MATHEMATICS
ESSAY PROBLEMS

Name : _____ **Participant ID** : _____

Country : _____



20th International Mathematics and Science Olympiad

Indonesia

18 November 2022

Instructions:

1. Write your name, country and index number on every page of this booklet.
2. Write your detailed solution in Arabic Numerical or English in the space provided for each question in this booklet. If you need more space for your working solutions, you may use the reverse side of each page, but please write "next side continued" in the last line.
3. There are 13 questions in this paper.
4. Each question is worth 3 marks and partial credits may be awarded.
5. Diagrams are NOT drawn to scale. They are intended only as aids.
6. You have 90 minutes to complete this paper.
7. Use black pen or blue pen or pencil to write your answer.

Do not turn over this page until you are told to do so.

ESSAY PROBLEMS

Name: _____ Country: _____ Participant ID: _____

1. What is the difference between the sum of even positive integers and the sum of odd positive integers less than 295 not divisible by 7?

Answer: _____

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2. Let a and b be positive integers that satisfy $\frac{2}{3a}+\frac{3}{2b}=\frac{1}{12}$, where $a \le b$. How many pairs of a and b are there?

Answer: _____ pairs

ESSAY PROBLEMS

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3. What is the digit sum of the number that is made up by writing integers from 1 to 2023 consecutively from left to right?

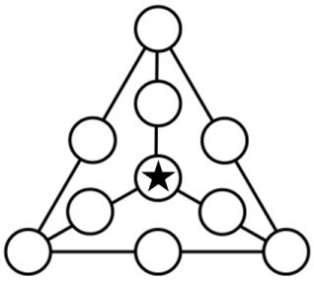
   "123456789101112131415…….20192020202120222023"

Answer: _____

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4. Fill in the ten circles in the following diagram with the numbers from 1 to 10. Each number can be used exactly once. There are six segments such that each segment connects three numbers and the sum of the numbers that lies on each segment are equal. How many possible value that can be fill in the circle with ★ symbol so that all of the requirements hold?



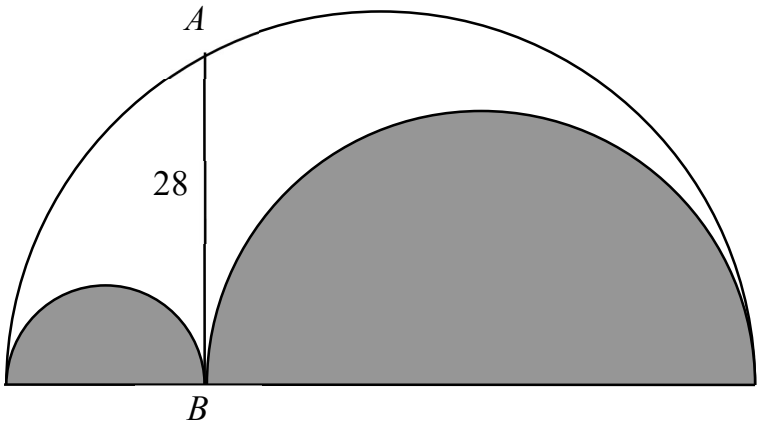
Answer: _____ possible values

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5. Three semicircles are drawn as in the diagram below. Let AB be a segment which is drawn from the diameter to the circumference of the largest semicircle and tangent to two shaded semicircles. What is the area, in cm^2, of the largest semicircle that is not covered by the smaller semicircles if the length of AB is 28 cm?

   (Use $\pi = \frac{22}{7}$)



Answer: _____ cm^2

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6. If a four-digit number, $\overline{abcd}$, is equal to the product of the two-digit number $\overline{ad}$ and the three-digit number $\overline{ada}$, then this four-digit number is called an *IMSO* number. What is the sum of all possible *IMSO* numbers?

Answer: _____

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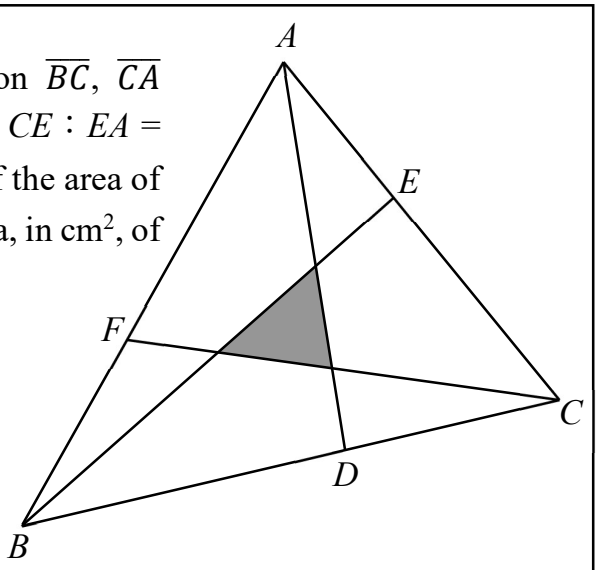
7. Consider the sequence of perfect square numbers 1, 4, 9, 16, ... Now, we add 50 to each of the terms and obtain a new sequence 51, 54, 59, 66, ..., after that, we calculate the greatest common divisor (*gcd*) of each pair of neighboring numbers, for example 51 has 54 as the neighbor so we calculate *gcd*(51, 54) = 3, 54 has 51 and 59 as the neighbor so we calculate *gcd*(51, 54) = 3 and *gcd*(54, 59)=1, and so on. What is the largest possible *gcd* value that we can get for this sequence?

Answer: _____

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8. In the triangle ABC, points D, E and F are on $\overline{BC}$, $\overline{CA}$ and $\overline{AB}$, respectively, so that $BD : DC = CE : EA = AF : FB = 3 : 2$, as shown in the figure. If the area of the shaded area is 100 cm^2, what is the area, in cm^2, of the triangle ABC?

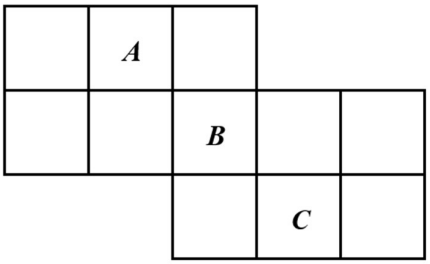


Answer: _____ cm^2

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9. In the diagram below, how many ways are there to colour the diagram using 4 colours (red, yellow, green, and blue) such that no adjacent tiles (square sharing the same side) use the same colour and the colour in *A, B,* and *C* are all different?

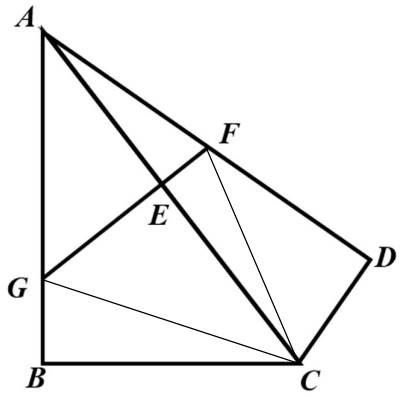


Answer: _____ ways

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10. In the diagram, ABC and ACD are right-angled triangles with $\angle ABC = \angle ADC = 90^\circ$, $AB = 20$, $BC = 15$, and $CD = 7$. Point E is the intersection of $\overline{AC}$ and $\overline{GF}$, where $AE : EC = 2 : 3$ and $\overline{AC}$ is perpendicular to $\overline{GF}$. What is the ratio of area BCG to area CEF?



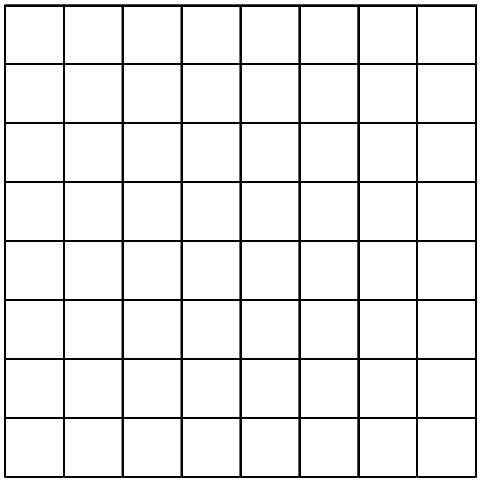
Answer: _____ : _____

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11. Given an 8 × 8 square grid. For each cell, we can draw 1 diagonal, 2 diagonals or nothing. What is the largest possible number of diagonals that we can draw so that no pair of diagonals share their end point? Give the reason and draw the diagram.

Answer: _____ Diagonals



Answer: _____

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12. Andy, Benn, Chloe, and Drian want to distribute 14 identical balls among them with following rules:
    - Every person must get at least one ball.
    - No one can have more balls than the sum of the balls from the other three people.

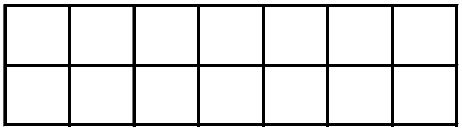
    In how many ways can the balls be distributed?

Answer: _____ ways

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13. Asep was given a 2×7 grid of unit squares. Two different squares are adjacent if they share a side. How many ways can Asep mark exactly 5 of the squares so that no two marked squares are adjacent?



Answer: _____ ways