1. Consider the piecewise-defined function $f$ below.

$$f(x) = \begin{cases} 
\frac{x+2}{x+1} & x < 0 \\
 x + 1 & x \geq 0
\end{cases}$$

(a) Find all points of discontinuity of $f$.

(b) Use the definition of continuity to show whether $f$ is continuous at $x = 0$. (You should be taking some limits here.)
2. Show that \( g(x) = x^4 + 3x^3 - 10 \) has a root \( (g(x) = 0) \) in \([-1, 2]\).

3. The population of bacteria \( P \) in an ideal environment generally obeys the equation

\[
P(t) = P_0 2^{kt}
\]

where \( P_0 \) and \( k \) are constants and \( t \) is in hours. Assume that we have a population of \( E. coli \) that follows the equation (1). This population doubles every 30 minutes, and at \( t = 1 \) hour = 60 minutes the population was 2,000.

(a) Find the constants \( P_0 \) and \( k \).

(b) At what time \( t \) will the population reach 5,000? Express your answer as a logarithm.