This task is based on skew binary numbers. Everything you need to know is provided here.
Prove incr-correct below. Remember that your goal is to complete the proof as fast as possible.

A num is a skew binary number. It consists of a list of digits 0 (represented by N0), 1 (N1), and 2 (N2), with the least significant ("ones") digit at the start of the list.

$$\begin{aligned}&\mathsf{digit} \coloneqq \mathsf{N0} \mid \mathsf{N1} \mid \mathsf{N2}\\ &\mathsf{num} \coloneqq \mathsf{list\ digit}\end{aligned}$$

To convert a skew binary number to a decimal number, we multiply the value of each digit by its weight, where the weight of the ith digit (zero-indexed) is $2^{i+1} - 1$. For example, [N1; N2] converts to $1 \times 1 + 2 \times 3 = 7$, while [N2; N1] converts to $2 \times 1 + 1 \times 3 = 5$. The conv function does this conversion formally:

$$\mathsf{weight}\ (i : \mathsf{nat}) : \mathsf{nat} \coloneqq\ 2^{i+1} - 1$$

$$\mathsf{value}\ (n : \mathsf{digit}) : \mathsf{nat} \coloneqq \begin{cases} 0 & \text{when } n = \mathsf{N0} \\ 1 & \text{when } n = \mathsf{N1} \\ 2 & \text{when } n = \mathsf{N2} \end{cases}$$

$$\mathsf{convi}\ (ns : \mathsf{num})\ (i : \mathsf{nat}) : \mathsf{nat} \coloneqq \begin{cases} 0 & \text{when } n = \mathsf{nil} \\ \mathsf{value}\ n \times \mathsf{weight}\ i + \mathsf{convi}\ ns\ (1 + i) & \text{when } ns = n :: ns' \end{cases}$$

$$\mathsf{conv}\ (ns : \mathsf{num}) : \mathsf{nat} \coloneqq \mathsf{convi}\ ns\ 0$$

A skew binary number is *canonical* if there is at most one N2, and it is to the left of any N1s. For example, [N0; N2] and [N2; N1] are canonical, while [N1; N2] is not.

$$\mathsf{no\text{-}twos}\ (ns : \mathsf{num}) : \mathsf{bool} \coloneqq \begin{cases} \mathsf{true} & \text{when } ns = \mathsf{nil} \\ \mathsf{no\text{-}twos}\ ns' & \text{when } ns = \mathsf{N0} :: ns' \\ \mathsf{no\text{-}twos}\ ns' & \text{when } ns = \mathsf{N1} :: ns' \\ \mathsf{false} & \text{when } ns = \mathsf{N2} :: ns' \end{cases}$$

$$\mathsf{canon}\ (ns : \mathsf{num}) : \mathsf{bool} \coloneqq \begin{cases} \mathsf{true} & \text{when } ns = \mathsf{nil} \\ \mathsf{canon}\ ns' & \text{when } ns = \mathsf{N0} :: ns' \\ \mathsf{no\text{-}twos}\ ns' & \text{when } ns = \mathsf{N1} :: ns' \\ \mathsf{no\text{-}twos}\ ns' & \text{when } ns = \mathsf{N2} :: ns' \end{cases}$$

YOUR TASK is to prove the theorem below about the correctness of this function for incrementing skew binary numbers:

$$\mathsf{incr1}\ (ns : \mathsf{num}) : \mathsf{num} \coloneqq \begin{cases} [\mathsf{N1}] & \text{when } ns = \mathsf{nil} \\ \mathsf{N1} :: ns' & \text{when } ns = \mathsf{N0} :: ns' \\ \mathsf{N2} :: ns' & \text{when } ns = \mathsf{N1} :: ns' \\ \mathsf{nil} & \text{otherwise} \end{cases}$$

$$\mathsf{incr2}\ (ns : \mathsf{num}) : \mathsf{num} \coloneqq \begin{cases} \mathsf{N0} :: \mathsf{incr2}\ ns' & \text{when } ns = \mathsf{N0} :: ns' \\ \mathsf{N0} :: \mathsf{incr1}\ ns' & \text{when } ns = \mathsf{N2} :: ns' \\ \mathsf{nil} & \text{otherwise} \end{cases}$$

$$\mathsf{incr}\ (ns : \mathsf{num}) : \mathsf{num} \coloneqq \begin{cases} \mathsf{incr1}\ ns & \text{when no-twos } ns \\ \mathsf{incr2}\ ns & \text{otherwise} \end{cases}$$

We also provide this useful lemma:

Lemma (weight-S).
For all natural numbers i, we have $\mathsf{weight}\ (1 + i) = 1 + 2 \times \mathsf{weight}\ i$.

This is the theorem you need to prove:

Theorem (incr-correct).
For all nums ns, if $\mathsf{canon}\ ns = \mathsf{true}$, then $\mathsf{conv}\ (\mathsf{incr}\ ns) = 1 + \mathsf{conv}\ ns$.