

# maths hard question with answer

**maths hard question with answer** challenges students and enthusiasts alike to sharpen their problem-solving skills and deepen their understanding of mathematical concepts. Tackling difficult math problems is essential for developing critical thinking, analytical reasoning, and precision. This article presents a selection of complex math questions paired with detailed solutions, ensuring that learners can not only practice but also comprehend the underlying principles. The focus is on a variety of topics, ranging from algebra and calculus to number theory and geometry, providing a comprehensive approach to mastering tough questions. Additionally, explanations emphasize step-by-step methods to arrive at correct answers, facilitating better retention and application. Whether preparing for competitive exams or seeking to enhance math proficiency, these problems serve as valuable resources. Below is an overview of the main sections covered in this article.

- Algebraic Hard Questions with Answers
- Calculus Challenging Problems with Solutions
- Number Theory Difficult Questions and Answers
- Geometry Complex Problems with Step-by-Step Solutions

## Algebraic Hard Questions with Answers

Algebra often forms the foundation of many advanced math problems. Difficult algebraic questions test one's ability to manipulate equations, work with polynomials, and apply functions effectively. This section presents challenging problems involving quadratic equations, systems of equations, and inequalities, accompanied by comprehensive answers.

## Quadratic Equations with Complex Roots

Consider the quadratic equation  $x^2 + 4x + 13 = 0$ . Finding the roots requires understanding the discriminant and handling complex numbers when the discriminant is negative.

1. Calculate the discriminant:  $\Delta = b^2 - 4ac = 16 - 52 = -36$ .
2. Since  $\Delta < 0$ , roots are complex:  $x = [-b \pm \sqrt{\Delta}]/2a = [-4 \pm \sqrt{(-36)}]/2$ .
3. Express  $\sqrt{(-36)}$  as  $6i$ , where  $i$  is the imaginary unit.
4. Roots:  $x = (-4 \pm 6i)/2 = -2 \pm 3i$ .

Thus, the solutions are  $x = -2 + 3i$  and  $x = -2 - 3i$ .

## System of Nonlinear Equations

Solve the system:

- $y = x^2 + 1$
- $y^2 = 4x + 5$

Substitute  $y$  from the first equation into the second:

1.  $(x^2 + 1)^2 = 4x + 5$
2. Expand left side:  $x^4 + 2x^2 + 1 = 4x + 5$
3. Rewrite:  $x^4 + 2x^2 - 4x - 4 = 0$
4. This quartic equation can be solved by trial or factorization methods.

By testing integer values:

- $x = 1: 1 + 2 - 4 - 4 = -5$  (not zero)
- $x = 2: 16 + 8 - 8 - 4 = 12$  (not zero)
- $x = -1: 1 + 2 + 4 - 4 = 3$  (not zero)
- $x = -2: 16 + 8 + 8 - 4 = 28$  (not zero)

Since no easy integer roots appear, numerical or graphical methods may be used to approximate the solutions. Alternatively, applying substitution or factoring techniques for quartic equations may help find exact roots.

## Calculus Challenging Problems with Solutions

Calculus problems often require integrating knowledge of derivatives, integrals, limits, and series. Hard calculus questions push learners to apply multiple concepts simultaneously to derive solutions. This section includes examples of difficult differentiation and integration problems with full answers.

### Evaluating a Difficult Limit

Find the limit:

$$\lim_{x \rightarrow 0} (\sin 5x) / (x)$$

Using the standard limit property  $\lim_{t \rightarrow 0} (\sin t)/t = 1$ , substitute  $t = 5x$ :

1. Rewrite limit as  $\lim_{x \rightarrow 0} (\sin 5x) / (x) = \lim_{x \rightarrow 0} 5 * (\sin 5x)/(5x)$
2. Since  $\lim_{t \rightarrow 0} (\sin t)/t = 1$ ,  $\lim_{x \rightarrow 0} (\sin 5x)/(5x) = 1$
3. Therefore, the limit equals  $5 * 1 = 5$ .

The answer is **5**.

## Integration of a Trigonometric Function

Evaluate the integral:

$$\int (x * \cos x^2) dx$$

Use substitution:

1. Let  $u = x^2 \rightarrow du = 2x dx \rightarrow (1/2) du = x dx$
2. Rewrite integral:  $\int \cos u * (1/2) du = (1/2) \int \cos u du$
3. Integrate:  $(1/2) \sin u + C$
4. Substitute back  $u = x^2$ :  $(1/2) \sin x^2 + C$

The solution is  $(1/2) \sin x^2 + C$ .

## Number Theory Difficult Questions and Answers

Number theory encompasses properties of integers, divisibility, prime numbers, and modular arithmetic. Hard questions in this area often involve proofs or problem-solving that require deep insight. This section explores challenging number theory problems complete with explanations and answers.

### Finding the Greatest Common Divisor (GCD)

Determine the GCD of 252 and 105 using the Euclidean algorithm:

1.  $252 \div 105 = 2$  remainder 42 ( $252 = 2 \times 105 + 42$ )
2.  $105 \div 42 = 2$  remainder 21 ( $105 = 2 \times 42 + 21$ )
3.  $42 \div 21 = 2$  remainder 0 ( $42 = 2 \times 21 + 0$ )

The last nonzero remainder is 21, so  $\text{GCD}(252, 105) = 21$ .

## Solving a Modular Arithmetic Problem

Find the remainder when  $7^{100}$  is divided by 13.

Apply modular exponentiation and Fermat's Little Theorem:

1. Since 13 is prime,  $7^{12} \equiv 1 \pmod{13}$
2. Find  $100 \bmod 12$ :  $100 \div 12 = 8$  remainder 4
3. Therefore,  $7^{100} \equiv 7^4 \pmod{13}$
4. Calculate  $7^4$ :  $7^2 = 49 \equiv 10 \pmod{13}$ , then  $7^4 = (7^2)^2 = 10^2 = 100 \equiv 9 \pmod{13}$

The remainder is **9**.

## Geometry Complex Problems with Step-by-Step Solutions

Geometry problems often involve spatial reasoning, properties of shapes, and trigonometric relationships. Complex geometry questions test the ability to combine formulas and theorems to solve for unknowns. This section includes difficult geometry questions with thorough solutions.

### Finding the Area of a Triangle Using Coordinates

Given points A(2, 3), B(5, 7), and C(9, 1), find the area of triangle ABC.

Use the coordinate geometry formula for area:

$$\text{Area} = \frac{1}{2} |x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$$

1. Substitute values:  $\frac{1}{2} |2(7 - 1) + 5(1 - 3) + 9(3 - 7)|$
2. Calculate inside:  $\frac{1}{2} |2 \times 6 + 5 \times (-2) + 9 \times (-4)| = \frac{1}{2} |12 - 10 - 36|$
3. Sum inside:  $\frac{1}{2} |-34| = \frac{1}{2} \times 34 = 17$

The area of triangle ABC is **17 square units**.

### Using the Pythagorean Theorem in 3D

Find the length of the diagonal of a rectangular box with dimensions 3 units, 4 units, and 12 units.

The diagonal  $d$  in 3D space is given by:

$$d = \sqrt{\text{length}^2 + \text{width}^2 + \text{height}^2}$$

1. Calculate:  $d = \sqrt{3^2 + 4^2 + 12^2} = \sqrt{9 + 16 + 144} = \sqrt{169}$

2. Therefore,  $d = 13$  units

The space diagonal length is **13 units**.

## Frequently Asked Questions

### What is the solution to the integral $\int (x^2 * e^x) dx$ ?

Use integration by parts twice: Let  $u = x^2$ ,  $dv = e^x dx$ . Then  $du = 2x dx$ ,  $v = e^x$ . So,  $\int x^2 e^x dx = x^2 e^x - \int 2x e^x dx$ . Apply integration by parts again on  $\int 2x e^x dx$  with  $u=2x$ ,  $dv=e^x dx$  to get the final answer:  $e^x(x^2 - 2x + 2) + C$ .

### How do you solve the differential equation $dy/dx = y^2 * \sin(x)$ ?

Separate variables:  $dy / y^2 = \sin(x) dx$ . Integrate both sides:  $\int y^{-2} dy = \int \sin(x) dx$ . This gives  $-1/y = -\cos(x) + C$ , or  $y = 1 / (\cos(x) + C)$ .

### What is the value of the limit $\lim_{(x \rightarrow 0)} (\sin(5x) / x)$ ?

Using the standard limit  $\lim_{(x \rightarrow 0)} (\sin(ax)/x) = a$ , we get  $\lim_{(x \rightarrow 0)} (\sin(5x)/x) = 5$ .

### How to find the roots of the cubic equation $x^3 - 6x^2 + 11x - 6 = 0$ ?

Try rational root theorem candidates: 1, 2, 3. Substitute  $x=1$ :  $1-6+11-6=0$ , so  $x=1$  is root. Divide polynomial by  $(x-1)$  to get  $x^2 - 5x + 6=0$ . Factor quadratic:  $(x-2)(x-3)=0$ , roots are 2 and 3. So roots are  $x=1, 2, 3$ .

### What is the solution to the system of equations: $2x + 3y = 7$ and $4x - y = 5$ ?

Multiply second equation by 3:  $12x - 3y = 15$ . Add to first equation:  $(2x + 3y) + (12x - 3y) = 7 + 15 \rightarrow 14x = 22 \rightarrow x = 22/14 = 11/7$ . Substitute back into first equation:  $2*(11/7) + 3y = 7 \rightarrow 22/7 + 3y = 7 \rightarrow 3y = 7 - 22/7 = (49 - 22)/7 = 27/7 \rightarrow y = 9/7$ .

### How to prove that the sum of the first $n$ natural numbers is $(n(n+1))/2$ ?

Use mathematical induction: Base case  $n=1$ :  $\text{sum}=1$ ,  $\text{formula}=1(1+1)/2=1$  correct. Assume true for  $n=k$ :  $\text{sum} = k(k+1)/2$ . For  $n=k+1$ :  $\text{sum} = k(k+1)/2 + (k+1) = (k(k+1) + 2(k+1))/2 = (k+1)(k+2)/2$ , which matches the formula. Thus proved.

# Additional Resources

## 1. *"Challenging Math Problems with Detailed Solutions"*

This book presents a curated collection of difficult math problems spanning various topics such as algebra, geometry, number theory, and combinatorics. Each problem is accompanied by a comprehensive, step-by-step solution that helps readers understand the underlying concepts and problem-solving strategies. It is ideal for advanced high school students and math enthusiasts looking to deepen their analytical skills.

## 2. *"Advanced Mathematical Problem Solving: Questions and Answers"*

Designed for competitive exam preparation and math Olympiads, this book offers a wide range of challenging problems with clear, detailed answers. It emphasizes critical thinking and creative approaches to tackle non-routine questions. Readers will benefit from the explanations that not only provide solutions but also discuss alternative methods.

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## 4. *"Tough Math Questions Answered: A Comprehensive Guide"*

This guide contains a broad spectrum of challenging math questions, from simple puzzles to complex proofs. Each question is solved with meticulous attention to detail, making it accessible for readers aiming to master problem-solving techniques. The book also includes tips and tricks to handle tricky questions efficiently.

## 5. *"Math Puzzles and Hard Problems with Solutions"*

Featuring a mix of puzzles and challenging problems, this book is crafted to stimulate logical thinking and mathematical creativity. Solutions are explained clearly, providing insights into different approaches and reasoning processes. It's suitable for learners who enjoy an engaging and interactive approach to math.

## 6. *"Olympiad-Level Math Problems with Answers"*

Focused on problems commonly encountered in math Olympiads, this book offers a collection of high-difficulty questions with complete solutions. It covers topics such as inequalities, functional equations, and combinatorics, helping students prepare effectively for competitive exams. The detailed answers help demystify complex problem-solving methods.

## 7. *"Hard Math Questions and Their Solutions for Enthusiasts"*

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Offering a clear and methodical approach, this book walks readers through challenging problems with step-by-step solutions. It emphasizes understanding the rationale behind each step to foster a deeper comprehension of complex concepts. Perfect for students aiming to improve their problem-solving accuracy and confidence.

## 9. "Mastering Hard Math Questions: Problems and Detailed Answers"

This book compiles a variety of sophisticated math problems along with detailed, well-explained solutions. It focuses on developing analytical thinking and problem-solving agility through practice. Readers will find valuable strategies and explanations that aid in mastering difficult mathematical challenges.

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as the fundamental pillars of great teaching. Additionally, the book includes four rich case studies, revisited throughout the curriculum, pedagogy, and assessment chapters, which help to showcase how these ideas can be applied in various contexts - so you can really see what it all looks like In Action.

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tensions are sensitively explored through interviews with young men and women, to show how doing mathematics fits or conflicts with their gender identities. Finally, the book explores the implications for teachers, including ways to promote gender equity in mathematics education. This is key reading for students on courses in gender and education, mathematics education, gender and curriculum, and social justice.

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**maths hard question with answer: Which Way Social Justice in Mathematics Education?** Leone Burton, 2003-02-28 This contributed volume explores equity and social justice within the field of mathematics education. In part one, Helga Jungwirth's introductory chapter provides a strong theoretical overview that is based in actual classroom behaviors and a typology that classifies the various interpretations found within this volume. Also in part one, Laurie Hart discusses developments in equity research in the United States. Part two focuses on results of studies about social justice and their impact on learning in mathematics classrooms in various parts of the world. For example, in a chapter on Peru, social justice does not just encompass gender, but also inequalities in opportunities to learn, such as problems of resources, living and social conditions, communal demands and language needs. And, part three focuses on computers as a resource to mathematics teaching. The contributors raise several important social justice issues which have previously remained unresearched. Although there are a number of chapters specifically dealing with gender, many of the authors use one of the following strategies: their gender-specific questions are set in a wider socio-cultural context, they challenge what have threatened to become false orthodoxies, or they raise other important issues. These other issues include the meaning of democratic citizenship for mathematics classrooms, the links between parents and children learning mathematics, and the preconceptions of some teachers of underprivileged students in Australia.

Other chapters explore different forms of classroom communication, participation, and assessment. The pieces on computers state that there is still not enough research to conclude whether computers in the mathematics classrooms are supportive of, or detrimental to, the learning of all students. The one thing on which every author in this volume does agree is that social justice in mathematics education has still not been attained, but that we must strive toward it to improve educational practices and society in general.

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