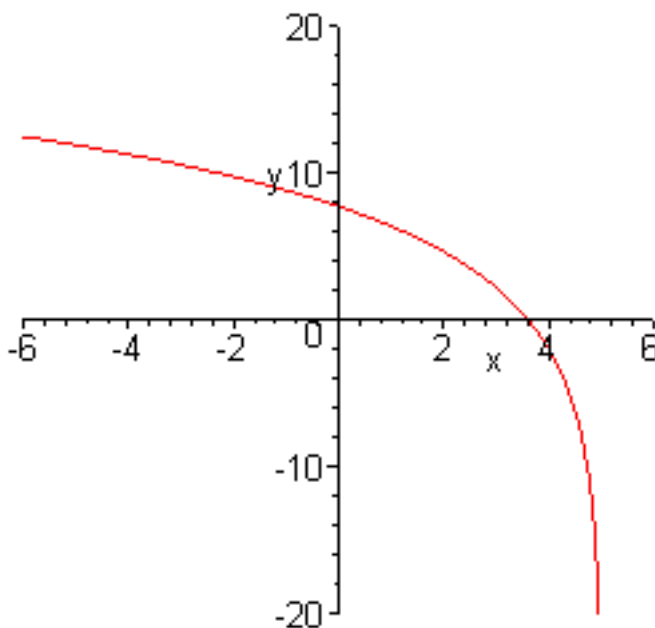
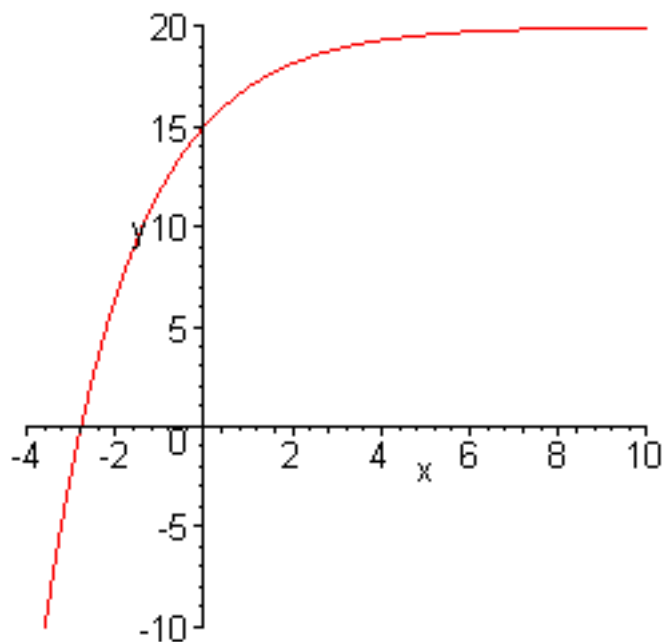
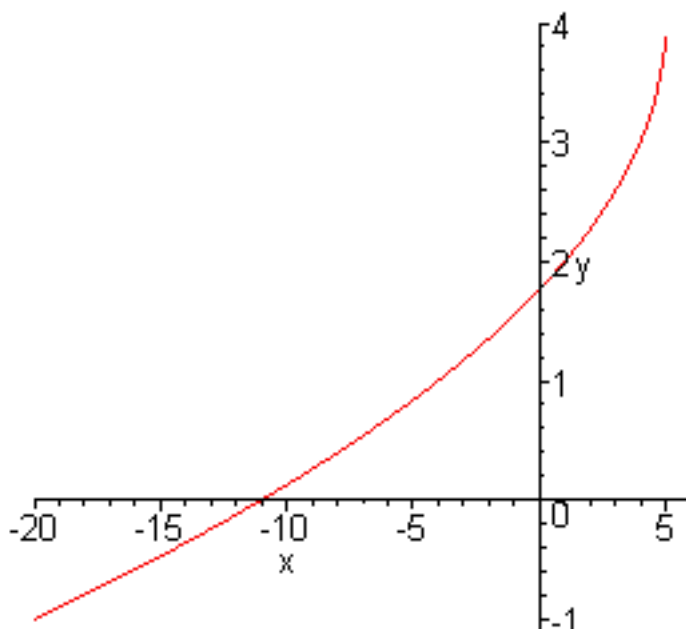
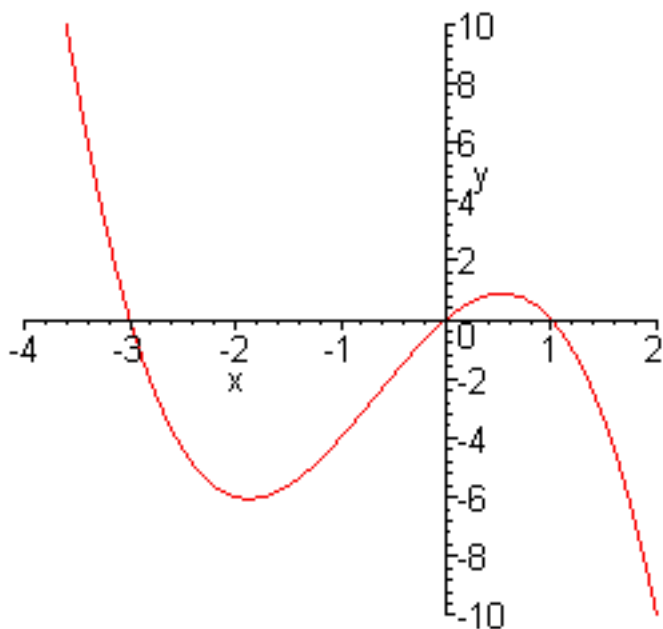


1. a. For $y = 20 - 5e^{-0.5x}$, the domain is all x . The x and y -intercepts are $(-2.773, 0)$ and $(0, 15)$, respectively. The horizontal asymptote as $x \rightarrow \infty$ is $y = 20$. The graph is below to the left.



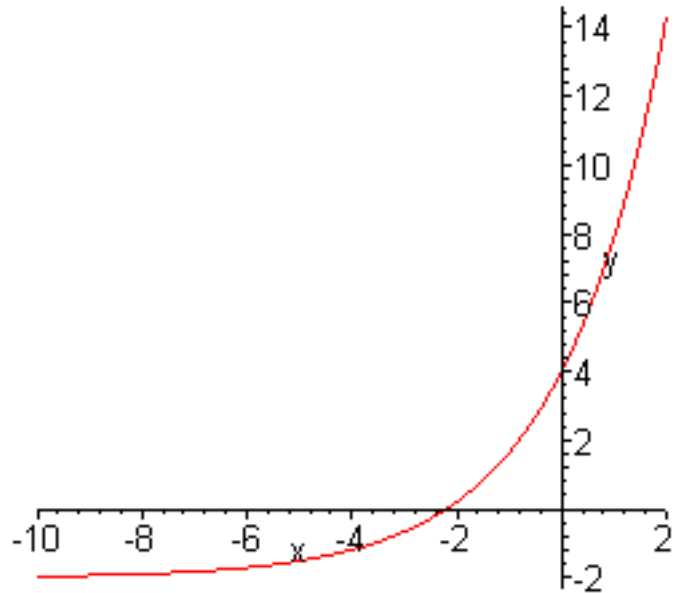
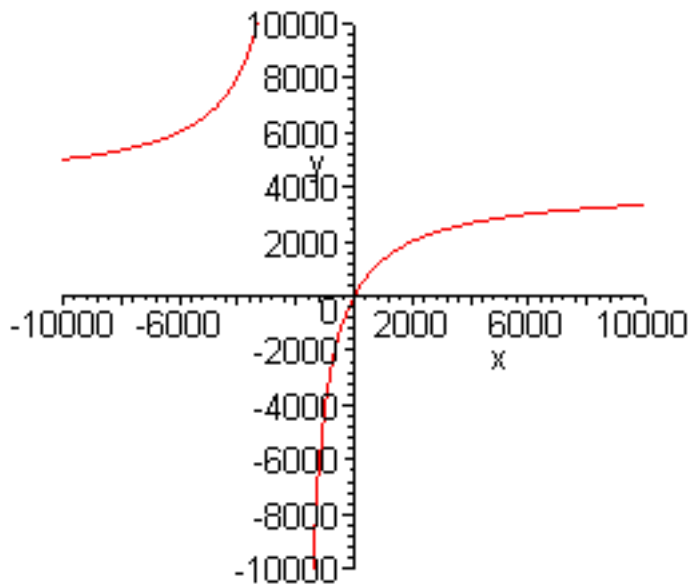
b. For $y = 6 \ln(5 - x) - 2$, the domain is $x < 5$. The x and y -intercepts are $(3.604, 0)$ and $(0, 7.657)$, respectively. The vertical asymptote is $x = 5$ with $y \rightarrow -\infty$. The graph is above to the right.

c. For $y = 3x - 2x^2 - x^3$, the domain is all x . The x and y -intercepts are $(-3, 0)$, $(0, 0)$ and $(1, 0)$. There are no asymptotes. The graph is below to the left.



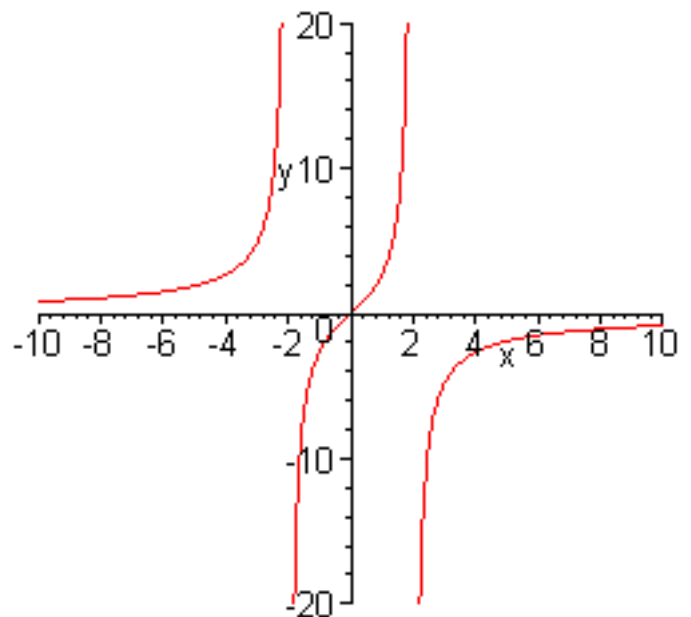
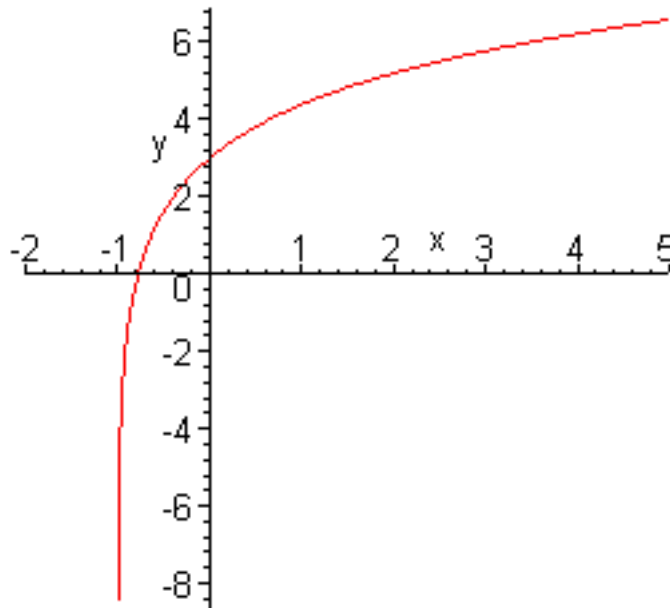
d. For $y = 4 - \sqrt{5 - x}$, the domain is $x \leq 5$. The x and y -intercepts are $(1.7639, 0)$ and $(0, -11)$. There are no asymptotes. The graph is above to the right.

e. For $y = \frac{4x}{2 + 0.001x}$, the domain is $x \neq -2000$. The vertical asymptote is $x = -2000$. The x and y -intercept is $(0, 0)$. The horizontal asymptote is $y = 4000$. The graph is below to the left.



f. For $y = 6e^{x/2} - 2$, the domain is all x . The x and y -intercepts are $(-2.197, 0)$ and $(0, 4)$. The horizontal asymptote as $x \rightarrow -\infty$ is $y = -2$. The graph is above to the right.

g. For $y = 3 + 2\ln(x + 1)$, the domain is $x > -1$. The x and y -intercepts are $(-0.7769, 0)$ and $(0, 3)$. The vertical asymptote is $x = -1$ with $y \rightarrow -\infty$. The graph is below to the left.



h. For $y = \frac{8x}{4 - x^2}$, the domain is $x \neq \pm 2$. The vertical asymptotes are $x = \pm 2$. The x and y -intercept is $(0, 0)$. A horizontal asymptote is $y = 0$ as $x \rightarrow \infty$. The graph is above to the right.

2. a. $H_1 = 2040$ and $H_2 = 2080.8$. In the general solution is given by $H_n = (1.02)^n H_0 = 2000(1.02)^n$.

b. The general solution is given by $G_n = (1.03)^n G_0 = 200(1.03)^n$. It takes 23.5 generations for the population to double.

c. The populations are equal in 236 generations.

3. a. The annual growth rate is $r = 0.011753$ (about 1.2% per year) and the general equation is $P_n = (1.011753)^n 179.3$.

b. The model predicts a population of 286.1 million in the year 2000. The error between this and the actual population is 1.7%.

c. The population will double about 59.3 years after 1960, or about the year 2019.

4. a. For France, the growth rate is $r = 0.051948$ (about 5.2% per decade) and the general equation is $P_n = (1.051948)^n 53.9$.

b. The population predictions are 59.6 million in the year 2000 and 66 million in the year 2020. The error in the year 2000 is 0.34%.

c. In Kenya, the growth rate is $r = 0.4491$ (about 44.9% per decade) and the general equation is $P_n = (1.4491)^n 16.7$. The population predictions are 35.1 million in the year 2000 and 73.6 million in the year 2020. It takes 1.87 decades, or about 18.7 years, for the population of Kenya to double.

d. The populations become equal in 3.66 decades, so the population of Kenya will first exceed that of France in 2017.

e. It follows that the annual growth rate in France is $r = 0.00508$, while in Kenya it is $r = 0.0378$.

5. a. The populations are $P_1 = 5600$, $P_2 = 6104$, $P_3 = 6470.2$, $P_4 = 6664.3$, and $P_5 = 6664.3$.

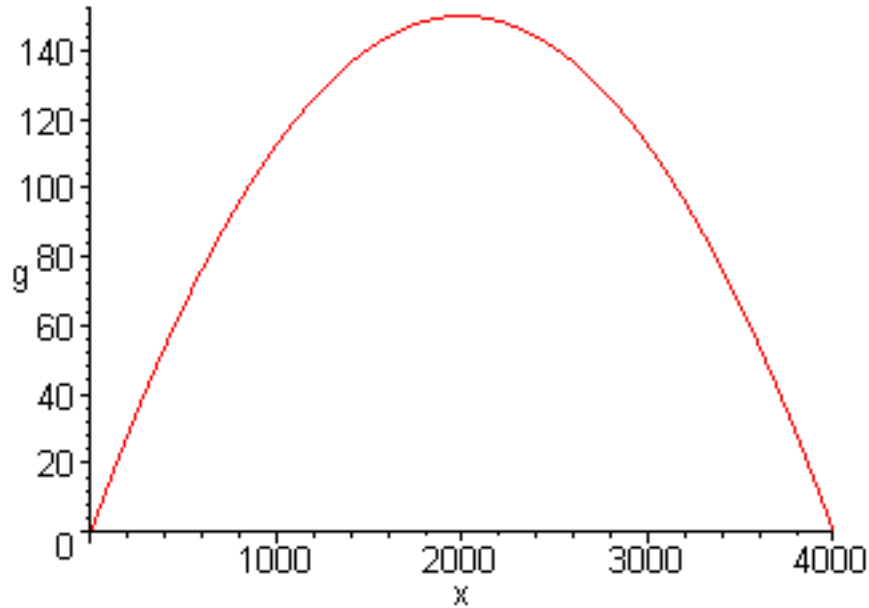
b. The growth rate falls to zero when $k(t) = 0$ or $t = 4$ weeks. From above, we see $P_4 = 6664.3$ organisms/liter.

c. The theoretical extinction level is when $1 + k(t) = 0$ or $t = 37.3$ weeks. If the model is iterated until it falls below 1 crustacean per liter of water, then $P_{26} = 0.647$ at which point the crustaceans will be effectively extinct.

6. a. $P_1 = 2150$ and $P_2 = 2299$.

b. The growth rate is zero when $P = 0$ and $P = 4000$. The maximum growth rate occurs at $P = 2000$. This maximum growth is $g(2000) = 150$ individuals \times 1000/cm³/hr. The sketch of $g(P)$ is below.

c. The two equilibria are $P = 0$ and $P = 4000$.



7. a. The populations in the first two years are $P_1 = 110$ and $P_2 = 121$. It takes about 7.3 years for the population to double.

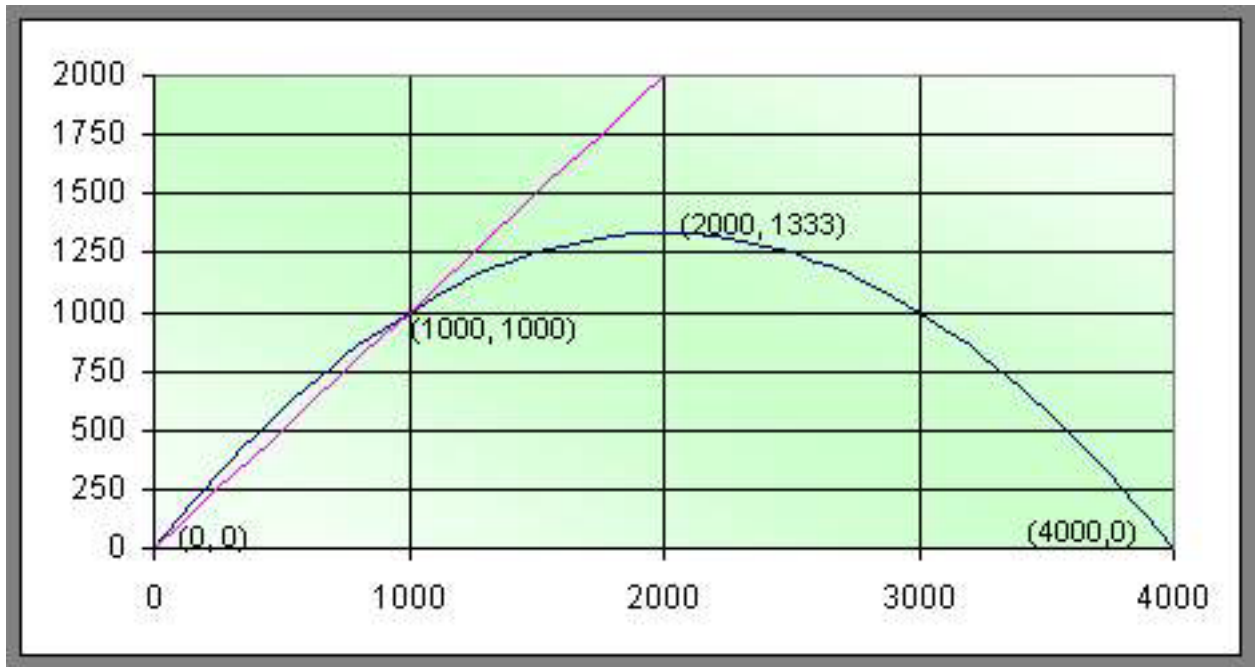
b. For the discrete logistic growth model, $P_1 = 105$ and $P_2 = 109.9875$.

c. The equilibria are $P_e = 0$ or $P_e = 200$.

8. a. For the discrete logistic growth model, $p_1 = 130$ and $p_2 = 167.7$.

b. The p_n -intercepts are $p_n = 0$ and 4000. The vertex occurs at (2000, 1333.3). The points of intersection are (0, 0) and (1000, 1000). The graph of the updating function and the identity map are shown below.

c. The equilibria are $p_e = 0$ and 1000. The equilibrium at $p_e = 0$ is unstable, and the one at $p_e = 1000$ is stable.



9. a. The 3 populations are $p_1 = 700$, $p_2 = 860$, and $p_3 = 988$.

b. The equilibrium is $p_e = 1500$. The equilibrium is stable.

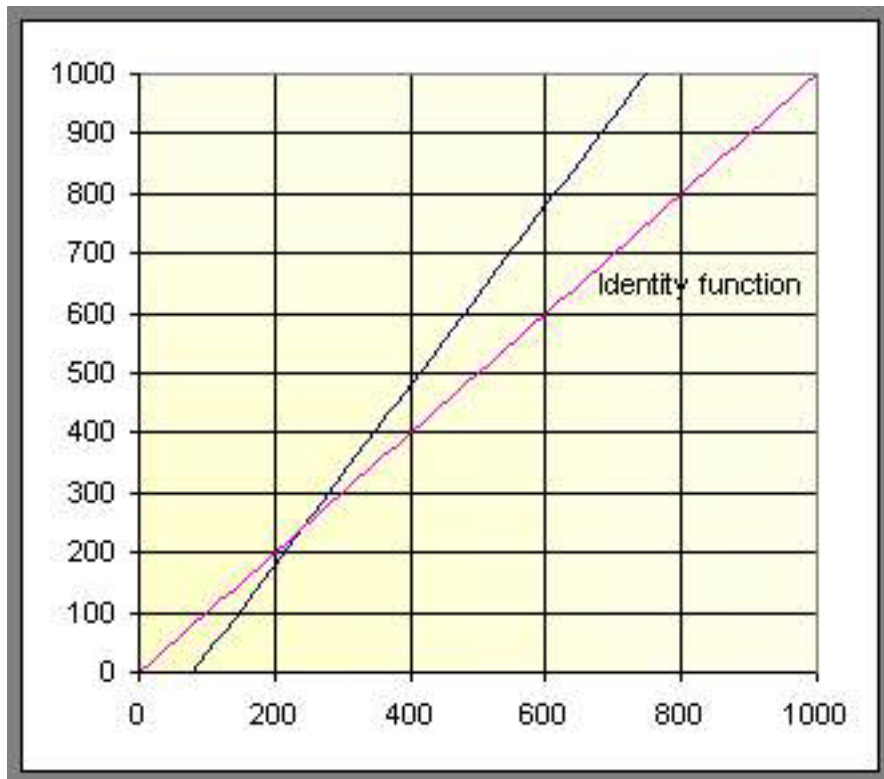
10. a. The breathing fraction is $q = 0.120536$, and the functional reserve capacity is $V_r = 2188.9$ ml.

b. The concentration of Helium in the next two breaths are $c_2 = 39.85$ and $c_3 = 35.67$. The equilibrium concentration is $c_e = \gamma = 5.2$ ppm of He, which is a stable equilibrium.

11. a. For the Malthusian growth model with dispersion, $P_{n+1} = (1+r)P_n - \mu$, $r = 0.5$ and $\mu = 120$. The populations in the next two weeks are $P_3 = 1117.5$ and $P_4 = 1556.25$.

b. The equilibrium is $P_e = 240$, and it is unstable.

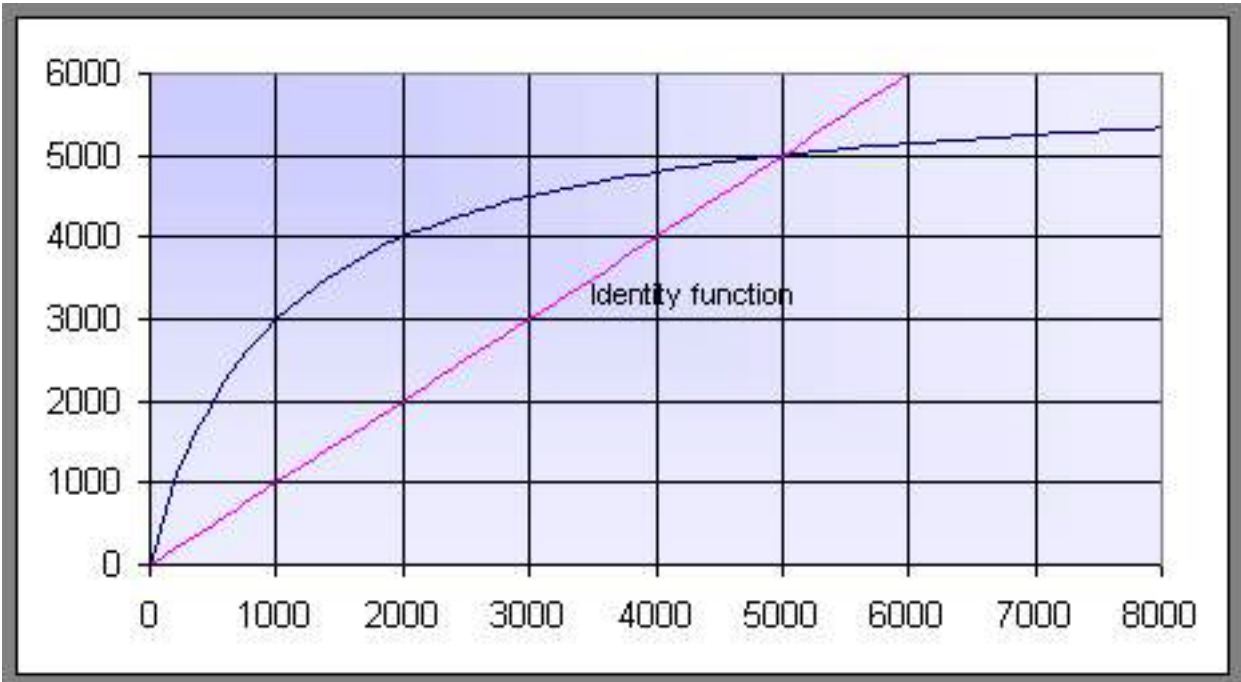
c. The graph of the updating function and identity map, $P_{n+1} = P_n$, are shown below. The only point of intersection occurs at the equilibrium found above.



12. a. Hassell's model, $p_{n+1} = H(p_n) = \frac{6p_n}{1+0.001p_n}$, with $p_0 = 2000$ gives $p_1 = 4000$ and $p_2 = 4800$.

b. The equilibria for this model are $p_e = 0$ and 5000.

c. The only intercept is $p = 0$. The horizontal asymptote is $H = 6000$. The graphs of $H(p)$ for $p > 0$ and the identity map, $p_{n+1} = p_n$ are shown below. These functions intersect at the equilibrium (5000, 5000).



13. a. The general solution is $a_n = 1.8^n a_0 = (50000)1.8^n$ with, $a_5 = (50,000)1.8^5 = 944,784$.

b. From the selection model, $p_2 = 0.5806$ and $p_0 = 0.419355$.

c. The equilibria are $p_e = 0$ and 1 . The limiting fraction for large n will be $p_e = 1$.

d. Below is the a graph of the updating function for the fraction of bacteria, p_n , of type a and the identity map for $0 \leq p \leq 1$.

