USING INDUCTION TO PROVE FIRST-ORDER RECURSIVE FORMULAE

1 If $u_{n+1} = 3u_n + 4$ and $u_1 = 1$, use mathematical induction to prove that $u_n = 3^n - 2$ for all positive integers n.

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4 A sequence is defined recursively as $u_1 = 5$, $u_2 = 13$, $u_n = 5u_{n-1} - 6u_{n-2}$ for $n \geq 3$. By induction, prove that $u_n = 2^n + 3^n$ for all positive integers n.

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7 The Fibonacci sequence is defined as $u_1 = 1$, $u_2 = 1$, $u_{n+2} = u_{n+1} + u_n$ for all positive integers $n \geq 1$.

Prove by induction that $u_n < \left(\frac{5}{3}\right)^n$ for all positive integers n.

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8 If $a_0 = 1$, $a_1 = 6$ and $a_n = 6a_{n-1} - 9a_{n-2}$, use mathematical induction to prove that $a_n = 3^n + n3^n$.

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9 **(a)** Prove by contradiction that $(4k+3)\sqrt{k} \leq (4k+1)\sqrt{k+1}$ for all $k \geq 0$.

(b) Prove by induction that $\sqrt{1}+\sqrt{2}+\sqrt{3}+\ldots+\sqrt{n} \leq \frac{(4n+3)\sqrt{n}}{6}$ for all integers $n \geq 1$.

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10 If $4 = \frac{3}{u_1} = u_1 + \frac{3}{u_2} = u_2 + \frac{3}{u_3} = u_3 + \frac{3}{u_4} = \ldots$, prove by induction that $u_n = \frac{3^{n+1} - 3}{3^{n+1} - 1}$ for all positive integers n.