2025–2026 Winter Break Math Challenges

Challenge 1: Digit puzzle

To ring in the new year, make the number 2026 in 9 different ways, each time by using copies of the same digit and the following operations (in addition to parentheses):

- Standard operations: $+, -, \times, \div$
- Negation: $-\square$
- Exponentiation of two numbers: $\square^{\square}$
- Square root of a number: $\sqrt{\square}$
- Factorial: $\square!$ (Note: you may use iterated factorial but not muilti-factorial, so that $3!! = (3!)! = 6! = 720$, and **not** $3!! = 3 \times 1 = 3$.)
- Concatenation (i.e. "glueing") of digits (only of the original digit used): dd

Your score for a particular digit is the number of copies you use, and your goal is to have the lowest score possible.

For example, you can make 2026 by using copies of the digit "9" as follows:

$$2026 = \underbrace{\frac{9}{9} + \frac{9}{9} + \cdots + \frac{9}{9}}_{\text{2026 times}}.$$

If you do it like this, you are using 4052 copies of 9, which is not good for you. A far more efficient way to do it is

$$2026 = 99 \times 9 \times 9 - 9 \times 9 \times 9 \times 9 + 99 \times 9 - 99 \times \sqrt{9} - 9 \times \sqrt{9} + \frac{9}{9}$$

which gets you there with only 18 copies (this is, of course, not optimal).

(1) Using the digit 1

(2) Using the digit 2

(3) Using the digit 3

(4) Using the digit 4

(5) Using the digit 5

(6) Using the digit 6

(7) Using the digit 7

(8) Using the digit 8

(9) Using the digit 9

Challenge 2: Approximations

To say goodbye to the last year, here is a puzzle about 2025. How close can you get to 2025 using the digits $2, 0, 2, 5$ exactly once? You may use the following operations (in addition to parentheses):

- Standard operations: $+, -, \times, \div$
- Negation: $-\square$
- Exponentiation of two numbers: $\square^{\square}$
- Square root of a number: $\sqrt{\square}$
- Factorial: $\square!$
  - Note: you may use iterated factorial but not multi-factorial, so that $3!! = (3!)! = 6! = 720$, and **not** $3!! = 3 \times 1 = 3$.
  - Hint: $0! = 1$
- Floor: $\lfloor \square \rfloor$ (this is the largest integer less than or equal to the input, so $\lfloor \pi \rfloor = 3$)

Notice you CANNOT use "glueing"!

Challenge 3: Art

Winter is a great time for beautiful images, especially in Calgary where we get so much sunlight. For this challenge, draw or paint a picture! It must be

(1) winter-themed, and

(2) math-related.

You must also write a short paragraph explaining how your art satisfies these two points. You will be judged on:

(1) the aesthetic and technical quality of the art,

(2) the depth of connection to mathematics, and

(3) the quality of writing.

Challenge 4: Poem

Since we just learned about primes, this challenge is to write a poem about primes. The more prime-like the poem is, the better! Here's an example of a poem I made and a short description to the side:

Pair: two.
Right here, three.
In this line are five.
Mark the words, you will find seven.
Ending this task requires a sentence with words numbering precisely eleven.

The nth line of the poem contains the nth prime and is composed of precisely that many words. It is also self-describing, in that the lines numerically describe the sentence used. Finally, it is an acrostic, a poem in which the first letter of each line spells a word, in this case, "PRIME."

Here is another example I made, with accompanying explanation:

They are the irreducible notes
In a vast and structured song.
Not born of multiplication,
But ancestors of it all.
From them, all rhythms spiral on.

Composites are the blended chords,
Built from their fundamental core.
Each prime stands out of time,
A solitary, waiting note,
On a forgotten, silent score.

And if two tones, in sequence, chime,
Across the silent, stretching staff,
That nearness is a fragile rhyme,
The space between lives two,
A brief defiance of the random path.

We can view the natural numbers as connected with music, with primes being the irreducible notes. They aren't innately formed from multiplication, but using multiplication gives rise to all natural numbers (greater than 1). The Ulam spiral is a popular graphical depiction of the prime numbers, and "rhythms spiral on" is also an allusion to the idea that the natural numbers continue without bound. If the primes are notes, then the composites are like chords of notes built from primes. Finally, the last stanza is a reference to twin primes, that is, primes that differ by 2. As the primes get larger, twin primes are more rare (and in fact, it is unknown if they continue forever), but they seem to show up again and again among the random chaos of the primes.

Include a small explanation of your poem. You will be judged on:

(1) mathematical correctness,

(2) form,

(3) rhyme or rhythm,

(4) poetic devices,

(5) coherence,

(6) imagery or mood, and

(7) significance.