

Problems

Time allowed: 4 hours.

NO calculators are to be used.

Questions 1 to 8 only require their numerical answers all of which are non-negative integers less than 1000. Questions 9 and 10 require written solutions which may include proofs. The bonus marks for the Investigation in Question 10 may be used to determine prize winners.

1. Two positive integers, a and b , satisfy the equation

$$\frac{2^a + 2^{2a} + 2^{2^a} + 2^{2^a}}{2024} = \frac{2^b}{23^b}$$

Find the value of $a + b$.

[2 marks]

2. The area of a right-angled triangle is 120 and each of its three sides has integer length. Find the length of its hypotenuse.

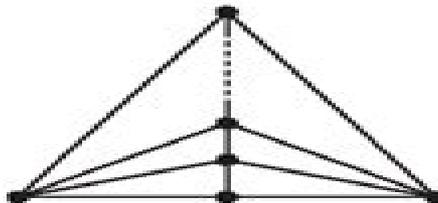
[2 marks]

3. Quadrilateral $ABCD$ has perimeter 60 cm and AB has length 9 cm. Sides AD and BC are parallel with distance 7 cm between them. Points E and F are chosen on sides BC and AD respectively so that the line EF divides $ABCD$ into two quadrilaterals with equal perimeters and equal areas.

What is the area of quadrilateral $ABCD$?

[3 marks]

4. In the following figure, all the central dots are collinear and the bottom three dots are collinear. There are exactly 2024 triangles that have dots as vertices (no three collinear dots form a triangle).



How many dots are there?

[2 marks]

5. Three positive integers a , b , c satisfy

$$a^2 + b - c = 100 \tag{1}$$

$$a + b^2 - c = 124 \tag{2}$$

Find $a + b + c$.

[3 marks]

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Table of Contents Mathematics Olympiad Problems And Solutions

1. Understanding the eBook Mathematics Olympiad Problems And Solutions
 - The Rise of Digital Reading Mathematics Olympiad Problems And Solutions
 - Advantages of eBooks Over Traditional Books
2. Identifying Mathematics Olympiad Problems And Solutions
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Mathematics Olympiad Problems And Solutions
 - User-Friendly Interface
4. Exploring eBook Recommendations from Mathematics Olympiad Problems And Solutions
 - Personalized Recommendations
 - Mathematics Olympiad Problems And Solutions User Reviews and Ratings
 - Mathematics Olympiad Problems And Solutions and Bestseller Lists
5. Accessing Mathematics Olympiad Problems And Solutions Free and Paid eBooks

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 - Mathematics Olympiad Problems And Solutions Budget-Friendly Options
6. Navigating Mathematics Olympiad Problems And Solutions eBook Formats
- ePub, PDF, MOBI, and More
 - Mathematics Olympiad Problems And Solutions Compatibility with Devices
 - Mathematics Olympiad Problems And Solutions Enhanced eBook Features
7. Enhancing Your Reading Experience
- Adjustable Fonts and Text Sizes of Mathematics Olympiad Problems And Solutions
 - Highlighting and Note-Taking Mathematics Olympiad Problems And Solutions
 - Interactive Elements Mathematics Olympiad Problems And Solutions
8. Staying Engaged with Mathematics Olympiad Problems And Solutions
- Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Mathematics Olympiad Problems And Solutions
9. Balancing eBooks and Physical Books Mathematics Olympiad Problems And Solutions
- Benefits of a Digital Library
 - Creating a Diverse Reading Collection Mathematics Olympiad Problems And Solutions
10. Overcoming Reading Challenges
- Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Mathematics Olympiad Problems And Solutions
- Setting Reading Goals Mathematics Olympiad Problems And Solutions
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Mathematics Olympiad Problems And Solutions
- Fact-Checking eBook Content of Mathematics Olympiad Problems And Solutions
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development

- Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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