8. [12 points] The velocity of an object, with air resistance, may in some circumstances be given as

\[ v(t) = \sqrt{\frac{g}{k}} \left( \frac{e^{2mt}}{e^{2mt} + 1} - \frac{1}{e^{2mt} + 1} \right), \]

where \( g \) is the acceleration due to gravity, \( k \) is a constant representing air resistance, and \( m = \sqrt{gk} \).

(a) [2 points of 12] Write an expression for the distance \( D \) that the object falls in the first \( t_0 \) seconds.

(b) [5 points of 12] Find the distance \( D \) (note that half of this calculation is significantly harder than the rest; do not waste too much time on it if you get stuck).

(e) [5 points of 12] Suppose \( \sqrt{g/k} = 10 \) and \( m = 1 \). Note that in this case \( v(3) = 9.95 \approx 10 \). Use a geometric argument to show that the distance traveled between \( t = 0 \) and \( t = 3 \), \( D(3) \), satisfies the inequality \( 15 < D(3) < 30 \).