

# Math Competition 2024

## Sample Questions

### Question 1:

**Environmental Science:** The local environmental agency, monitoring pollution levels in a nearby lake, observes an exponential decrease in pollutant concentration from 85 g/L to 75 g/L within a week due to filtration processes.

- Determine the pollutant level in the lake after 4 weeks.
- If an additional pollutant is dumped once at the end of week 2, increasing the concentration by 10%, what will be the concentration 4 weeks after its introduction?
- How long will it take for the concentration to reduce to 10 g/L after the introduction of the new source?

### Question 2:

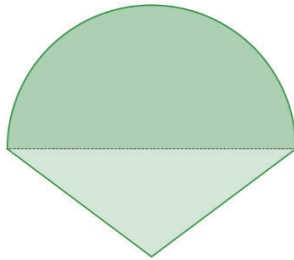
**Finance:** John invests \$2000, which earns 6% (simple) interest per year. At the same time, Sarah invests an unknown amount, which earns 8% (simple) interest per year.

After one year, both John and Sarah have earned the same amount of interest. How much did Sarah invest?

### Question 3:

**Agriculture:** Consider a triangular-shaped farmland as shown in figure, where the lengths of the two sides each equal 4 meters more than half of the base side. Additionally, the area of the triangular land is 6 times the length of the base side. To expand the land area, a semicircular portion is appended to the base side of the triangular land. Calculate the total area and perimeter of the land.

Figure not drawn to scale.



### Question 4:

**Computer Science:** A *binary string* is an ordered list of zeroes and ones (for example: 01010010 is a binary string of length 8).

- How many unique binary strings of length 12 are there?
- How many binary strings of length 12 end in the string 1101?
- How many binary strings of length 12 have more than one 0?

Question 5:

Suppose I roll three regular six-sided dice: A red die, a blue die, and a green die. Let  $R$  be the number shown on the red die,  $B$  be the number shown on the blue die, and  $G$  be the number shown on the green die.

What is the probability that  $R + B$  is greater than  $B + G$ ?

Question 6:

A band of five thieves are arrested. One of the thieves is the leader, but when questioned, the thieves give the following responses:

**Bruno:** Vijay is the leader.

**Regina:** Bruno is not the leader.

**Viktor:** The leader's name has exactly 5 letters.

**Vijay:** The leader's name starts with "V".

**Hitomi:** The leader is lying.

Given that exactly two of the thieves are lying, and the other three are telling the truth, who is the leader of the thieves?

Question 7:

**Electrical Engineering:** The total resistance ( $R_T$ ) of a circuit consisting of two parallel resistors with resistance  $R_1$  and  $R_2$  is given by the formula:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

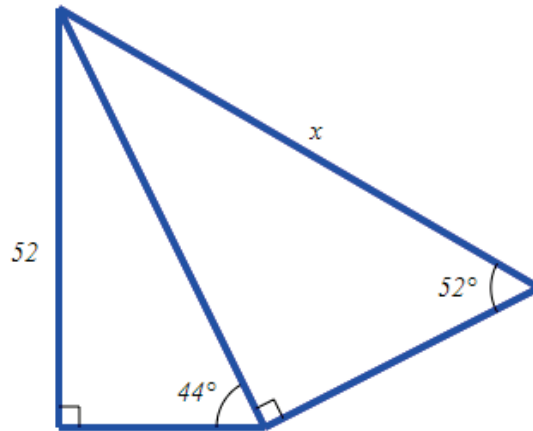
What is the value of  $R_1$ , given that  $R_2 = 2\Omega$  and the total resistance is  $R_T = 1.5\Omega$ ?

Question 8:

**Nursing Practice:** As a nurse, part of Izaak's daily duties is to mix medications in the proper proportions for his patients. For one of his regular patients, he always mixes Medication A with Medication B in the **same proportion**. Last week, his patient's doctor indicated that he should mix 50 milligrams of Medication A with 15 milligrams of Medication B. This week, however, the doctor said to only use 9 milligrams of Medication B. How many milligrams of Medication A should be mixed this week?

Question 9:

Find  $x$  correct to 2 decimal places. (NOTE: The diagram is NOT drawn to scale)



Question 10:

**Art and Design:** Fibonacci numbers and the golden ratio, derived from the Fibonacci sequence, are commonly used in art, architecture, and design for creating aesthetically pleasing compositions.

The list of the first ten numbers in the Fibonacci sequence is as follows:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, .....

Write the next five numbers that will occur in this sequence.

(HINT: *Recognize the pattern in the given numbers*).