

Solutions

Twentieth International Olympiad, 1978

1978/1. Since 1978^n and 1978^m agree in their last three digits, the difference

$$1978^n - 1978^m = 1978^m(1978^{n-m} - 1)$$

is divisible by $10^3 = 2^3 \cdot 5^3$; and since the second factor above is odd, 2^3 divides the first. Also

$$1978^m = 2^m \cdot 989^m,$$

so $m \geq 3$.

We can write $m + n = (n - m) + 2m$; to minimize this sum, we take $m = 3$ and seek the smallest value of $d = n - m$, such that $1978^d - 1$ is divisible by $5^3 = 125$, i.e.

$$1978^d \equiv 1 \pmod{125}.$$

We shall twice make use of the following

LEMMA. *Let d be the smallest exponent such that $a^d \equiv 1 \pmod{N}$. Then any other exponent g for which $a^g \equiv 1 \pmod{N}$ is a multiple of d .*

PROOF: If d does not divide g , then $g = qd + r$ with $0 < r < d$, and $a^g \equiv a^{qd}a^r \equiv 1 \pmod{N}$ implies $a^r \equiv 1 \pmod{N}$ with $0 < r < d$, contradicting the minimality of d . So $d|g$.

Fermat's theorem states:† For any prime p and any integer a not divisible by p ,

$$(1) \quad a^{p-1} \equiv 1 \pmod{p}.$$

For example,

$$1978^4 \equiv 1 \pmod{5}.$$

†For a proof, see e.g. p. 126 of S. L. Greitzer, *The International Mathematical Olympiads*, vol. 27 in this NML series.

Math Olympiad Problems And Solutions

LL Leslie

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Math Olympiad Problems And Solutions:

Math Olympiad Problems And Solutions Book Review: Unveiling the Power of Words

In a global driven by information and connectivity, the ability of words has be much more evident than ever. They have the capability to inspire, provoke, and ignite change. Such may be the essence of the book **Math Olympiad Problems And Solutions**, a literary masterpiece that delves deep to the significance of words and their impact on our lives. Published by a renowned author, this captivating work takes readers on a transformative journey, unraveling the secrets and potential behind every word. In this review, we shall explore the book is key themes, examine its writing style, and analyze its overall effect on readers.

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Table of Contents Math Olympiad Problems And Solutions

1. Understanding the eBook Math Olympiad Problems And Solutions
 - The Rise of Digital Reading Math Olympiad Problems And Solutions
 - Advantages of eBooks Over Traditional Books
2. Identifying Math 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 Math Olympiad Problems And Solutions
 - User-Friendly Interface
4. Exploring eBook Recommendations from Math Olympiad Problems And Solutions
 - Personalized Recommendations
 - Math Olympiad Problems And Solutions User Reviews and Ratings
 - Math Olympiad Problems And Solutions and Bestseller Lists

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