Solution.
You can solve this entire problem based on the information given to you in Figure 1.71 and the equation \( I(x) = I(0)e^{-\alpha x} \), given in the problem.

(a): We are given two ways of finding the value of \( I(z) \) based on \( I(0) \), one method that uses the graph provided and one that uses the formula. This suggests that we can find two formulas for \( I(z) \), one using each method, and set them equal to each other to find \( \alpha \):

The axis corresponding to \( 100 \frac{I(z)}{I(0)} \) is logarithmically scaled (you can tell this because you get from one tick on the graph to the next by multiplying by a constant, 10 in this case, instead of adding a constant). Therefore, if you take the base 10 log of the quantity measured by the axis, \( \log_{10}(100 \frac{I(z)}{I(0)}) \), the points on the new axis range from 2 (corresponding to 100 on the logarithmic scale) to -1 (corresponding to 0.1 on the logarithmic scale). (I'll try to put a graph here later if I have time)

This is a straight line, so if we take the variable \( Y = \log_{10}(100 \frac{I(z)}{I(0)}) \) as a function of \( z \), we see that \( Y(z) = 2 - \frac{1}{5}z \) for lake 1, \( Y(z) = 2 - \frac{2}{15}z \) for lake 2, and \( Y(z) = 2 - \frac{1}{10}z \) for lake 3. Since \( Y \) is defined as \( \log_{10}(100 \frac{I(z)}{I(0)}) \), we can raise 10 to the power of each side:

For lake 1:

\[
10^Y = 10^{2 - \frac{1}{5}z} \\
100 \frac{I(z)}{I(0)} = 10^2 \cdot 10^{-\frac{1}{5}z} \\
100 \frac{I(z)}{I(0)} = 100 \cdot 10^{-\frac{1}{5}z} \\
\frac{I(z)}{I(0)} = 10^{-\frac{1}{5}z} \\
I(z) = I(0) \cdot 10^{-\frac{1}{5}z}
\]

However, as noted earlier, we already have the formula \( I(z) = I(0)e^{-\alpha z} \), so we can set our two expressions for \( I(z) \) equal to each other to solve for \( \alpha \):
\[ I(0) \cdot 10^{-\frac{1}{5}z} = I(0)e^{-\alpha z} \]
\[ 10^{-\frac{1}{5}z} = e^{-\alpha z} \]
\[ \ln(10^{-\frac{1}{5}z}) = \ln(e^{-\alpha z}) \]
\[ \alpha z = -\frac{1}{5}z \cdot \ln(10) = -\alpha z \cdot 1 \]
\[ \frac{1}{5}z \cdot \ln(10) = \alpha z \]
\[ \frac{1}{5} \ln(10) = \alpha \]

Similarly, the values of \( \alpha \) for lake 2 and lake 3 are \( \frac{2}{10} \ln(10) \) and \( \frac{1}{10} \ln(10) \), respectively.