

6.5 Start Thinking

The exponential equation $3 \cdot 7^x = -2 \cdot 8^x$ can be graphed on a graphing calculator using a system of equations:

$$y = 3 \cdot 7^x$$

$$y = -2 \cdot 8^x$$

Explain how to get the system shown above from the equation. Graph the system. Is there an intersection? Use the equations to explain why.

6.5 Warm Up

Simplify.

$$1. \frac{t^6 u^3}{t^3 u}$$

$$2. \frac{g^7 h^3 m}{hg^6}$$

$$3. \left(\frac{3a^2 b^6}{2} \right)^3$$

$$4. \left(\frac{f^{-4} g^3}{h^{-5}} \right)^1$$

$$5. \frac{m^3 p^3}{mp}$$

$$6. \frac{c^5 d^3 f^4}{cd^5 f^2}$$

6.5 Cumulative Review Warm Up

Solve the inequality. Graph the solution.

$$1. 5x > 5$$

$$2. -21 \geq 7n$$

$$3. \frac{x}{5} < -3$$

$$4. 25 \leq \frac{5}{4}w$$

$$5. -5t > 10$$

$$6. -8 \leq -4z$$

6.5 Practice A

In Exercises 1–9, solve the equation. Check your solution.

1. $3^{4x} = 3^{12}$

2. $2^{x+3} = 2^5$

3. $5^{3x} = 5^{2x-7}$

4. $3^x = 27$

5. $5^x = 625$

6. $11^{x-4} = 121^x$

7. $\left(\frac{1}{3}\right)^x = 81$

8. $\frac{1}{125} = 5^{2x+7}$

9. $7^{5-4x} = \frac{1}{343}$

10. Describe and correct the error in solving the exponential equation.

$\begin{aligned} \times \quad \left(\frac{1}{6}\right)^{3x-1} &= 36^{x-7} \\ \left(6^{-1}\right)^{3x-1} &= \left(6^{-2}\right)^{x-7} \\ -3x + 1 &= -2x + 14 \\ x &= -13 \end{aligned}$
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In Exercises 11–16, use a graphing calculator to solve the equation.

11. $5^{x-1} = 10$

12. $3^{x+5} = 7$

13. $\left(\frac{1}{3}\right)^{6x+1} = -5$

14. $\left(\frac{1}{4}\right)^{x+2} = 9$

15. $3^{x-5} = 3x - 4$

16. $4x + 1 = 5^{x-3}$

In Exercises 17–19, solve the equation using the Property of Equality for Exponential Equations.

17. $40 \cdot 5^{x-2} = 200$

18. $8 \cdot 2^{x+6} = 32$

19. $3(4^{-3x-1}) = 48$

20. A bacterial culture triples in size every hour. You begin observing the number of bacteria 2 hours after the culture is prepared. The amount y of bacteria x hours after the culture is prepared is represented by $y = 162(3^{x-2})$. When will there be 8100 bacteria?

In Exercises 21–23, solve the equation.

21. $2^{3x-6} = 8^{x-2}$

22. $9^{3x-2} = 27^{2x-2}$

23. $2^{4(x-3)} = 16^{x+1}$

In Exercises 24 and 25, solve the equation.

24. $7^{x+3} = \sqrt{7}$

25. $\left(\sqrt[4]{10}\right)^x = 10^{3x-1}$

6.5 Practice B

In Exercises 1–9, solve the equation. Check your solution.

1. $3^{8x} = 3^{5x-6}$

2. $4^x = 2^{5x+3}$

3. $8^{5x} = 4^{4x+7}$

4. $25^{x-2} = 125^{3x+1}$

5. $9^{x-6} = 729^{3(x+2)}$

6. $4^{6(-x+2)} = 8^{-3x-4}$

7. $\left(\frac{1}{8}\right)^{2x+4} = 16^{4-x}$

8. $\left(\frac{2}{3}\right)^{x+8} = \left(\frac{3}{2}\right)^{2x-5}$

9. $\left(\frac{5}{4}\right)^{3x+5} = \left(\frac{16}{25}\right)^{-4x}$

10. Describe and correct the error in solving the exponential equation.

$$\begin{aligned} \times \quad & \left(\frac{1}{16}\right)^{3x} = 64^{x-4} \\ & (4^{-2})^{3x} = (8^2)^{x-4} \\ & -6x = 2x - 8 \\ & x = 1 \end{aligned}$$

In Exercises 11–16, use a graphing calculator to solve the equation.

11. $4^{-x+2} = -\frac{1}{3}x + 5$

12. $\frac{1}{2}x + 3 = \left(\frac{1}{5}\right)^{2x+1}$

13. $6^x = 4^{-x+3}$

14. $5^{x-4} = 3^{-x}$

15. $3^{x+2} = -4^{-x+1}$

16. $3^{-x-5} = 2^{x+3}$

17. A bread dough doubles in size every hour. You begin measuring the volume of the dough 1 hour after the dough is prepared. The volume y (in cubic inches) of the dough x hours after the dough is prepared is represented by $y = 35(2^{x-1})$.

When will the volume of the dough be 4200 cubic inches?

In Exercises 18–20, solve the equation.

18. $125^{x-1} = 5^{3x-2}$

19. $8^{2x+1} = 2^{3(2x+1)}$

20. $3^{8(2x-1)} = 81^{4x-2}$

21. You deposit \$750 in a savings account that earns 4% annual interest compounded yearly. Write and solve an exponential equation to determine when the balance of the account will be \$1000.

In Exercises 22 and 23, solve the equation.

22. $(\sqrt[5]{3})^x = 3^{3x-5}$

23. $(\sqrt[6]{2})^{2x} = (\sqrt[4]{2})^{x-3}$

6.5 Enrichment and Extension**Challenge: Solve Exponential Equations**

Solve the exponential equation.

1. $9^{x-3} = \frac{\left(\frac{1}{27}\right)^x}{3^{x+6}}$

2. $4^{2x+3} \cdot \left(\frac{1}{4}\right)^{3x} = 4^{x-7}$

3. $\frac{\left(\frac{1}{6}\right)^x}{216^{3x-4}} = 1$

4. $\frac{\left(\frac{1}{27}\right)^{-x}}{\left(\frac{1}{3}\right)^{x-5}} = 9^{2x}$

5. $\frac{32^{x-3}}{16^{3x+1}} = 4^x \cdot 2^{-3x+7}$

6. $\frac{5^{-3x+2}}{125} = 25^x \cdot 5^{3x}$

7. $\frac{\left(\frac{1}{2}\right)^x}{16^{4x+2}} = 0$

6.5 Puzzle Time

How Did The Beetle Uncover The Ant's Secret Plan?

Circle the letter of each correct answer in the boxes below. The circled letters will spell out the answer to the riddle.

Solve the equation. Check your solution.

1. $7^{8x} = 7^{16}$

2. $9^{x-5} = 9^{11}$

3. $4^{10x} = 4^{6x+12}$

4. $8^{5x} = 8^{x-8}$

5. $3^x = 81$

6. $6^{x-3} = 36^x$

7. $343^x = 7^{x-8}$

8. $125^x = 5^{x+12}$

9. $\left(\frac{1}{2}\right)^x = 128$

10. $\frac{1}{256} = 4^{5x+1}$

11. $100^{x-7} = \left(\frac{1}{1000}\right)^{x-7}$

12. $\left(\frac{1}{243}\right)^{x-3} = 27^{-2x+3}$

Use a graphing calculator to solve the equation. Round your answer to the nearest hundredth.

13. $6^{x+5} = 9$

14. $\left(\frac{1}{4}\right)^{6x-2} = 7^x$

15. $4x - 3 = 8^{x-2}$

16. $2^{x-4} = 3^{-x}$

D	I	F	T	G	K	B	V	U	G	H	G	L	B	E	C
15	-4	-28	16	-24	8	-3.77	24	-2	7	-15	4	-19	0.48	-7	-0.01
D	K	I	N	T	O	S	P	P	Q	H	B	O	W	N	E
3	28	-6	-0.55	6	19	-3	-8	0.77	24	-1	-0.48	0.27	0.01	2	1.55