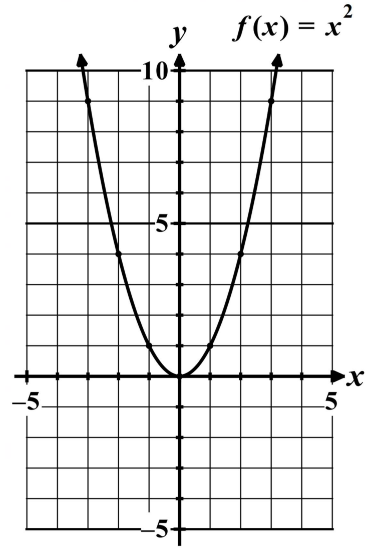
Name: ____________________________________ Date: _________________________

VERTICAL SHIFTING OF FUNCTIONS
N-GEN MATH® ALGEBRA I

We can build new functions from others by various types of ***transformations****. Perhaps the simplest of these transformations is a* ***vertical shift*** *of a function.*

***Exercise* #1:** The function $f(x)=x^2$ is shown graphed on the grid. The function $g(x)$ is defined by the formula $g(x)=f(x)+3$.



(a) Write a formula in terms of *x* for the function $g(x)$.

(b) Graph $g(x)$ on the same grid as $f(x)$. Show a table of values in the space to the right.

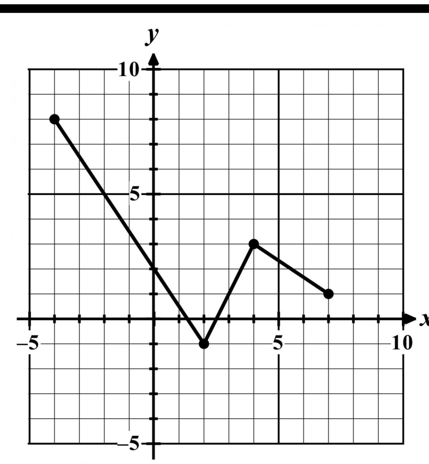
(c) Describe how the graph of $g(x)$ compares to the graph of $f(x)$.

(d) How would the graph of $h(x)=x^2-4$ compare to the graph of $f(x)=x^2$? Produce a graph of $h(x)$ on the same grid using your answer to this question.

Vertical shifting of functions is the simplest of all transformations because it occurs by simply adding or subtracting a value from the original function.

> **VERTICAL SHIFTING OF A FUNCTION**
>
> If k is a **positive number** then $g(x)=f(x)+k$ represents an upward shift of $f(x)$ by k units and $g(x)=f(x)-k$ represents a downward shift of $f(x)$ by k units.

***Exercise* #2:** The graph of $f(x)$ is shown. The function $g(x)$ is defined by the formula $g(x)=f(x)-3$



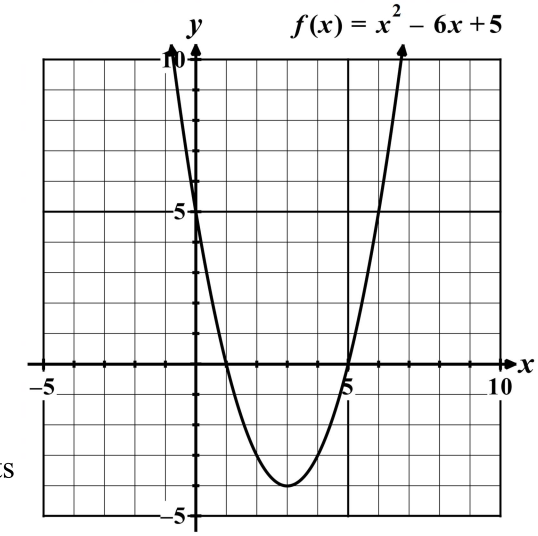
(a) What is the value of $g(-4)$. Show how you found it.

(b) How will the graph of $g(x)$ compare to that of $f(x)$?

(c) Create a graph of $g(x)$ on the same grid.

Any function can be shifted up or down based on adding or subtracting a constant from its formula.

***Exercise* #3:** The function $f(x)=x^2-6x+5$ is shown graphed on the grid. The function $g(x)$ is defined by the formula $g(x)=f(x)+4$.



(a) Give a formula for $g(x)$ in terms of x.

(b) How will the graph of $g(x)$ compare to that of $f(x)$?

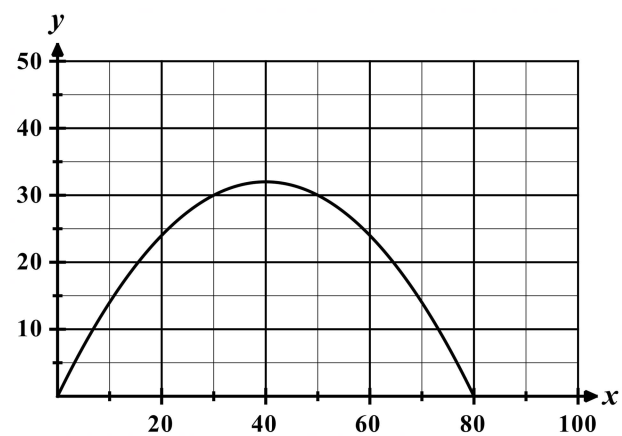
(c) Using your answer to (b), graph $g(x)$ on the same grid.

(d) The function $g(x)$ has only one zero. Algebraically determine its value.

(e) How does the graph of $g(x)$ support your answer to part (d)?

Vertical shifting of functions can also have practical applications.

***Exercise* #4:** A physics experiment is run where a projectile is fired from the ground surface. Its height, as a function of the horizontal distance it has traveled, is given by $h(x)=-0.02x^2+1.6x$. The graph is shown below.



(a) Using the axis of symmetry formula, show that the maximum of the function $h(x)$ must occur at $x=40$.

(b) The projectile is then fired off of the top of a 15-foot-tall platform so that its new height function is given by:

$$g(x)=h(x)+15$$

Graph $g(x)$ on the grid

(c) What would be the peak height the projectile would reach that was fired off the platform? Justify your answer.

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VERTICAL SHIFTING OF FUNCTIONS
N-GEN MATH® ALGEBRA I HOMEWORK

FLUENCY

1. If $f(x)=3x+7$ and $g(x)=f(x)-9$, then which of the following is a correct formula for $g(x)$ in terms of x?

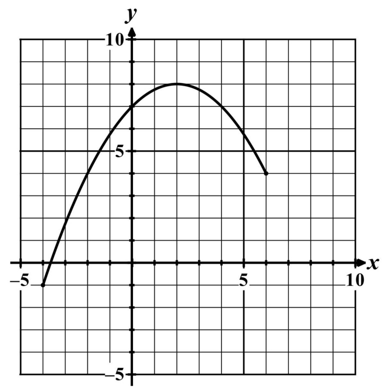
   (1) $g(x)=3x+16$

   (2) $g(x)=-6x+7$

   (3) $g(x)=3x-2$

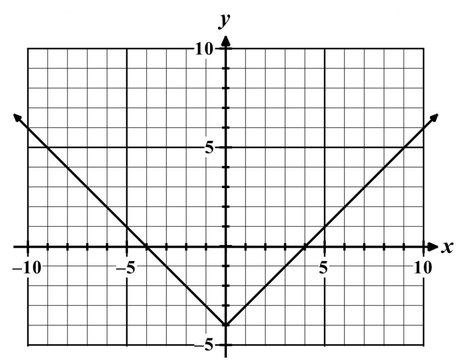
   (4) $g(x)=12x+7$ __________

2. The function $g(x)$ is shown graphed. If $h(x)=g(x)-5$ then which of the following is the value of $h(4)$?



   (1) -6
   (2) 2
   (3) 3
   (4) 8 __________

3. Which of the following is the formula for the graph shown below?



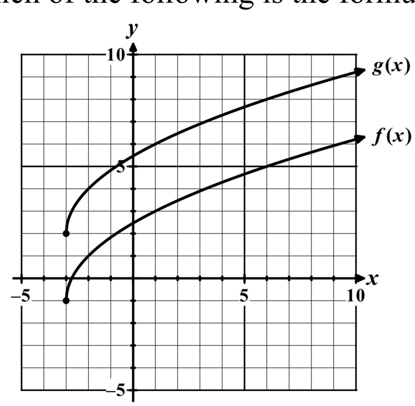
   (1) $y=(x-4)^2$

   (2) $y=x^2-4$

   (3) $y=|x-4|$

   (4) $y=|x|-4$ __________

4. The function $f(x)$ has the formula $f(x)=2\sqrt{x+3}-1$. Which of the following is the formula for the function $g(x)$ shown on the same graph?



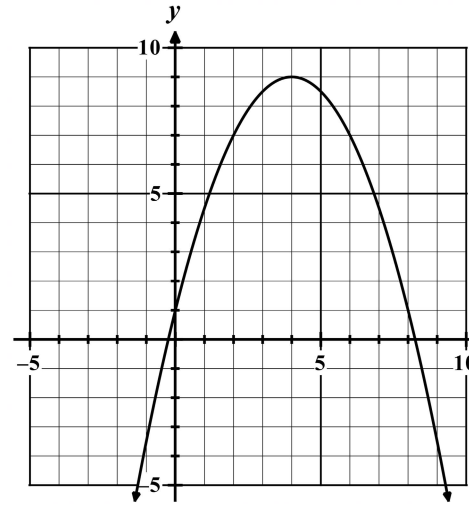
   (1) $g(x)=2\sqrt{x+3}+2$

   (2) $g(x)=2\sqrt{x+6}-1$

   (3) $g(x)=2\sqrt{x+3}+3$

   (4) $g(x)=2\sqrt{x+6}+1$ __________

5. The function $f(x)=-0.5x^2+4x+1$ shown on the grid. The function $g(x)$ is defined by $g(x)=f(x)-5$.



(a) Give a formula for $g(x)$ in terms of x.

(b) How will the graph of $g(x)$ compare to the graph of $f(x)$?

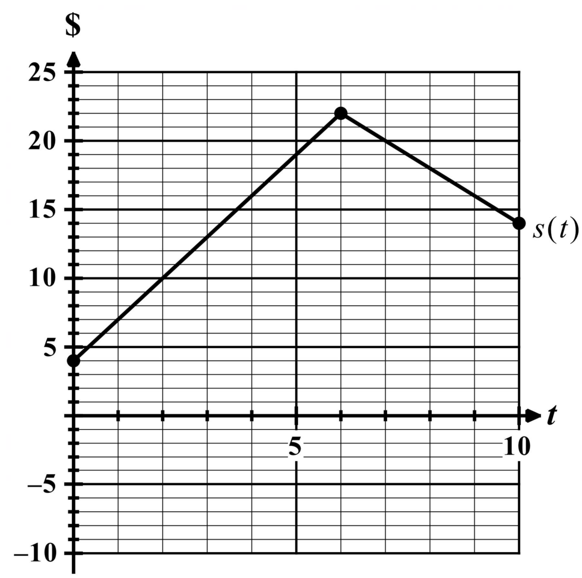
(c) Draw a graph of $g(x)$ on the grid.

(d) Give an estimate for the larger solution to the equation $g(x)=0$. Explain how you produced your estimate.

APPLICATIONS

6. A lemonade stand is operating over a 10-day period. Its sales, in dollars, for a given day since opening is given by the function $s(t)$ shown graphed below. The lemonade stand must spend \$10 per day on materials. Because of this, the profit they earn is given by the function $p(t)=s(t)-10$.

(a) What is the value of $p(4)$? Justify.



(b) Graph $p(t)$ on the same grid.

(c) What is the maximum profit the lemonade stand makes?

(d) For what value of t is $p(t)=0$?

(e) Over what interval of days is the profit at least \$6 per day? Justify.