How many altogether?

29. There are 9 steps up to the library. How many ways of going up one or two at a time? (HARD)

30. These arrows are carved on the library.

(a) how many times do the arrows cross (including the points hidden by the ribbon)?
(b) how many more times could you make them cross if you moved one arrow?
(c) what is the maximum number of crossing places if you can move all the arrows?

31. The Graduate pub has some interesting mathematical shapes on its outer walls.

(a) Draw the ones you can see;

(b) what shape can you see in the middle of the 5 pointed one?

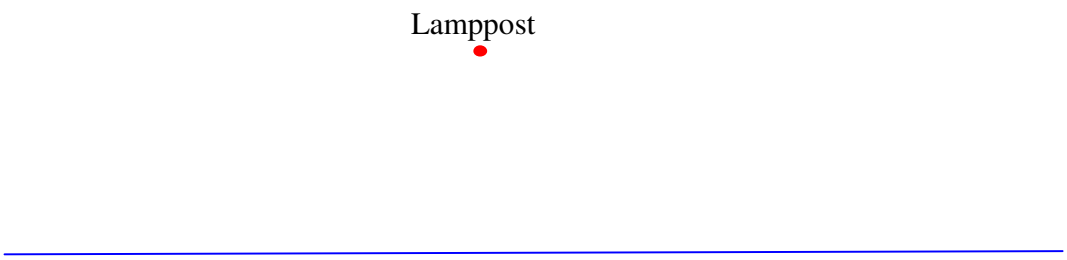
(c) if the 6 pointed one was perfectly drawn how big would the angle inside each of the 'points' of it be?

*Cross back across the road to the university and turn left along the pavement of Arundel Gate to stand in front of the Owen building, where there are trees and lamp-posts.*

32. Choose a lamp post. Look at the railings between you and the university (white with blue posts).

Find a place you can stand so you are the same distance from the lamppost as from the railings.

Find some more places that this is true for. (If there are several of you, you can each stand in a different place.)




If you mark all the possible places on this diagram, what is the name of the curve that they make?

**End of Trail**

*Thanks to our sponsors:*

**cre8ate maths** is a Y&H teacher CPD project which supports KS3 mathematics. Free resources are available from http://cre8atemaths.cseprojects.org/

Do you want to put the M in STEM? - you might like to go to the **Engineering a Better World** website at http://eabw.cseprojects.org/ and look at the Solar Challenge resources - they provide a good starting point for cross curricular work which includes mathematics.

Supported by YORKSHIRE FORWARD The Region's Development Agency