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Lesson 3: Tracking the Tortoise
Ready, Set, Go

Ready

Solve for the value of x.

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

2. $7^{3x-2} = 7^{-2x+8}$

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

4. $3^{5x-4} = 9^{2x-3}$

5. $8^{x+1} = 2^{2x+3}$

6. $3^{x+1} = \dfrac{1}{81}$

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Set

In the fairy tale "Jack and the Beanstalk", Jack plants a magic bean before he goes to bed. In the morning, Jack discovers a giant beanstalk that has grown so large, it disappears into the clouds.

But here is the part of the story you never heard. Written on the bag containing the magic beans was this note.

> *Plant a magic bean in rich soil just as the sun is setting.*
>
> *Do not look at the plant site for 10 hours. (This is part of the magic.)*
>
> *After the bean has been in the ground for 1 hour, the growth of the sprout can be modeled by the function $b(t) = 3^t$*
>
> *(b in feet and t in hours).*

Time (hours)	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
Height (feet)	3	5.2	9	15.6	27	46.8	81	140.3	243	420.9	729	1,262.7	2,187	3,788

Jack was a good math student, so although he never looked at his beanstalk during the night, he used the function to calculate how tall it should be as it grew. The given table shows the calculations he made every half hour.

Hence, Jack was not surprised when, in the morning, he saw that the top of the beanstalk had disappeared into the clouds.

7. Demonstrate how Jack used the model $b(t) = 3^t$ to calculate how high the beanstalk would be after 6 hours had passed. (You may use the table but write down where you would put the numbers in the function if you didn't have the table.)

8. During that same night, a neighbor was playing with his drone. It was programmed to hover at 243 ft. How many hours had the beanstalk been growing when it was as high as the drone?

9. Did you use the table in the same way to answer #8 as you did to answer #7? Explain.

10. While Jack was making his table, he was wondering how tall the beanstalk would be after the magical 10 hours had passed. He quickly typed the function into his calculator to find out. Write the expression Jack would have typed into his calculator.
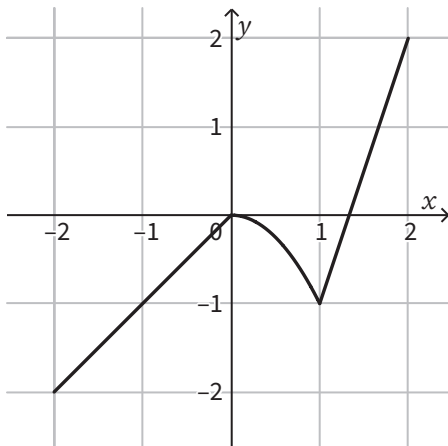
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11. Commercial jets fly between $30{,}000$ ft and $36{,}000$ ft. About how many hours of growing could pass before the beanstalk might interfere with commercial aircrafts? Explain how you got your answer.

12. Use the table to find $b(7)$ and $b^{-1}(11{,}364)$.

13. Use the table to find $b(9)$ and $b^{-1}(9)$.

14. Explain why it's possible to answer some questions about the height of the beanstalk by just substituting the numbers into the function rule and why sometimes you can only use the table.

15. Jack's table represents a function. Is it an invertible function? Justify your answer.

16. Graph the inverse of $f(x)$ on the same set of axes.

17. This question refers to $f(x)$ in #16. The equation of $f(x)$ on the interval $[-2, 0]$ is $g(x) = x$. Find the equation of $g^{-1}(x)$ on the interval $[-2, 0]$.

18. A table of values for $f(x) = 3 - x$ on the interval $[-1, 4]$ is given. Find the equation for

$f^{-1}(x)$. Justify your answer.

$f(x)$	4	3	2	1	0	-1
x	-1	0	1	2	3	4

Go

The functions are defined:

- $f(x) = -2x$
- $g(x) = 2x + 5$
- $h(x) = x^2 + 3x - 10$

Calculate the indicated function values.

19. $f(b^2)$

20. $f(g(x))$

21. $g(b^2)$

22. $h(f(x))$

23. $h(b^2)$

24. $h(g(x))$