

This set of resources explores the ‘Square Sum’ problem as featured in the videos below.

<https://youtu.be/G1m7qoLCJDY?si=gTjS9NCd7U1aMD5Z>

https://youtu.be/7_ph5djCCnM?si=BtVxE46ldoO2rJLF

This problem asks: what order can we put the whole numbers 1 to 15, such that each pair of adjacent numbers adds up to a square number?

We've made three resources that could be used to explore this problem.

Students could cut the numbers out and move them around to help them solve the puzzle.

This is a sheet where students can record their solution. The instructions on the sheet introduce students to the problem.

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Numbers in **adjacent circles** need to add up to a **square number**, as in the example below.

4

+

5

9

Fill in the circles using the numbers **1 to 15, once each**.

Fill in the squares to show the square numbers they add up to in each case.

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If students are trying this without moving the cut-out numbers around first, then they will likely want to use pencil so they can rub out mistakes.

Tip: It might help the students to think about what numbers must go at the ends of the chain. The numbers 8 and 9 have only one option for what they could be paired with to make a square, so they must go at either ends of the chain.

The file **‘Square Sum 1-15, With Help’**:

This is the same as the one above aside from the first couple of numbers are given.

With this additional help the puzzle becomes much more straight forward – if the students start at the beginning, there is now only one option for what could be in each of the circles.

i.e the next circle must necessarily be filled with 15, and the circle after that must necessarily be filled with 10, and so on.

See the **‘Square Sum Solutions’** file for the solutions.

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Square Sum 1-23

This is the same puzzle as above but for 1 to 23, rather than 1 to 15.

It is more difficult than the 1 to 15 puzzle, as there are more 'wrong choices'.

For this puzzle your students could try the puzzle from scratch, using both pages of the file '**Numbers**' to move numbers around. This is very tricky!

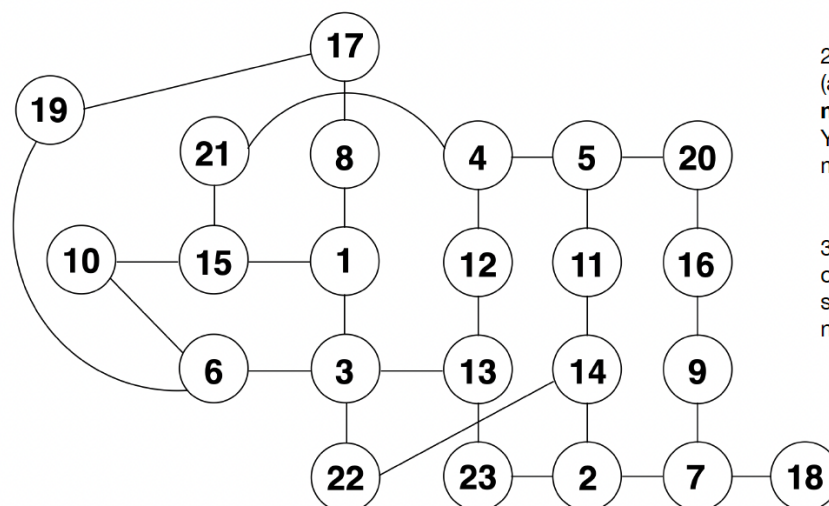
A more contained (but still tricky) task is in the file '**Square Sum 1-23**'. Shown below.

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Any two numbers that are adjacent (connected by a line) in this diagram add together to make a square.

1) Check you can find the following examples in the diagram: $19 + 6 = 25$, $21 + 4 = 25$, $20 + 16 = 36$



2) Draw a route through the diagram (along the lines), so that you **visit every number exactly once**. You'll want to use a pencil to rub out mistakes!

3) Use the path you've drawn to write out the numbers 1 to 23 in an order such that every adjacent pair of numbers adds to a square.

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We've used simpler terminology in this worksheet. If using correct terminology, the 'diagram' should be referred to as a 'graph', the numbers are 'nodes' and the lines/connections are 'edges'.

In graph theory, a route through a graph that visits every node exactly once, is called a Hamiltonian Path. So, the Square Sums 1-23 task is effectively to find a Hamiltonian Path on the graph we've drawn.

See the '**Square Sums Solutions**' document for solutions. We found two different solutions!