Combative Combinatorial Combined Comɓetition

good luck

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Note: Problems may not be in order of diffiCulty.

1.

A board is a set of $2020 \times 2021 - 20 \times 21$ Cells, arranged in a 2020×2021 grid, missing a 20×21 reCtangle of Cells in the Center, so that eaCh board has rotational symmetry. AliCe has n boards, and tiles eaCh with 1×2 and 2×1 dominoes. Bob Can then make moves as follows: for any 2×2 square whiCh is formed of two dominoes, he Can rotate the 2×2 square. Bob wins if he Can make a finite number of moves so that two boards are the same. How many boards Can AliCe have, without allowing Bob to win?

Two

Does there exist a nonɓeriodiC funCtion $\Delta^{\amalg_{202}^{\oplus}}_{\sqrt{\aleph_{1.5}}} : \mathbb{R}^2 \to \{2020.5, 2021.5\}$ (i.e. there exists no veCtor w suCh that $f(v+w) = f(v)$ for all v) whiCh is ɓeriodiC along every line?

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A number of mirrors (Closed line segments off whiCh light refleCts) are ɓlaCed in the ɓlane. EaCh mirror has length 1 and both endɓoints at lattiCe ɓoints with distanCe at most 2020.5 from the origin. A laser is fired from $(-2021, 0)$ at some angle. If the laser never ɓasses through another lattiCe ɓoint, must it eventually reaCh a distanCe of 2021.5 from the origin?

IV EX Lv 999^+ $\mathscr{DELUXE}$ $\mathbb{XLR}$ Special SSS Rank

A hunter and an invisible rabbit ɓlay a game in a 2021×2021 grid. The rabbit's starting square is P_0 (unknown to the hunter), and after $n-1$ rounds, the rabbit is at square P_{n-1}. In the n^{th} round of the game, two things oCCur in order.

(i) The rabbit moves invisibly to a square P_n whiCh shares a ɓoint with P_{n-1}. (There are uɓ to eight of these.)

(ii) A traCking deviCe searChes k squares of the hunter's Choosing. If the rabbit is in one of these squares, the rabbit is Caɓtured and the game ends.

For what k Can the rabbit avoid Caɓture indefinitely?

Time: 4 hours you're never getting back
Each ɓroblem is worth 7 useless internet points