Grade 6 Math Circles
February 21/22/23 2023
Logic Games - Problem Set

1. This puzzle is known as the "bridge and torch" problem. Four people are crossing a bridge at night, so they all need a torch—but they just have one that only lasts 15 minutes. Ariel can cross in one minute, Belle in two minutes, Cindy in five minutes and Mulan in eight minutes. No more than two people can cross at a time, and when two cross, they have to go at the slower person's pace. How do they get across in 15 minutes?

2. During our lesson, we saw a simple version of Einstein's riddle, and used a simple table to organize our ideas. This time we will take it a step further with more complicated clues, and we will organize the information using a grid-style table.

	Clarinet	Oboe	Zither	Tambura	8 years	9 years	10 years	11 years
Larry								
Harry								
Barry								
Tarry								
8 years								
9 years								
10 years								
11 years								

Four children go to the same music school, but they all play different instruments and are of different ages. Using the following clues, determine who plays each instrument and how old they are:

(a) Larry plays the tambura

(b) The boy who plays the zither is one year younger than Barry

(c) Tarry is younger than the boy that plays the tambura

(d) The boy who plays the clarinet is two years older than Barry

3. In the lesson we learned about the **Kyudoku puzzle**. Solve the following medium and hard-leveled puzzles, respectively':

(a) Medium Kyudoku

4	5	2	5	3	8
7	4	4	9	3	7
1	7	9	4	7	7
7	6	2	7	1	3
7	9	1	5	9	4
4	8	3	5	5	1

(b) Hard Kyudoku

9	1	6	2	7	9
7	7	9	8	5	9
2	4	3	6	9	8
5	4	4	2	2	2
7	8	5	8	4	9
9	8	3	9	6	6

4. A **Nonogrid** (also known as a Picture Grid) is a square puzzle whose objective is to fill in certain squares, resulting in a fun image. At the end of the game, you should have coloured boxes and blank boxes (you can replace the blank boxes with "crossed out" boxes if you wish). There are numbers beside each row and on top of each column that give hints about the boxes you are to fill in. Here is how the hints work:

- A single number represents how many black boxes are filled in consecutively within that row/column. For instance, if there is a '4' beside a row/column, there are 4 boxes filled in. They **must** be filled in beside each other, with no spaces in between them.

- If there is more than one number listed beside the row/column, it means there are "blocks" of filled in boxes. For instance, if you see "1 2" that means that there is one box filled in and then two boxes in a row filled in. There must be at least one "empty" box between the single block and the block of two.

- In every puzzle, the boxes are filled in according to the numbers beside/on top of the row/column. For rows, you follow the order from left to right. For columns, you follow the order from top to bottom. So if there is a 2 and then a 3 underneath, it means that two filled in boxes appear "before" the three filled in boxes.

(a) Small nonogrid

(b) Medium nonogrid
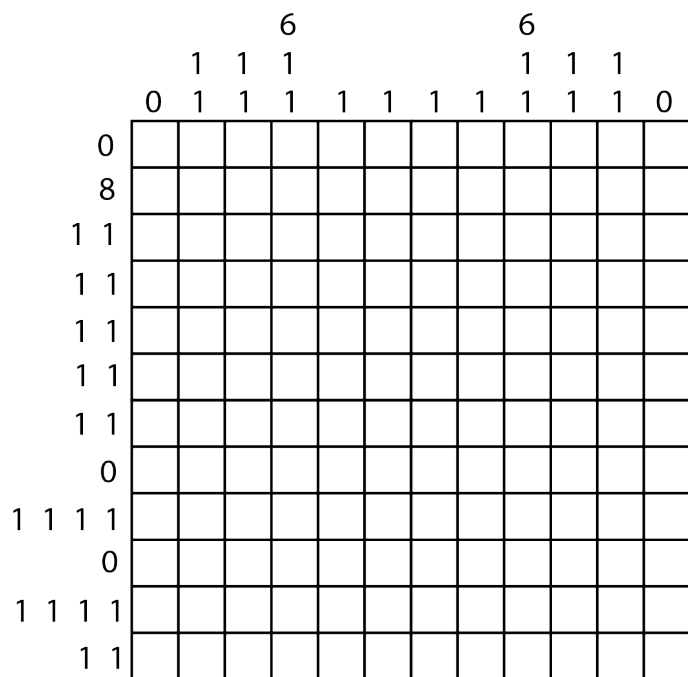
5. 3-In-A-Row is a grid puzzle that relies on colours to be solved. Each row and column have exactly the same amount of blue and white boxes, which is half of the size of the grid. For instance, a 6x6 grid has 3 blue boxes and 3 white boxes in each row and column. The only restriction in this puzzle is that you *cannot* have three boxes in a row of the same colour, or in other words, there can be at most two boxes of the same colour next to each other.

Given the following 3-In-A-Row grid, fill it in according to the rules above:
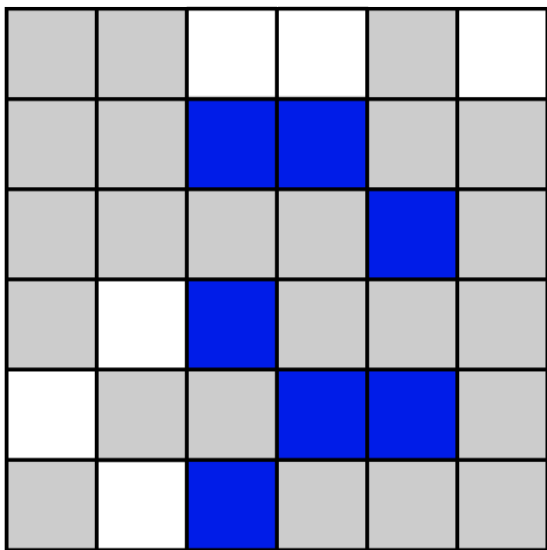
6. **Calcudoku** is a Latin square puzzle based on mathematical operations. Each row and colum must contain the digits 1 to the size of the grid (so if the sides of the square are 6 boxes long, it must contain the digits 1 through 6). The grid is broken up into "cages", shown by different colours and dashes borders. There is a number and a math operation $(+, -, \times$ or $\div)$ in the top left corner of each cage. You must fill in these cages such that when you apply the operation to all of the values inside of them, the answer that you get is the number written in the top left corner.

For example, take this cage taken from a 4x4 grid:

The clue in the top-left corner tells me that I need to find two numbers whose sum is 8. Since I am limited to digits 1, 2, 3, 4, I know that my answer must include 3 and 4. To decide where these numbers go, I use what I have in the rest of the grid.

Fill in the following 4x4 Calcudoku puzzle. Recall the strategies we discussed, and don't be afraid of making mistakes!
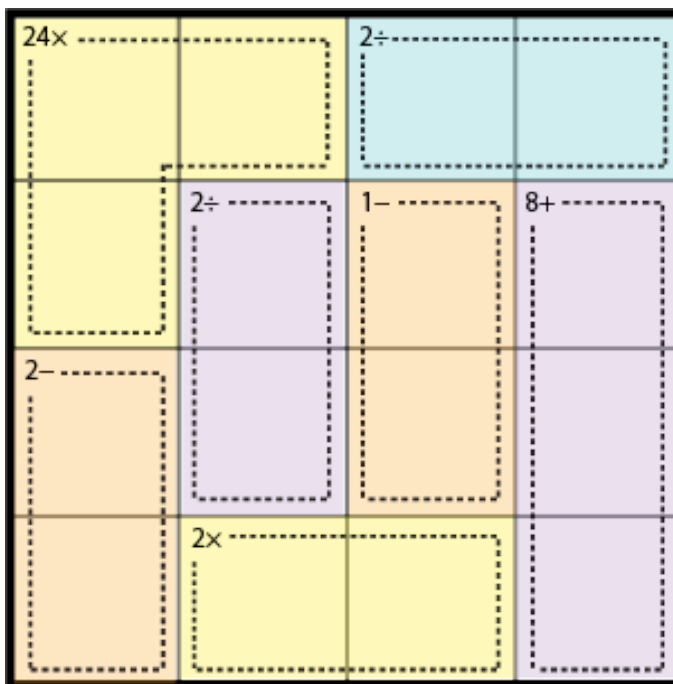
7. Logic Equations combine grid puzzles with algebra: given several equations, the objective of the game is to determine the values of the variables that are used. The values are between 1 and the size of the grid, inclusive, and each variable has a unique value.

(a) Determine the values of A, B, C, D given the equations:

- $AC > 4$
- $A + C \neq 6$
- $CD = 4$

	1	2	3	4
A				
B				
C				
D				

(b) Determine the values of A, B, C, D, E given the equations:

- $2A = B + D$
- $B > A$
- $2C = A + B$

	1	2	3	4	5
A					
B					
C					
D					
E					

8. Skyscrapers is another grid puzzle, whose objective is to label skyscrapers on the grid such that in each row and column all the different sized skyscrapers appear exactly once. The sizes of the skyscrapers are labeled using the numbers 1 through 4, with 1 being the smallest skyscraper and 4 being the tallest. Similarly to Nonogrids, the numbers at the sides indicate information about how to fill in the rows and columns.