02-20-25 MTH 161-004N

1.6 Graphs of Functions
   1.6.2 Exercises
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1.7 Transformations
   1.7.1 Exercises
   page 140: 1,4, 19, 24, 48, 56

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Copilot, do you think that pre-calculus is fun?

Precalc can be a bit intense, but, for some, it's like solving a big, satisfying puzzle. The challenge of wrapping your head around new concepts can be a thrill for those who enjoy math. What about you? Having fun with it?

I have fun with math all the time.

Nice, a math enthusiast! There's something really rewarding about cracking a tough problem or seeing how different mathematical concepts connect, isn't there? What areas of math do you enjoy the most?

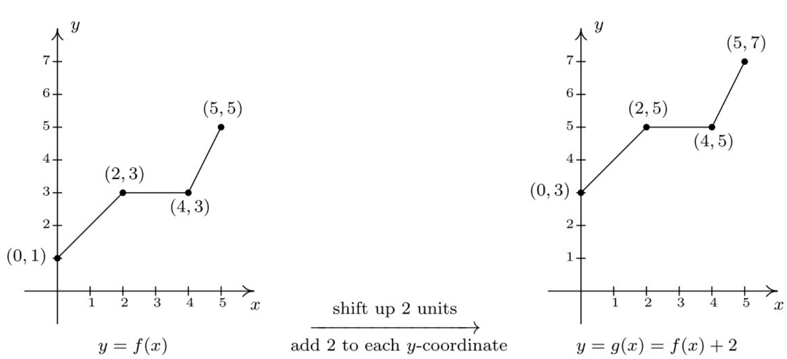
Well, now I've got to start teaching my class. I'll talk to you later.

Good luck with your class! Catch you later, Donald!

1.7
Memorize

Theorem 1.2. Vertical Shifts. Suppose f is a function and k is a positive number.

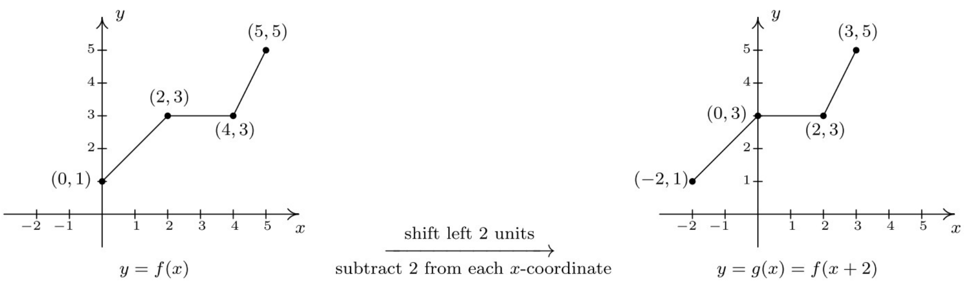
- To graph $y = f(x) + k$, shift the graph of $y = f(x)$ up k units by adding k to the y-coordinates of the points on the graph of f.
- To graph $y = f(x) - k$, shift the graph of $y = f(x)$ down k units by subtracting k from the y-coordinates of the points on the graph of f.

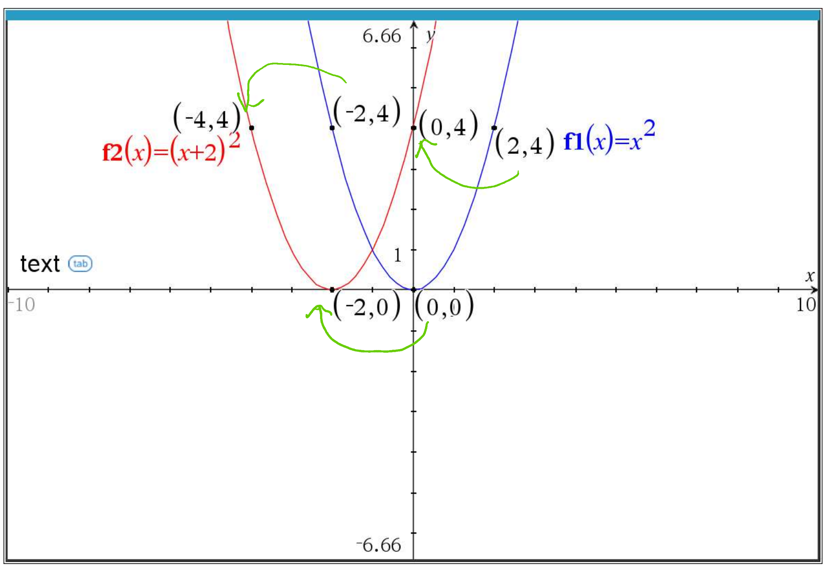


Memorize

Theorem 1.3. Horizontal Shifts. Suppose f is a function and h is a positive number.

- To graph $y = f(x + h)$, shift the graph of $y = f(x)$ left h units by subtracting h from the x-coordinates of the points on the graph of f.
- To graph $y = f(x - h)$, shift the graph of $y = f(x)$ right h units by adding h to the x-coordinates of the points on the graph of f.





Memorize

Theorem 1.4. Reflections. Suppose f is a function.

- To graph $y = -f(x)$, reflect the graph of $y = f(x)$ across the x-axis by multiplying the y-coordinates of the points on the graph of f by -1.
- To graph $y = f(-x)$, reflect the graph of $y = f(x)$ across the y-axis by multiplying the x-coordinates of the points on the graph of f by -1.

Memorize

Theorem 1.5. Vertical Scalings. Suppose f is a function and $a > 0$. To graph $y = af(x)$, multiply all of the y-coordinates of the points on the graph of f by a. We say the graph of f has been vertically scaled by a factor of a.

- If $a > 1$, we say the graph of f has undergone a vertical stretching (expansion, dilation) by a factor of a.
- If $0 < a < 1$, we say the graph of f has undergone a vertical shrinking (compression, contraction) by a factor of $\frac{1}{a}$.

Memorize

Theorem 1.6. Horizontal Scalings. Suppose f is a function and $b > 0$. To graph $y = f(bx)$, divide all of the x-coordinates of the points on the graph of f by b. We say the graph of f has been horizontally scaled by a factor of $\frac{1}{b}$.

- If $0 < b < 1$, we say the graph of f has undergone a horizontal stretching (expansion, dilation) by a factor of $\frac{1}{b}$.
- If $b > 1$, we say the graph of f has undergone a horizontal shrinking (compression, contraction) by a factor of b.

Supplied

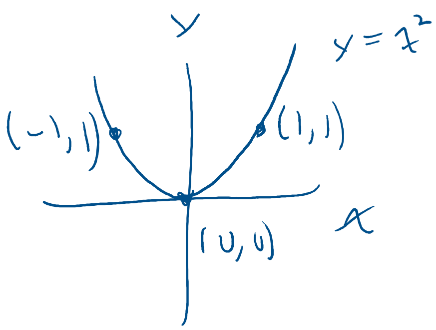
Theorem 1.7. Transformations. Suppose f is a function. If $A \neq 0$ and $B \neq 0$, then to graph

$$g(x) = Af(Bx + H) + K$$

1. Subtract H from each of the x-coordinates of the points on the graph of f. This results in a horizontal shift to the left if $H > 0$ or right if $H < 0$.
2. Divide the x-coordinates of the points on the graph obtained in Step 1 by B. This results in a horizontal scaling, but may also include a reflection about the y-axis if $B < 0$.
3. Multiply the y-coordinates of the points on the graph obtained in Step 2 by A. This results in a vertical scaling, but may also include a reflection about the x-axis if $A < 0$.
4. Add K to each of the y-coordinates of the points on the graph obtained in Step 3. This results in a vertical shift up if $K > 0$ or down if $K < 0$.

Let $f(x) = x^2$

Let $g(x) = 3(2x-1)^2 + 4$



$A = 3$

$B = 2$

$H = -1$

$K = 4$

$(-1, 1)$ $\quad$ $(0, 0)$ $\quad$ $(1, 1)$

① $(-1-(-1), 1)$ $\quad$ $(0-(-1), 0)$ $\quad$ $(1-(-1), 1)$

(1) $(-1-(-1), 1)$ $\quad (0-(-1), 0)$ $\quad (1-(-1), 1)$

$(0, 1)$ $\quad (1, 0)$ $\quad (2, 1)$

(2) $(\frac{0}{2}, 1)$ $\quad (\frac{1}{2}, 0)$ $\quad (\frac{2}{2}, 1)$

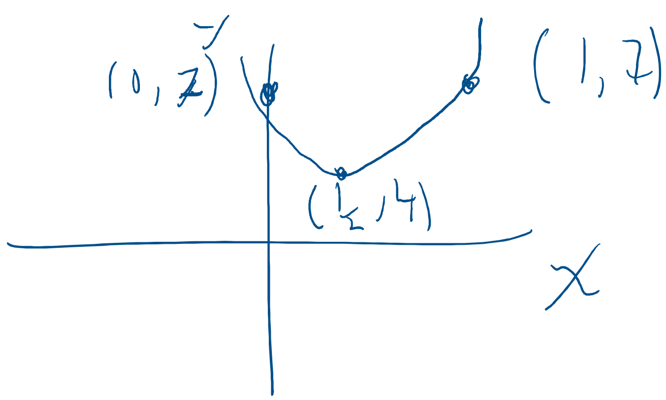
$(0, 1)$ $\quad (\frac{1}{2}, 0)$ $\quad (1, 1)$

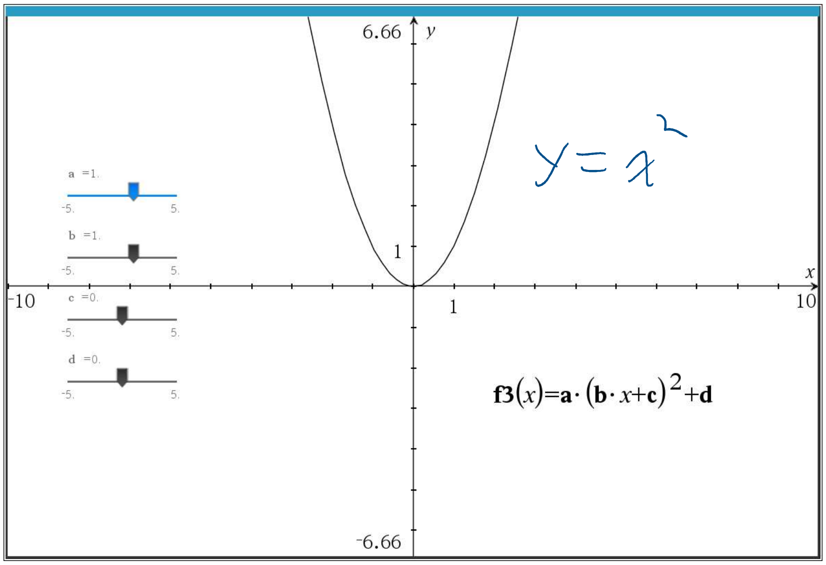
(3) $(0, (3)(1))$ $\quad (\frac{1}{2}, (3)(0))$ $\quad (1, (3)(1))$

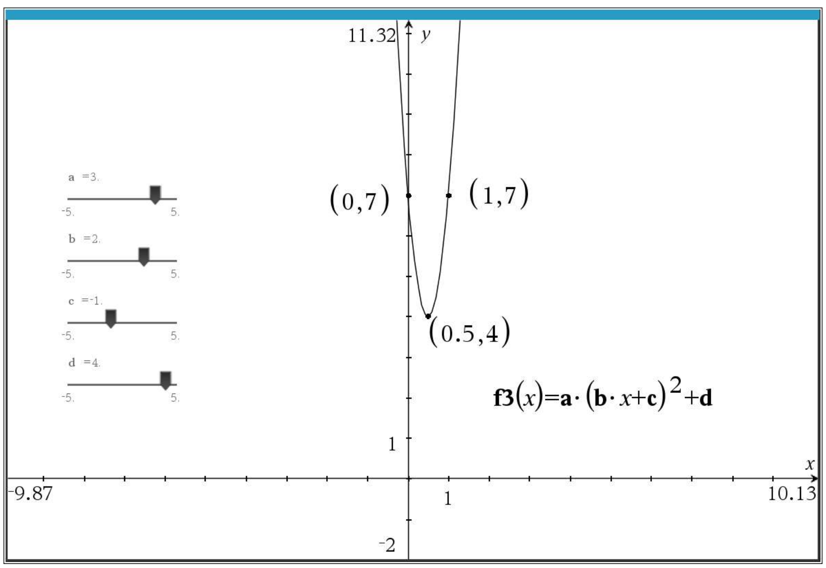
$(0, 3)$ $\quad (\frac{1}{2}, 0)$ $\quad (1, 3)$

(4) $(0, 3+4)$ $\quad (\frac{1}{2}, 0+4)$ $\quad (1, 3+4)$

$(0, 7)$ $\quad (\frac{1}{2}, 4)$ $\quad (1, 7)$





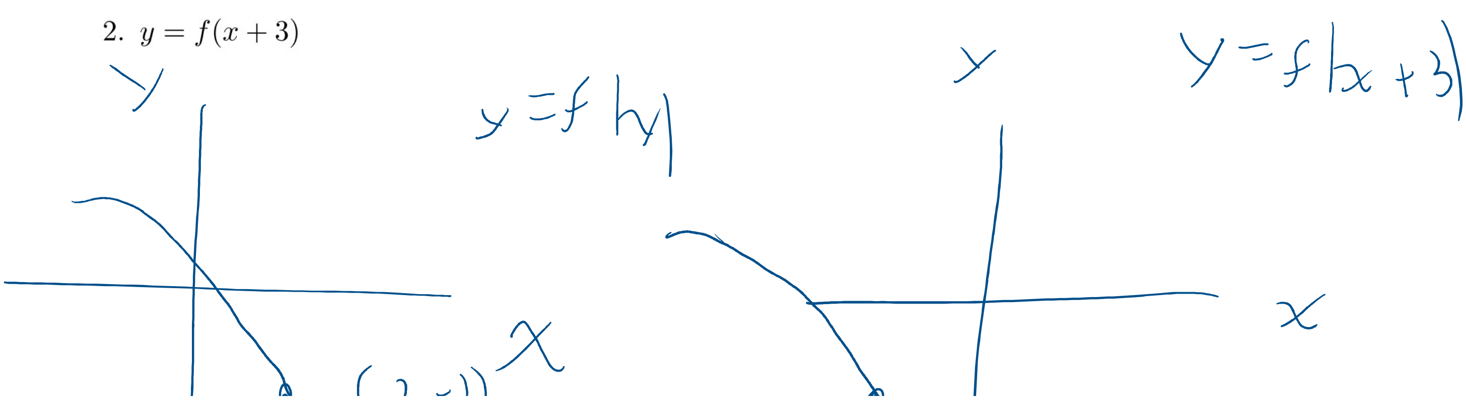


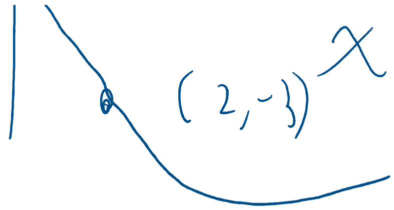
Use Trace to check that the transformed points are on the transformed graph

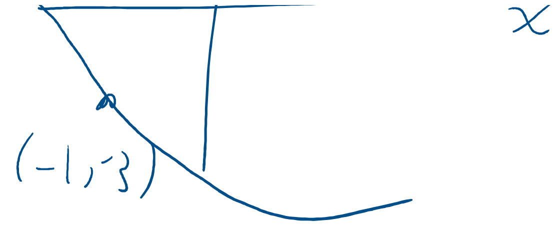
1.7.1 Exercises

Suppose $(2,-3)$ is on the graph of $y = f(x)$. In Exercises 1 - 18, use Theorem 1.7 to find a point on the graph of the given transformed function.

2. $y = f(x+3)$







use Thm 1.7

$A = 1 \quad H = 3$

$B = 1 \quad k = 0$

(1) $(2, -3)$

$(2-3, -3)$

$(-1, -3)$

(2) $\left(-\frac{1}{1}, -3\right)$

$(-1, -3)$

(3) $(-1, (-3)(1))$

$(-1, -3)$

(4) $(-1, -3 + 0)$

$\boxed{(-1, -3)}$

Your Name MTH 161-004N quiz 3 calculator OK

1. Find and simplify the difference quotient $\frac{\Delta f}{\Delta x}$

for $f(x) = -2x + 3$.

$$\frac{\Delta f}{\Delta x} = \frac{f(x+h) - f(x)}{h} = \frac{[-2(x+h)+3] - [-2x+3]}{h}$$

$$= \frac{-\cancel{2x} - 2h + \cancel{3} + \cancel{2x} - \cancel{3}}{h} = \frac{-2\cancel{h}}{\cancel{h}} = \boxed{-2}$$

$$= \frac{-\cancel{2x} - 2h + \cancel{3} + \cancel{2x} - \cancel{3}}{h} = \frac{-2\cancel{h}}{\cancel{h}} = \boxed{-2}$$

2. Is $f(x) = x^3$ even, odd, or neither? Show the calculation that justifies your answer.

$$f(-x) = (-x)^3 = (-1)^3 x^3 = -x^3 = -f(x)$$

$\therefore$ f is odd

3. Is every function a relation? Why or why not?

A relation is a set of points in the plane, or a set of ordered pairs of real numbers (x,y).

A function is a relation for which each x has a unique corresponding y, so a function is a relation by its definition.