1. Part (a)

   $y = y_o\ e^{kt}$

   For $y_o = 100$ and $y = 200$ and $t = \dfrac{1}{3} \longrightarrow 200 = 100\ e^{k/3} \longrightarrow k = 3\ln 2$

   $y = 100\ e^{(3\ln 2)t}$

   Part (b)

   When $t = 10 \longrightarrow y = 100\ e^{(3\ln 2)10}$

   $y \approx 1.074 \text{ x } 10^{11}$

   Therefore after 10 hours there will be approximately $1.074 \text{ x } 10^{11}$ cells.

   Part (c)

   When $y = 10000 \longrightarrow 10000 = 100\ e^{(3\ln 2)t}$

   $t \approx 2.215$

   Therefore the population will reach 10000 cells after approximately 2.215 hours.

2. Part (a)

   $y = y_o\ e^{kt}$

   For $y_o = 4000$ and $y = 12000$ and $t = \dfrac{1}{2} \longrightarrow 12000 = 4000\ e^{k/2} \longrightarrow k = 2\ln 3$

   $y = 4000\ e^{(2\ln 3)t}$

   Part (b)

   When $t = 20 \longrightarrow y = 4000\ e^{(3\ln 2)(1/3)}$

   $y \approx 8320$

   Therefore after 20 minutes there will be approximately 8320 bacteria.

   Part (c)

   When $y = 20000 \longrightarrow 20000 = 4000\ e^{(2\ln 3)t}$

   $t \approx .732$

   Therefore the population will reach 20000 bacteria after approximately .732 hours.

3. Part (a)

   $y = y_o\, e^{kt}$

   For $y_o = 500$ and $y = 8000$ and $t = 3 \longrightarrow 8000 = 500\, e^{3k} \longrightarrow k = \dfrac{4\ln 2}{3}$

   $y = 500\, e^{((4\ln 2)/3)t}$

   Part (b)

   When $t = 4 \longrightarrow y = 500\, e^{((4\ln 2)/3)(4)}$

   $y \approx 20159$

   Therefore after 4 hours there will be approximately 20159 bacteria.

   Part (c)

   When $y = 30000 \longrightarrow 30000 = 500\, e^{((4\ln 2)/3)t}$

   $t \approx 4.430$

   Therefore the population will reach 30000 bacteria after approximately 4.430 hours.

4. Part (a)

   $y = y_o\, e^{kt}$

   For $y_o = 400$ and $y = 25600$ and $t = 4 \longrightarrow 25600 = 400\, e^{4k} \longrightarrow k = \dfrac{1}{4}\ln 64$

   Now, $400 = y_o\, e^{(2)\frac{1}{4}\ln 64} \longrightarrow y_o \approx 50$

   Therefore the initial population is about 50.

   Part (b)

   $y = 50\, e^{(t)(1/4)(\ln 64)}$

   Part (c)

   Doubling time given by $t = \dfrac{\ln 2}{k} \longrightarrow t = \dfrac{\ln 2}{\frac{1}{4}\ln 64} \longrightarrow t = \dfrac{2}{3}$

   Therefore the time is takes the population to double is 40 minutes.

   Part (d)

   $100000 = 50\, e^{(t)(1/4)(\ln 64)} \longrightarrow t \approx 7.311$

   Therefore the population will reach 100000 in about 7.311 hours.

5. Part (a)

   Using $(0, 728)$ and $(50, 906)$ and $y = y_o\, e^{kt}$ yields $906 = 728e^{50k} \longrightarrow k = \dfrac{1}{50}\ln\dfrac{906}{728}$

   The population in 1900 is then given by $y = 728\, e^{150k}$where $k = \dfrac{1}{50}\ln\dfrac{906}{728} \longrightarrow y \approx 1403.207.$

   Therefore the population in 1900 would be approximately 1403.207 million.

   To find the population in 1950 use $t = 200$.

   $y = 728\, e^{200k}$where $k = \dfrac{1}{50}\ln\dfrac{906}{728} \longrightarrow y \approx 1746.299$

   Therefore the population in 1900 would be approximately 1746.299 million.

   Part (b)

   Using $(0, 1608)$ and $(50, 2517)$ and $y = y_o\, e^{kt}$ yields $2517 = 1608\, e^{50k} \longrightarrow k = \dfrac{1}{50}\ln\dfrac{2517}{1608}$

   The population in 1992 is then given by $y = 1608\, e^{92k}$where $k = \dfrac{1}{50}\ln\dfrac{2517}{1608} \longrightarrow y \approx 3667.286.$

   Therefore the population in 1992 would be approximately 3667.286 million. (About 3.7 billion)

   The discrepancy may be explained by a declining mortality rate.

6. Part(a)

   $$A = P_o\, e^{rt}$$

   $$A = 20000\, e^{.08t}$$

   $$30000 = 20000\, e^{.08t}$$

   $$t \approx 5.068$$

   Therefore the investment will be worth 30000 dollars in about 5 years.

   Part (b)

   $$A = 20000\, e^{.08t}$$

   Therefore the original investment of 20000 will be double in about 8.6 years.

   $$40000 = 20000\, e^{.08t}$$

   $$t \approx 8.664$$

   We could have also found the "doubling time" by using $t = \dfrac{\ln 2}{k} = \dfrac{\ln 2}{.08} \approx 8.664.$

7. Since doubling time is given by $t = \dfrac{\ln 2}{k}$ the interest rate would be given by $k = \dfrac{\ln 2}{t} = \dfrac{\ln 2}{12} \approx .058 \longrightarrow 5.8\%$

8. Doubling time is given by $t = \dfrac{\ln 2}{k} \longrightarrow t = \dfrac{\ln 2}{.04} \approx 17.$

   Therefore the demand will double in 17 years . . . in 2013.

9. Part (a)

   Using $(0, .52)$ and $(8, .66)$

   $y = y_o\ e^{kt}$

   For $y_o = .52$ and $y = .66$ and $t = 8 \longrightarrow .66 = .52\ e^{8t} \longrightarrow k = \frac{1}{8}\ \ln \frac{.66}{.52}$

   $y = .52\ e^{(1/8) \ln(.66/.52)t}$

   Part (b)

   When $t = 28 \longrightarrow y = .52\ e^{28k}$

   $y \approx 1.198$

   Therefore in 1998 the cost will be about \$1.20.

   Part (c)

   When $y = 1.04 \longrightarrow 1.04 = .52\ e^{kt}$

   $t \approx 23.259$

   Therefore the cost will double in the 24th year… 1994.

   Note:You could also use the doubling time formula.

10. $A = P_o\ e^{rt}$

    For $P_o = 24$ and $r = .05$ and $t = 373$,

    $A = 24\ e^{(.05)(373)} \longrightarrow A \approx 3018584441$

    Therefore, in 1999 Manhattan would be worth about 3 billion dollars.

11. $A = P_o\ e^{rt}$

    For $A = 100000$ and $P_o = 1000$ and $t = 50$,

    $100000 = 1000\ e^{50r} \longrightarrow r \approx .092$

    Therefore the rate would have to be about 9.2%.

12. Part (a)

$y = y_o \, e^{kt}$

For $y_o = .04$ and $y = .32$ and $t = 33 \longrightarrow .32 = .04 \, e^{33k} \longrightarrow k = \frac{1}{33} \ln \frac{.33}{.04} \approx .064$

Therefore the growth rate was about 6.4%

Part (b)

When $t = 37 \longrightarrow y = .04 \, e^{37k}$

$y \approx .412$

Therefore the cost of a stamp in 1999 would be about 41 cents.