

Notes - Exponential Growth and Decay

1. Solve the following. Show all work to receive credit.

Exponential Growth/Decay: $P = P_0 e^{rt}$ or $P = P_0 2^{t/h}$ where: P = New Amount
 P_0 = Original Amount
 r = rate (as decimal)
 (positive = growth) (negative = decay)

1. A culture of bacteria in your growth starts with 10,000 bacteria, and the number doubles every 40 minutes. Find a formula for the number of bacteria at time t .

$$2 = e^{40k} \quad \ln 2 = 40k \ln e$$

a. How many bacteria are present after one hour?

$$P = 10000 e^{(\ln 2 / 40) 60}$$

$$P \approx 28284.291 \quad \approx 28,284 \text{ bacteria}$$

b. After how many minutes will there be 100,000 bacteria?

$$100,000 = 10,000 e^{(\ln 2 / 40) t}$$

$$\ln 10 = \left(\frac{\ln 2}{40} \right) t \ln e$$

$$t = \frac{40 \ln 10}{\ln 2} \approx 132.8771 \text{ min}$$

After 132.878 min there will be at least 100,000 bacteria

2. Polonium has a half-life of 140 days. Suppose a sample of this substance has a mass of 300 mg. Find a formula for the amount of the sample remaining at time t .

$$1 = 2 e^{140k} \quad k = \frac{\ln(1/2)}{140}$$

a. What is the amount of Polonium after one year?

$$P = 300 e^{365 \left(\frac{\ln(1/2)}{140} \right)}$$

$$P \approx 0.16412 \text{ mg}$$

slightly more than 0.164 mg

b. How long will it take for the sample to decay to a mass of 200 mg?

$$200 = 300 e^{\left(\frac{\ln(2/3)}{140} \right) t}$$

$$t = \frac{140 \ln(2/3)}{\ln 2} \approx 11.8937$$

$$\ln \frac{2}{3} = \frac{\ln(1/2)}{140} t$$

$$\text{approx } 11.89 \text{ days}$$

3. Iodine-131 is a radioactive isotope that decays according to the equation $A = A_0 e^{-0.087t}$, (where A_0 is the initial amount present and A is the amount present at time t in days). (NOTE: IN THIS CASE WE ARE GIVEN "RATE")

a. What is the half-life of iodine-131?

$$\frac{1}{2} = e^{-0.087t}$$

approx 7.96 days

$$t = \frac{\ln(1/2)}{-0.087} \approx 7.9672 \text{ days}$$

b. How long does it take for 100 grams of iodine-131 to decay to 30 grams?

$$30 = 100 e^{-0.087t}$$

approx 26.467 days

$$t = \frac{\ln(0.3)}{-0.087} \approx 26.46647$$

for less than 30 gms.

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Thomas Griffiths



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