

2004 AMC 12A-#21
(Series, Trigonometric Functions)

If $\sum_{n=0}^{20} \cos 2^n \theta = 5$,
what is the value of $\cos 20\theta$?

- (A) $\frac{1}{5}$
- (B) $\frac{2}{5}$
- (C) $\frac{\sqrt{5}}{5}$
- (D) $\frac{3}{5}$
- (E) $\frac{4}{5}$

1998 AIME - #15
(Eulerian Circuit)

Define a *domino* to be an ordered pair of *distinct* positive integers. A *proper sequence of dominos* is a list of distinct dominos in which the immediately preceding pair, and in which (i, j) and (j, i) do not both appear for any i and j . Let D_{40} be the set of all dominos whose coordinates are no larger than 40. Find the length of the longest proper sequence of dominos that can be formed using the dominos of D_{40} .

2005 AMC 12B-#22
(Complex numbers, Sequences)

A sequence of complex numbers z_0, z_1, z_2, \dots is defined by the rule

$$z_{n+1} = \frac{iz_n}{z_n}$$

where \bar{z}_n is the complex conjugate of z_n and $i^2 = -1$. Suppose that $|z_0| = 1$ and $z_{2005} = 1$. How many values are there for z_0 ?

- (A) 1
- (B) 2
- (C) 4
- (D) 2005
- (E) 2^{2005}

2005 USAMO - #2
(Fermat's Theorem, Diophantine Equations)

Prove that the system

$$x^6 + x^3 + x^3y + y = 147^{157}$$

$$x^3 + x^3y + y^2 + y + z^6 = 157^{147}$$

has no solutions in integers x, y , and z .

2006 AMC 12A-#18
(Function notation)

The function f has the property that for each real number x in its domain, $1/x$ is also in its domain and

$$f(x) + f\left(\frac{1}{x}\right) = x.$$

What is the largest set of real numbers that can be in the domain of f ?

- (A) $\{x \mid x \neq 0\}$
- (B) $\{x \mid x < 0\}$
- (C) $\{x \mid x > 0\}$
- (D) $\{x \mid x \neq -1 \text{ and } x \neq 0 \text{ and } x \neq 1\}$
- (E) $\{-1, 1\}$

2005 AMC 12A-#23
(Logarithms)

Two distinct numbers a and b are chosen randomly from the set $\{2, 2^2, 2^3, \dots, 2^{25}\}$. What is the probability that $\log_a b$ is an integer?

- (A) $\frac{2}{25}$
- (B) $\frac{31}{300}$
- (C) $\frac{13}{100}$
- (D) $\frac{7}{50}$
- (E) $\frac{1}{2}$

Euler



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- Number Theory
- Ship Design
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Leonhard Euler...



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