Plank Countdown

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Please do not actually try this one manually.

Problem 0

What are the first four digits of 3^{15}?

Source: well known joke in the math community. Answer: 1434

Problem 1

Let a and b be five-digit palindromes (without leading zeroes) such that $a < b$ and there are no other five-digit palindromes strictly between a and b. What are all possible values of $b - a$? (A number is a palindrome if it reads the same forwards and backwards in base 10.)

Answer 1

Casework on how many ‘carries’ there are between consecutives. 100, 110, 11.
Source: HMMT Feb 2018 C2.

Problem 2

Quadrilateral $ABCD$ is cyclic with $AB = CD = 6$. Given that $AC = BD = 8$ and $AD + 3 = BC$, what is $[ABCD]$?

Note

$[A_1 \ldots A_n]$ denotes the area of that polygon.

Answer 2

Ptolemy to find the missing lengths AD, BC, then Brahmagupta to find the area. $33\sqrt{15}/4$.
Source: BMT 2020 TB G2.

Every face of a cube is colored one of 3 colors at random. What is the expected number of edges that lie along two faces of different colors?

Linearity of expectation. Probability that two adjacent faces are different colours is $2/3$. 8.
Source: BMT 2018 TB C1.

Remark

BMT tiebreaker problems are also meant to be fast paced- these problems are supposed to be solved in 15 mins though most contestants finish before then. CMM TB does not work for this purpose, on the other hand....

There is a unique 4-digit positive integer $n = \underline{abcd}$ with $\underline{ab} \cdot \underline{cd} = n/3 - 2$. What is the sum of the digits of n?

Answer 4

12. This is a 1434 joke invented by one of my friends. Source: 2023 AMC 12B*/13 (a mock AMC you can find on AoPS)

Find the number of ordered pairs of integers (a, b) such that a, b are divisors of 720 but ab is not.

Answer 5

Complementary counting. 2520.
Source: HMMT Feb 2016 C3

Compute the probability that a random permutation of the letters in BERKELEY does not have the three E's all on the same side of the Y.

Shockingly this is a BMT problem again. (2018 TB C1) We only care about the locations of the Y's and the E's. $2 \cdot 1/4 = 1/2$.

Right triangle ABC with its right angle at B has angle bisector $\overline{AD}$ with D on $\overline{BC}$, as well as altitude $\overline{BE}$ with E on $\overline{AC}$. If $\overline{DE} \perp \overline{BC}$ and $AB = 1$, compute AC.

Answer 7

Trig bash. $(1+\sqrt{5})/2$.
Source: BMT 2021 TB G2

Let Ω and ω be circles with radii 123 and 61, respectively, such that the center of Ω lies on ω. A chord of Ω is cut by ω into three segments, whose lengths are in the ratio $1 : 2 : 3$ in that order. Given that this chord is not a diameter of ω, compute the length of this chord.

Answer 8

Synthetic and power of a point. 42.
Source: 2024 HMMT Feb G3

In triangle ABC with $AB = 8$ and $AC = 10$, the incenter I is reflected across side AB to point X and across side AC to point Y. Given that segment XY bisects $\overline{AI}$, compute BC^2.

Answer 9

Use synthetic to get $\angle A = 60^\circ$. 84 by some bashing.
Source: HMMT Nov 2020 General 7

Find the integer closest to

$$\frac{1}{\sqrt[4]{5^4+1}-\sqrt[4]{5^4-1}}.$$

Rationalise the denominator. 250.
Source: HMMT Feb 2014 A6

Greta writes $2, 3, \ldots, 101$ on a chalkboard. Every minute she erases two chosen numbers x, y from the board, and writes $xy/(x + y - 1)$ in their place. After 99 minutes, what number remains?

This is a contrived invariant problem. The invariant in question is

$$\prod_k \frac{1}{1 - 1/x_k}$$

where the nums on the board are $x_1, \ldots$.
Source: BMT 2022 TB A3

A positive integer is called extra-even if all of its digits are even. Compute the number of positive integers n less than or equal to 2022 such that both n and 2n are both extra-even.

Figure out from experimenting that $0, 2, 4$ are the only legal digits. 31.
Source: BMT 2022 TB C2

Problem

Let a and b be real numbers such that $a + b = 16$ and $a^3 - b^3 = ab^2 - a^2b + 2048$. Compute ab^2.

Factor, divide, etc to obtain a, b. 192.
Source: BMT 2025 TB A2

I ran out of problem ideas

Thank you for playing!! :3