

# Graphing Exponential Functions

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 26

## Quick Review

An **exponential function** has form  $y = a \cdot b^x$ , where  $a$  is the **initial value** ( $y$ -intercept) and  $b$  is the **base** ( $b > 0, b \neq 1$ ). The graph: passes through  $(0, a)$ . If  $b > 1$ , exponential **growth** (rises to the right, approaches 0 to the left). If  $0 < b < 1$ , exponential **decay** (falls to the right and approaches 0 to the right). The **horizontal asymptote** is  $y = 0$  — the graph gets arbitrarily close but never touches. Domain: all real numbers. Range:  $y > 0$  (the graph stays above the  $x$ -axis when  $a > 0$ ). **Big idea:** exponentials grow (or decay) by *constant ratios*, unlike linear functions which change by constant amounts.

## PRACTICE

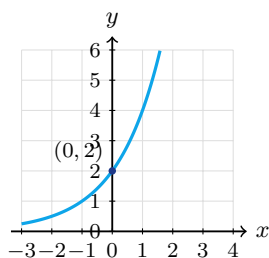
Identify features of each exponential.

- |   |       |  |       |
|---|-------|--|-------|
| 1. $y = 2^x$ ; $y$ -int                     | _____ | 11. Range of $y = 2^x$                       | _____ |
| 2. $y = 3^x$ ; growth or decay?             | _____ | 12. $y = 2^{x+1}$ ; $y$ -int                 | _____ |
| 3. $y = (\frac{1}{2})^x$ ; growth or decay? | _____ | 13. $y = 2^x - 3$ ; asymptote                | _____ |
| 4. $y = 5 \cdot 2^x$ ; $y$ -int             | _____ | 14. $y = 2^{-x}$ ; growth or decay?          | _____ |
| 5. $y = 2^x$ ; $y$ at $x = 2$               | _____ | 15. $y = 3 \cdot 2^x$ ; $y$ at $x = 2$       | _____ |
| 6. $y = (\frac{1}{3})^x$ ; $y$ at $x = 2$   | _____ | 16. $y = (1.5)^x$ ; growth or decay?         | _____ |
| 7. $y = 4 \cdot 3^x$ ; $y$ at $x = 0$       | _____ | 17. $y = 100 \cdot (0.9)^x$ ; $y$ at $x = 1$ | _____ |
| 8. $y = 10 \cdot (0.5)^x$ ; $y$ at $x = 1$  | _____ | 18. $y = 2^x$ ; $y$ at $x = -2$              | _____ |
| 9. Horizontal asymptote of $y = 2^x$        | _____ | 19. $y = 5^x$ ; $y$ at $x = 3$               | _____ |
| 10. Domain of $y = 3^x$                     | _____ | 20. $y = a \cdot b^x$ ; decay if             | _____ |

## VISUAL PRACTICE

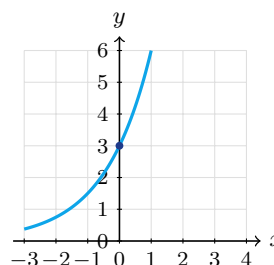
Use the graph, table, chart, or diagram to answer the question.

21. Use the graph of  $y = 2 \cdot 2^x$ . What is the  $y$ -intercept?



Answer: \_\_\_\_\_

22. Use the graph of  $y = 3 \cdot 2^x$ . What is the  $y$ -intercept?



Answer: \_\_\_\_\_



**◆ Word Problems**

**23.** A small town has 1,000 residents and its population grows by 5% each year. Write an exponential model for the population after  $t$  years.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

**24.** A car worth \$20,000 loses 12%/year. Write the model and find value after 5 years.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

**25.** A lab culture starts with 500 bacteria and doubles every 2 hours. Find the population after 6 hours.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

**26.** A drug's level in the body halves every 4 hours, starting at 200 mg. Find amount after 12 hours.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_



## Answer Keys

- |                  |   |
|------------------|---|
| 1. (0, 1)        | 14. decay                               |
| 2. growth        | 15. 12                                  |
| 3. decay         | 16. growth                              |
| 4. (0, 5)        | 17. 90                                  |
| 5. 8             | 18. $\frac{1}{4}$                       |
| 6. $\frac{1}{9}$ | 19. 125                                 |
| 7. 4             | 20. $0 < b < 1$                         |
| 8. 5             | 21. 2                                   |
| 9. $y = 0$       | 22. 3                                   |
| 10. $\mathbb{R}$ | 23. $P(t) = 1000 \cdot 1.05^t$          |
| 11. $y > 0$      | 24. $V = 20000 \cdot 0.88^t$ ; \$10,555 |
| 12. (0, 2)       | 25. 4000                                |
| 13. $y = -3$     | 26. 25 mg                               |

### Step-by-Step Tutor Notes

1. Take it one clear step at a time and keep the original question in mind.  $2^0 = 1$ . So the answer is (0, 1).
2. Start with the definition the problem is testing, then apply it directly.  $b = 3 > 1$ . So the answer is growth.
3. Start with the definition the problem is testing, then apply it directly.  $0 < b < 1$ . So the answer is decay.
4. Take it one clear step at a time and keep the original question in mind.  $a = 5$ . So the answer is (0, 5).
5. Start with the definition the problem is testing, then apply it directly.  $2^3 = 8$ . So the answer is 8.
6. Take it one clear step at a time and keep the original question in mind.  $(\frac{1}{3})^2 = \frac{1}{9}$ . So the answer is  $\frac{1}{9}$ .
7. Take it one clear step at a time and keep the original question in mind. Initial value. So the answer is 4.
8. Start with the definition the problem is testing, then apply it directly.  $10 \cdot 0.5 = 5$ . So the answer is 5.
9. Take it one clear step at a time and keep the original question in mind. Basic exponential functions approach  $y = 0$ . So the answer is  $y = 0$ .
10. Use the clue in the question first, then let the arithmetic finish the job. All real  $x$ . So the answer is  $\mathbb{R}$ .
11. Use the clue in the question first, then let the arithmetic finish the job. Always positive. So the answer is  $y > 0$ .
12. Start with the definition the problem is testing, then apply it directly.  $2^{0+1} = 2$ . So the answer is (0, 2).
13. Use the clue in the question first, then let the arithmetic finish the job. Vertical shift down 3 moves asymptote. So the answer is  $y = -3$ .
14. Focus on the main idea of the problem, then simplify carefully.  $2^{-x} = (\frac{1}{2})^x$ , decay form. So the answer is decay.
15. Take it one clear step at a time and keep the original question in mind.  $3 \cdot 4 = 12$ . So the answer is 12.
16. Focus on the main idea of the problem, then simplify carefully.  $b = 1.5 > 1$ . So the answer is growth.
17. Start with the definition the problem is testing, then apply it directly.  $100 \cdot 0.9$ . So the answer is 90.
18. Start with the definition the problem is testing, then apply it directly.  $2^{-2} = \frac{1}{4}$ . So the answer is  $\frac{1}{4}$ .
19. Focus on the main idea of the problem, then simplify carefully.  $5^3$ . So the answer is 125.
20. Use the clue in the question first, then let the arithmetic finish the job. Base between 0 and 1. So the answer is  $0 < b < 1$ .
21. Use the clue in the question first, then let the arithmetic finish the job. The graph crosses the  $y$ -axis when  $x = 0$ . That point is (0, 2). So the answer is 2.
22. Take it one clear step at a time and keep the original question in mind. The  $y$ -intercept occurs when  $x = 0$ . The graph crosses at (0, 3). So the answer is 3.
23. Name the quantities first so the model is easy to read. Multiplier per year:  $1 + 0.05 = 1.05$ . Initial: 1000.
24. Loses 12%, keeps 88%.  $V(5) = 20000 \cdot 0.88^5 \approx 10554.64$ , so the value is about \$10,555 to the nearest dollar.
25. Set up the model from the story, then calculate carefully. After 6 hours = 3 doublings:  $500 \cdot 2^3 = 4000$ .
26. Name the quantities first so the model is easy to read. 3 half-lives:  $200 \cdot (\frac{1}{2})^3 = 25$  mg.



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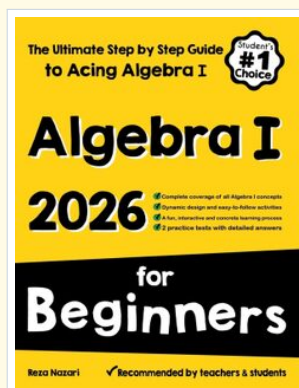
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