Question 1. This is a magic square:

4	9	2
3	5	7
8	1	6

A magic square is an arrangement of numbers in a square grid, with these rules:

I. The sum of the numbers in each row and column is the same,

II. The diagonals also sum to the same thing,

III. All the numbers in the grid are different, and

IV. Every number from 1 to the number of squares in the grid appears once.

(a) Can you find any other 3×3 magic squares? What does the row sum have to be?

(b) Find all the 1×1 magic squares. (Hint: there aren't very many.)

(c) Now find all the 2×2 magic squares. (Hint: there aren't many of these either.)

Question 2. It's a bit difficult to find 2×2 magic squares, so let's make it easier by getting rid of some of the rules.

(a) How many 2×2 magic squares are there if we only use rules I., III. and IV.?

(b) What if we only use rules I. and III.?

(c) Or just rule I.?

Question 3. Now try to look for 4×4 magic squares. Which combinations of rules make this easier or harder? (Make sure you always use rule I..)

Question 4. I'm going to tell you about a New Way of Adding Numbers. Here's how it works:

- The only numbers are 0 and 1. Forget about 2 and 17 and 95206 and all that nonsense.
- Here are the addition rules:

$$0 + 0 = 0, \qquad 0 + 1 = 1, \qquad 1 + 0 = 1, \qquad 1 + 1 = 0.$$

Got it? Great! Let's practise this new addition. Calculate these:

$$1 + 1 + 0 = \underline{\quad\quad} \qquad 0 + 0 + 1 + 1 + 0 = \underline{\quad\quad}$$

$$0 + 1 + 1 + 0 + 1 + 1 = \underline{\quad\quad} \qquad 1 + 1 + 1 + 1 + 0 + 1 + 1 + 1 = \underline{\quad\quad}$$

$$1 + 0 + 1 + 0 + 1 + 1 + 0 + 1 + 1 + 1 + 0 + 1 = \underline{\quad\quad}$$

$$1 + 1 + 0 + 1 + 0 + 1 + 1 + 1 + 0 + 1 + 0 + 1 + 0 + 0 + 0 + 1 = \underline{\quad\quad}$$

(Is there an easy way to do this?)

Question 5. Remember magic squares? We're going to make some using this New Way of Adding! Let's just use rule I. for magic squares, to make it simple. Here's an example:

1	1	0	0
0	1	0	1
1	1	0	0
0	1	0	1

(Did we make a mistake? Start by checking that this really is a magic square. . .)

How many 2×2 magic squares are there? How many of them have rows that sum to 0, and how many of them have rows that sum to 1?

How many 3×3 magic squares are there where the rows sum to 0?

What about 4×4, or 5×5, or 6×6, or. . .

Question 6. Let's play a game!

Mewtwo and Alakazam have some cards with the numbers 1 to 9 written on them, and on each player's turn, they take one of the cards. If a player has collected three cards that sum to 15, they win. If there are no cards left and no one has a set of three that adds to 15, the game is a draw.

What's a good strategy?

Why did we put this game on a worksheet about magic squares?