Exponential Decay

Name: _____ Date: _____ Score: _____ / 24

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.

1. A bike originally costs $\$500$ and loses 20% of its value in one year. What is its value after that year? _____

2. A device has value 1000 and loses 5% during one period. What value remains? _____

3. A computer depreciates by 15% each year. What multiplier should be used? _____

4. A decay model uses multiplier 0.72. What percent decay rate does that represent? _____

5. A sample starts at 80 grams and goes through two half-lives. How much remains? _____

6. A medicine amount starts at 200 mg and halves twice. How much remains? _____

7. A machine value is modeled by $10000(0.9)^t$. What is the value when $t = 3$? _____

8. A car value is modeled by $V(t) = 30000(0.85)^t$. Estimate $V(4)$. _____

9. A phone starts at value 500 and depreciates by 18% each year. Write the decay model. _____

10. A radioactive sample starts at 80 grams and has a half-life of 4 days. How much remains after 12 days? _____

11. The model $A(t) = 120(0.5)^t$ uses time in days. What is the half-life? _____

12. The model $A(t) = 120(0.5)^{t/6}$ uses time in hours. What is the half-life? _____

13. A machine loses 5% of its value each year. What multiplier belongs in the yearly decay model? _____

14. A sample starts at 640 grams and is multiplied by 0.5 each hour. How much remains after 3 hours? _____

15. A car starts at value 900 and keeps 80% of its value each year. What is the value after 2 years? _____

16. Is $y = 50(0.93)^t$ an exponential growth model or an exponential decay model? _____

17. A product loses 10% of its value each year. What fraction of the original value remains after t years? _____

18. A model is $A(t) = 200e^{-0.04t}$. Does it represent exponential growth or decay? _____

19. A substance decays by 40% each time period. What percent remains after one period? _____

20. Can an exponential decay model with a positive starting value ever become negative? _____

♦ Word Problems

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

_____

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

_____

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

_____

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

Step-by-Step Tutor Notes

1. Losing 20% leaves 80% of the value, so use multiplier 0.80: $500(0.80) = 400$.
2. 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.
3. 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.
4. 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%.
5. 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.
6. 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.
7. 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.
8. 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 $\approx \$15{,}660$.
9. The multiplier is $1 - 0.18 = 0.82$, so the model is $y = 500(0.82)^t$.
10. 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.
11. Each increase of 1 in t multiplies the amount by 0.5, so the half-life is 1 day.
12. When $t = 6$, the exponent is 1, so the amount has been halved after 6 hours.
13. 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.
14. 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.
15. 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.
16. 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.
17. Each year leaves 90% of the previous value, so the remaining fraction is 0.9^t.
18. 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.
19. 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%.
20. No. It can get closer and closer to zero, but multiplying by a positive decay factor keeps it positive.
21. 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.
22. Name the quantities first so the model is easy to read. The car keeps 85% each year, so $V = 30000(0.85)^4 \approx 15660$.
23. Set up the model from the story, then calculate carefully. The multiplier is 0.82. Then $900(0.82)^3 \approx 496$.
24. 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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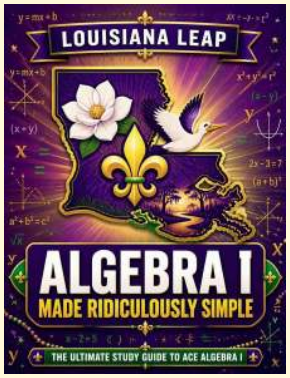

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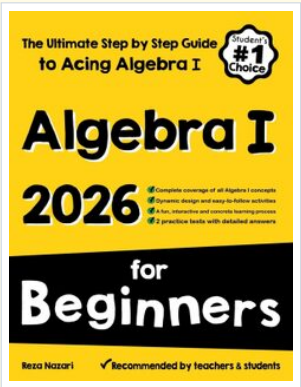

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