

Exponential Decay

Name: _____

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Score: _____ / 24

Q Quick Review

Exponential decay multiplies by a factor between 0 and 1 each equal time period. The model is $y = a(1 - r)^t$, where a is the initial value and r is the decay rate. A 12% decay rate uses multiplier 0.88 because 88% remains. Half-life is a special decay model: if a quantity halves every h units, use $y = a \left(\frac{1}{2}\right)^{t/h}$.

PRACTICE

Model or evaluate each exponential decay situation.

- A bike originally costs \$500 and loses 20% of its value in one year. What is its value after that year? _____
- A device has value 1000 and loses 5% during one period. What value remains? _____
- A computer depreciates by 15% each year. What multiplier should be used? _____
- A decay model uses multiplier 0.72. What percent decay rate does that represent? _____
- A sample starts at 80 grams and goes through two half-lives. How much remains? _____
- A medicine amount starts at 200 mg and halves twice. How much remains? _____
- A machine value is modeled by $10000(0.9)^t$. What is the value when $t = 3$? _____
- A car value is modeled by $V(t) = 30000(0.85)^t$. Estimate $V(4)$. _____
- A phone starts at value 500 and depreciates by 18% each year. Write the decay model. _____
- A radioactive sample starts at 80 grams and has a half-life of 4 days. How much remains after 12 days? _____
- The model $A(t) = 120(0.5)^t$ uses time in days. What is the half-life? _____
- The model $A(t) = 120(0.5)^{t/6}$ uses time in hours. What is the half-life? _____
- A machine loses 5% of its value each year. What multiplier belongs in the yearly decay model? _____
- A sample starts at 640 grams and is multiplied by 0.5 each hour. How much remains after 3 hours? _____
- A car starts at value 900 and keeps 80% of its value each year. What is the value after 2 years? _____
- Is $y = 50(0.93)^t$ an exponential growth model or an exponential decay model? _____
- A product loses 10% of its value each year. What fraction of the original value remains after t years? _____
- A model is $A(t) = 200e^{-0.04t}$. Does it represent exponential growth or decay? _____
- A substance decays by 40% each time period. What percent remains after one period? _____
- Can an exponential decay model with a positive starting value ever become negative? _____

◆ Word Problems

- A radioactive sample of 80 g has a half-life of 4 days. How much remains after 12 days?

- A car worth \$30,000 depreciates by 15% each year. Estimate its value after 4 years.

- A phone originally costs \$900 and loses 18% of its value each year. Estimate its value after 3 years.

- A medicine amount starts at 200 mg and halves every 5 hours. How much remains after 15 hours?



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Answer Keys

- | | |
|-----------------------|------------------------|
| 1. \$400 | 13. 0.95 |
| 2. 950 | 14. 80 |
| 3. 0.85 | 15. 576 |
| 4. 28% | 16. decay |
| 5. 20 | 17. 0.9^t |
| 6. 50 | 18. decay |
| 7. 7290 | 19. 60% |
| 8. $\approx \$15,660$ | 20. no |
| 9. $y = 500(0.82)^t$ | 21. 10 g |
| 10. 10 | 22. $\approx \$15,660$ |
| 11. 1 day | 23. $\approx \$496$ |
| 12. 6 | 24. 25 mg |

Step-by-Step Tutor Notes

- Losing 20% leaves 80% of the value, so use multiplier 0.80: $500(0.80) = 400$.
- Focus on the main idea of the problem, then simplify carefully. A 5% loss leaves multiplier 0.95, so $1000(0.95) = 950$. So the answer is 950.
- Work one inverse operation at a time and keep both sides balanced. Subtract the decay rate from 1: $1 - 0.15 = 0.85$. After simplifying, the answer is 0.85.
- Compare the change in output to the change in input, because slope is a rate of change. The missing part is $1 - 0.72 = 0.28$, so the decay rate is 28%. So the requested value is 28%.
- Use the clue in the question first, then let the arithmetic finish the job. Two half-lives leave one fourth of the original amount: $80(0.5)^2 = 20$. So the answer is 20.
- Work one inverse operation at a time and keep both sides balanced. Halving twice means multiply by $(\frac{1}{2})^2$, so $200(\frac{1}{2})^2 = 50$. After simplifying, the answer is 50.
- Move carefully through the arithmetic; one clean operation usually unlocks the next one. Multiply by 0.9 three times: $10000(0.9)^3 = 7290$. After simplifying, the answer is 7290.
- Put the given value into the expression first, then simplify from the inside out. Substitute $t = 4$: $30000(0.85)^4 \approx 15660$. That confirms the final answer is $\approx \$15,660$.
- The multiplier is $1 - 0.18 = 0.82$, so the model is $y = 500(0.82)^t$.
- This is a good place to slow down, check the notation, and simplify cleanly. Twelve days is 3 half-lives, so $80(\frac{1}{2})^3 = 10$ grams. So the answer is 10.
- Each increase of 1 in t multiplies the amount by 0.5, so the half-life is 1 day.
- When $t = 6$, the exponent is 1, so the amount has been halved after 6 hours.
- Start with the definition the problem is testing, then apply it directly. A 5% loss means 95% remains, so the multiplier is 0.95. So the answer is 0.95.
- Start with the definition the problem is testing, then apply it directly. The model is $640(0.5)^t$. At $t = 3$, $640(0.5)^3 = 80$. So the answer is 80.
- Start with the definition the problem is testing, then apply it directly. Keeping 80% means multiplier 0.8, so $900(0.8)^2 = 576$. So the answer is 576.
- Take it one clear step at a time and keep the original question in mind. The multiplier 0.93 is between 0 and 1, so the model shows decay. So the answer is decay.
- Each year leaves 90% of the previous value, so the remaining fraction is 0.9^t .
- Use the clue in the question first, then let the arithmetic finish the job. The exponent coefficient is negative, so the model decreases over time. So the answer is decay.
- This is a good place to slow down, check the notation, and simplify cleanly. If 40% is lost, the remaining percent is $100\% - 40\% = 60\%$. So the answer is 60%.
- No. It can get closer and closer to zero, but multiplying by a positive decay factor keeps it positive.
- Use the given numbers to build the model, then finish the calculation. Twelve days is three half-lives, so $80(\frac{1}{2})^3 = 10$ g.
- Name the quantities first so the model is easy to read. The car keeps 85% each year, so $V = 30000(0.85)^4 \approx 15660$.
- Set up the model from the story, then calculate carefully. The multiplier is 0.82. Then $900(0.82)^3 \approx 496$.
- Use the given numbers to build the model, then finish the calculation. Fifteen hours is three half-lives, so $200(\frac{1}{2})^3 = 25$ mg.



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