

# 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?

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

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

b. After how many minutes will there be 100,000 bacteria? After 132.878 minutes, there will be 100,000 bacteria

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

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

$$t = \frac{40 \ln 10}{\ln 2} \approx 132.878 \text{ min}$$

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?

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

slightly more than 0.144 mg

$$P \approx 0.14412 \text{ mg}$$

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

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

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

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

$$\text{approx } 11.8937 \text{ days}$$

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 7.9672 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

$$t = \frac{\ln(0.3)}{-0.087} \approx 26.46687$$

for less than 30 grs.

# Odessywarr Pre Cal Answers

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