In a 1985 study of Little Rock Lake in Wisconsin, 400 gallons of 18M sulfuric acid were added to the lake over six years. The initial pH of the lake was 6.1 and the final pH was 4.7. If none of the acid was consumed in chemical reactions, estimate the volume of the lake.

Solution:

\[ pH = -\log[H^+] \Rightarrow [H^+] = 10^{-pH} \]

1. Concentration before addition of acid was:
\[ [H^+]_1 = 10^{-6.1} = 7.9 \times 10^{-7} \text{ mol/l} \]

2. Concentration after addition of acid has become:
\[ [H^+]_2 = 10^{-4.7} = 2.0 \times 10^{-5} \text{ mol/l} \]

3. Volume of acid is:
\[ V(l) = V(g) \times 3.785 \]
\[ V(l) = 400 \times 3.785 = 1514.164 \text{ (l)} \]

4. Concentration of H\(^+\)-ions:
\[ H_2SO_4 \rightarrow 2H^+ + SO_4^{2-} \]
\[ [H^+] = 2 \times [H_2SO_4] \]
\[ [H^+]_3 = 2 \times 1514.164 \times 18 = 54509.9 \text{ (mol)} \]
\[ \Delta[H^+] = [H^+]_2 - [H^+]_1 \]
\[ \Delta[H^+] = 2.0 \times 10^{-5} - 7.9 \times 10^{-7} = 1.9 \times 10^{-5} \frac{\text{mol}}{l} \]

\[ \Delta[H^+] = \frac{[H^+]_3}{V_{lake} + V_{acid}} \Rightarrow V_{lake} = \frac{[H^+]_3}{\Delta[H^+]} - V_{acid} \]
\[ V_{lake} = \frac{54509.9}{1.9 \times 10^{-5} - 1514.164} = 2845236.240 \text{ (l)} \]
\[ = 2845236.24 \text{ (m}^3\) \]

Answer: 2845236.24 m\(^3\).