



**Problem 1**

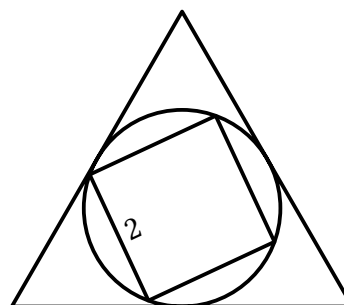
Each of the integer fractions  $a/b$ ,  $c/d$ , and  $e/f$  is in lowest terms, and they satisfy

$$256^{a/b} = 512, \quad 512^{c/d} = 4096, \quad \text{and} \quad 4096^{e/f} = 256.$$

What is  $a^2 + b^2 + c^2 + d^2 + e^2 + f^2$ ?

**Problem 2**

A square with side length 2 is inscribed in the inscribed circle of an equilateral triangle. What is the square of the side length of the triangle?



**Problem 3**

How many positive integers have all their digits in strictly increasing order?

**Problem 4**

A quadratic polynomial  $f(x)$  with constant term 123456 satisfies  $f(2525) = f(5252)$ . What is the product of the digits of  $f(7777)$ ?

**Problem 5**

Prime numbers  $p$ ,  $q$ , and  $r$  are such that both  $p$ ,  $q$ , and  $r$  divide  $p+q+r$  evenly. Additionally, they satisfy  $pqr < 2023$ , and the product  $pqr$  is the largest possible given these conditions. What is  $p + q + r$ ?

**Problem 6**

Nils has a deck of cards containing six identical blank cards, each of them with two indistinguishable sides. He wants to write all the numbers 1, 2, ..., 12 on these cards, one number on each side of each card, so that the sum of the numbers on the two sides of each card is even. In how many ways can he do so?

**Problem 7**

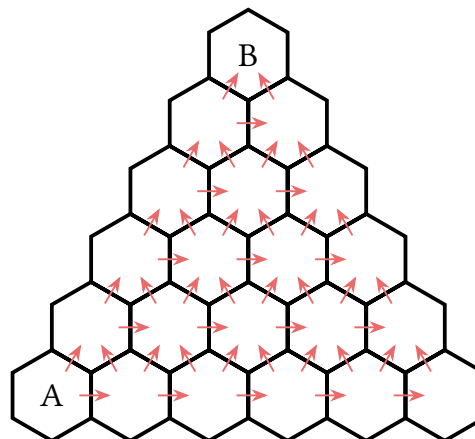
What is the largest integer  $k$  such that for some positive integer  $a$ , 2023 does not divide  $\frac{(a+k)!}{a!}$  evenly?



**Problem 8**

The cells in the picture are connected by one-way gates letting you pass from each cell to the next cell to the right, or to one of the two neighbours in the row above – where these cells exist.

How many paths are there from A to B?



**Problem 9**

Natural numbers  $m$  and  $n$  satisfy  $3m^2 + n^2 = 4mn + 2m + 800$ . What is the largest possible value of  $m$ ?

**Problem 10**

The slanted lines in the picture divide two sides of the square into five equal parts, and the other two sides into three equal parts each. The shaded area has area 70.

What is the area of the square?

