8.7 Exercises

1. Suppose that the population of a certain town grows at an annual rate of 6%. If the population is currently 5,000, what will it be in 7 years? Round your answer to the nearest integer.

2. Suppose that the population of a certain town grows at an annual rate of 5%. If the population is currently 2,000, how many years will it take for it to double? Round your answer to the nearest hundredth.

3. Suppose that a certain radioactive isotope has an annual decay rate of 7.2%. How many years will it take for a 227 gram sample to decay to 93 grams? Round your answer to the nearest hundredth.

4. Suppose that a certain radioactive isotope has an annual decay rate of 6.8%. How many years will it take for a 399 gram sample to decay to 157 grams? Round your answer to the nearest hundredth.

5. Suppose that the population of a certain town grows at an annual rate of 8%. If the population is currently 4,000, how many years will it take for it to double? Round your answer to the nearest hundredth.

6. Suppose that a certain radioactive isotope has an annual decay rate of 19.2%. Starting with a 443 gram sample, how many grams will be left after 9 years? Round your answer to the nearest hundredth.

7. Suppose that a certain radioactive isotope has an annual decay rate of 17.4%. What is the half-life (in years) of the isotope? Round your answer to the nearest hundredth.

8. Suppose that the population of a certain town grows at an annual rate of 7%. If the population is currently 8,000, how many years will it take for it to reach 18,000? Round your answer to the nearest hundredth.

9. Suppose that a certain radioactive isotope has an annual decay rate of 17.3%. Starting with a 214 gram sample, how many grams will be left after 5 years? Round your answer to the nearest hundredth.

10. Suppose that the population of a certain town grows at an annual rate of 7%. If the population grows to 2,000 in 7 years, what was the original population? Round your answer to the nearest integer.

11. Suppose that the population of a certain town grows at an annual rate of 3%. If the population is currently 3,000, how many years will it take for it to double? Round your answer to the nearest hundredth.

12. Suppose that a certain radioactive isotope has an annual decay rate of 12.5%. Starting with a 127 gram sample, how many grams will be left after 6 years? Round your answer to the nearest hundredth.

13. Suppose that a certain radioactive isotope has an annual decay rate of 13.1%.

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Starting with a 353 gram sample, how many grams will be left after 7 years? Round your answer to the nearest hundredth.

14. Suppose that the population of a certain town grows at an annual rate of 2%. If the population grows to 9,000 in 4 years, what was the original population? Round your answer to the nearest integer.

15. Suppose that the population of a certain town grows at an annual rate of 2%. If the population is currently 7,000, how many years will it take for it to double? Round your answer to the nearest hundredth.

16. Suppose that a certain radioactive isotope has an annual decay rate of 5.3%. How many years will it take for a 217 gram sample to decay to 84 grams? Round your answer to the nearest hundredth.

17. Suppose that a certain radioactive isotope has an annual decay rate of 18.7%. How many years will it take for a 324 gram sample to decay to 163 grams? Round your answer to the nearest hundredth.

18. Suppose that the population of a certain town grows at an annual rate of 8%. If the population is currently 8,000, how many years will it take for it to reach 18,000? Round your answer to the nearest hundredth.

19. Suppose that a certain radioactive isotope has an annual decay rate of 2.3%. If a particular sample decays to 25 grams after 8 years, how big (in grams) was the original sample? Round your answer to the nearest hundredth.

20. Suppose that the population of a certain town grows at an annual rate of 4%. If the population is currently 7,000, how many years will it take for it to reach 17,000? Round your answer to the nearest hundredth.

21. Suppose that a certain radioactive isotope has an annual decay rate of 9.8%. If a particular sample decays to 11 grams after 6 years, how big (in grams) was the original sample? Round your answer to the nearest hundredth.

22. Suppose that the population of a certain town grows at an annual rate of 5%. If the population grows to 6,000 in 3 years, what was the original population? Round your answer to the nearest integer.

23. Suppose that the population of a certain town grows at an annual rate of 8%. If the population is currently 6,000, what will it be in 5 years? Round your answer to the nearest integer.

24. Suppose that a certain radioactive isotope has an annual decay rate of 15.8%. What is the half-life (in years) of the isotope? Round your answer to the nearest hundredth.

25. Suppose that the population of a certain town grows at an annual rate of 9%. If the population grows to 7,000 in 5 years, what was the original population? Round your answer to the nearest integer.

26. Suppose that a certain radioactive isotope has an annual decay rate of 18.6%. If a particular sample decays to 41 grams after 3 years, how big (in grams) was the original sample? Round your answer to the nearest hundredth.

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27. Suppose that a certain radioactive isotope has an annual decay rate of 5.2%. What is the half-life (in years) of the isotope? Round your answer to the nearest hundredth.

28. Suppose that a certain radioactive isotope has an annual decay rate of 6.5%. What is the half-life (in years) of the isotope? Round your answer to the nearest hundredth.

29. Suppose that the population of a certain town grows at an annual rate of 8%. If the population is currently 2,000, how many years will it take for it to reach 7,000? Round your answer to the nearest hundredth.

30. Suppose that a certain radioactive isotope has an annual decay rate of 3.7%. If a particular sample decays to 47 grams after 8 years, how big (in grams) was the original sample? Round your answer to the nearest hundredth.

31. Suppose that the population of a certain town grows at an annual rate of 6%. If the population is currently 7,000, what will it be in 7 years? Round your answer to the nearest integer.

32. Suppose that the population of a certain town grows at an annual rate of 4%. If the population is currently 1,000, what will it be in 3 years? Round your answer to the nearest integer.

In Exercises 33-40, use the fact that the decay rate of carbon-14 is 0.012%. Round your answer to the nearest year.

33. Suppose that only 8.6% of the normal amount of carbon-14 remains in a fragment of bone. How old is the bone?

34. Suppose that only 5.2% of the normal amount of carbon-14 remains in a fragment of bone. How old is the bone?

35. Suppose that 90.1% of the normal amount of carbon-14 remains in a piece of wood. How old is the wood?

36. Suppose that 83.6% of the normal amount of carbon-14 remains in a piece of cloth. How old is the cloth?

37. Suppose that only 6.2% of the normal amount of carbon-14 remains in a fragment of bone. How old is the bone?

38. Suppose that only 1.3% of the normal amount of carbon-14 remains in a fragment of bone. How old is the bone?

39. Suppose that 96.7% of the normal amount of carbon-14 remains in a piece of cloth. How old is the cloth?

40. Suppose that 84.9% of the normal amount of carbon-14 remains in a piece of wood. How old is the wood?
8.7 Solutions

1. 

\[ P(t) = 5000e^{0.06t} \implies P(7) = 5000e^{(0.06)(7)} \]
\[ \implies P(7) \approx 7609.80777809317 \]

3. \[ P(t) = 227e^{-0.072t} \]. Therefore,

\[ 93 = 227e^{-0.072t} \implies \frac{93}{227} = e^{-0.072t} \]
\[ \implies \ln\left(\frac{93}{227}\right) = -0.072t \]
\[ \implies t = \frac{\ln\left(\frac{93}{227}\right)}{-0.072} \approx 12.3937572823354 \]

5. \[ P(t) = 4000e^{0.08t} \]. Therefore,

\[ 8000 = 4000e^{0.08t} \implies 2 = e^{0.08t} \]
\[ \implies \ln(2) = 0.08t \]
\[ \implies t = \frac{\ln(2)}{0.08} \approx 8.6643397569932 \]

7. \[ P(t) = P_0e^{-0.174t} \]. Therefore,

\[ \frac{P_0}{2} = P_0e^{-0.174t} \implies \frac{1}{2} = e^{-0.174t} \]
\[ \implies \ln(0.5) = -0.174t \]
\[ \implies t = \frac{\ln(0.5)}{-0.174} \approx 3.9836044859767 \]

9. 

\[ P(t) = 214e^{-0.173t} \implies P(5) = 214e^{-(0.173)(5)} \]
\[ \implies P(5) \approx 90.1050322622467 \]
11. \( P(t) = 3000e^{0.03t} \). Therefore,
\[
6000 = 3000e^{0.03t} \implies 2 = e^{0.03t} \\
\implies \ln(2) = 0.03t \\
\implies t = \frac{\ln(2)}{0.03} \approx 23.1049060186648
\]

13.
\[
P(t) = 353e^{-0.131t} \implies P(7) = 353e^{-0.131(7)} \\
\implies P(7) \approx 141.099886848361
\]

15. \( P(t) = 7000e^{0.02t} \). Therefore,
\[
14000 = 7000e^{0.02t} \implies 2 = e^{0.02t} \\
\implies \ln(2) = 0.02t \\
\implies t = \frac{\ln(2)}{0.02} \approx 34.6573590279973
\]

17. \( P(t) = 324e^{-0.187t} \). Therefore,
\[
163 = 324e^{-0.187t} \implies \frac{163}{324} = e^{-0.187t} \\
\implies \ln\left(\frac{163}{324}\right) = -0.187t \\
\implies t = \frac{\ln\left(\frac{163}{324}\right)}{-0.187} \approx 3.67376104270357
\]

19. \( P(t) = P_0e^{-0.023t} \). Therefore,
\[
25 = P_0e^{-0.023(8)} \implies 25e^{(0.023)(8)} = P_0 \\
\implies P_0 \approx 30.0503955774075
\]

21. \( P(t) = P_0e^{-0.098t} \). Therefore,
\[
11 = P_0e^{-0.098(6)} \implies 11e^{(0.098)(6)} = P_0 \\
\implies P_0 \approx 19.8042244855375
\]

23.
\[
P(t) = 6000e^{0.08t} \implies P(5) = 6000e^{(0.08)(5)} \\
\implies P(5) \approx 8950.94818584762
\]
25. $P(t) = P_0e^{0.09t}$. Therefore,

$$7,000 = P_0e^{(0.09)(5)} \implies 7,000e^{-(0.09)(5)} = P_0 \implies P_0 \approx 4463.39706135241$$

27. $P(t) = P_0e^{-0.052t}$. Therefore,

$$\frac{P_0}{2} = P_0e^{-0.052t} \implies \frac{1}{2} = e^{-0.052t} \implies \ln(0.5) = -0.052t \implies t = \frac{\ln(0.5)}{-0.052} \approx 13.3297534723066$$

29. $P(t) = 2000e^{0.08t}$. Therefore,

$$7000 = 2000e^{0.08t} \implies \frac{7}{2} = e^{0.08t} \implies \ln\left(\frac{7}{2}\right) = 0.08t \implies t = \frac{\ln\left(\frac{7}{2}\right)}{0.08} \approx 15.6595371061921$$

31.

$$P(t) = 7000e^{0.06t} \implies P(7) = 7000e^{(0.06)(7)} \implies P(7) \approx 10653.7308893304$$

33. $P(t) = P_0e^{-0.00012t}$. Therefore,

$$0.086P_0 = P_0e^{-0.00012t} \implies 0.086P_0 = P_0e^{-0.00012t} \implies \ln (0.086) = -0.00012t \implies t = \frac{\ln(0.086)}{-0.00012} \approx 20445.0665227386$$

35. $P(t) = P_0e^{-0.00012t}$. Therefore,

$$0.901P_0 = P_0e^{-0.00012t} \implies 0.901P_0 = P_0e^{-0.00012t} \implies \ln (0.901) = -0.00012t \implies t = \frac{\ln(0.901)}{-0.00012} \approx 868.750178114994$$

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37. \( P(t) = P_0 e^{-0.00012t} \). Therefore,

\[
0.062P_0 = P_0 e^{-0.00012t} \implies 0.062P_0 = P_0 e^{-0.00012t} \\
\implies \ln (0.062) = -0.00012t \\
\implies t = \frac{\ln(0.062)}{-0.00012} \approx 2317.8407828087
\]

39. \( P(t) = P_0 e^{-0.00012t} \). Therefore,

\[
0.967P_0 = P_0 e^{-0.00012t} \implies 0.967P_0 = P_0 e^{-0.00012t} \\
\implies \ln (0.967) = -0.00012t \\
\implies t = \frac{\ln(0.967)}{-0.00012} \approx 279.639862740355
\]