Sec. 6.1 Vertical and Horizontal Shifts

Transformations –

1. **Vertical Shifts** – Moves an entire graph up or down. When $y = f(x)$ is transformed to $y = f(x) + k$ or $(-k)$, the graph is shifted vertically up or down.

Ex. Graph $f(x) = x^2$
$f(x) = x^2 - 4$ shifted down 4
$f(x) = x^2 + 6$ Shifted up 6

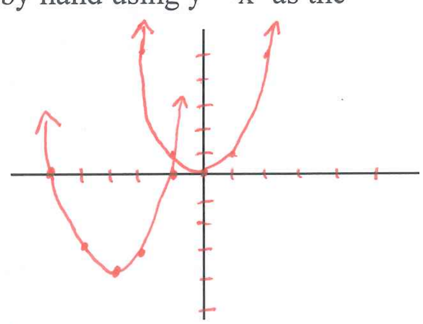
What do you notice happens to the graphs?

2. **Horizontal Shifts** – Moves an entire graph left or right. When $y = f(x)$ is transformed to $y = f(x + k)$ or $(- k)$. Graph moves left if it is + k and right if – k.

Ex. Graph $f(x) = x^2$
$f(x) = (x - 3)^2$ Shifted 3 to right
$f(x) = (x + 2)^2$ Shift 2 to left

What do you notice happens to the graphs?

Ex. Tell what happened to $y = (x + 3)^2 - 4$. Then graph by hand using $y = x^2$ as the transformation base.



Ex. Determine the equation of the graph whose vertex is (-3, 5) and whose y-intercept is –4. Then find the graph's maximum or minimum value. Also tell how the graph has moved from the original quadratic function.

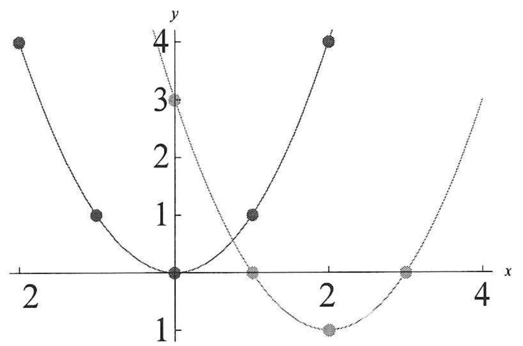
$y = a(x-h)^2 + k$
$y = a(x+3)^2 + 5$
$-4 = a(0+3)^2 + 5$
$-4 = 9a + 5$
$-9 = 9a$
$-1 = a$

$y = -(x+3)^2 + 5$
← opens downward

MAX VALUE AT
VERTEX $(-3, 5)$

Shifted left three and up 5.

Example 1 A graph of $f(x) = x^2$ is shown in blue. Define g by shifting the graph of f to the right 2 units and down 1 unit; the graph of g is shown in red. Find a formula for g in terms of f. Find a formula for g in terms of x.



$\boxed{g(x) = f(x-2) - 1}$ ← g in terms of f

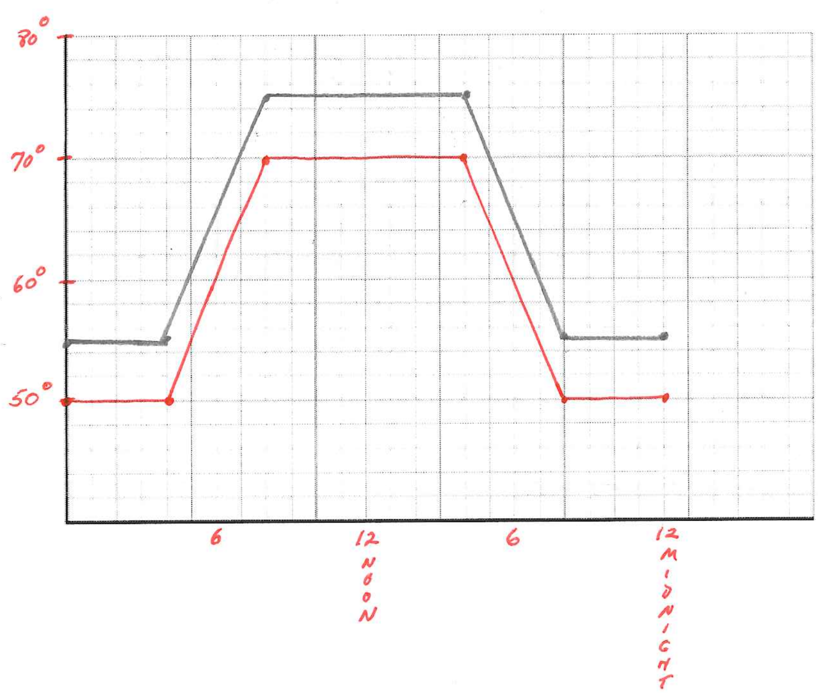
$= (x-2)^2 - 1$

$= x^2 - 4x + 4 - 1$

$\boxed{g(x) = x^2 - 4x + 3}$

Example 2: To save money, an office building is kept warm only during business hours. At midnight ($t = 0$), the building's temperature (H) is 50°F. This temperature is maintained until 4 am. Then the building begins to warm up so that by 8 am the temperature is 70°F. At 4 pm the building begins to cool. By 8 pm, the temperature is again 50°F. Suppose that the building's superintendent decides to keep the building 5°F warmer than before.

a. Graph the original office temperature with temperature as a function of time.
b. Graph the new office temperature with temperature as a function of time.
c. Write an equation that compares the original office temperature with the new office temperature.



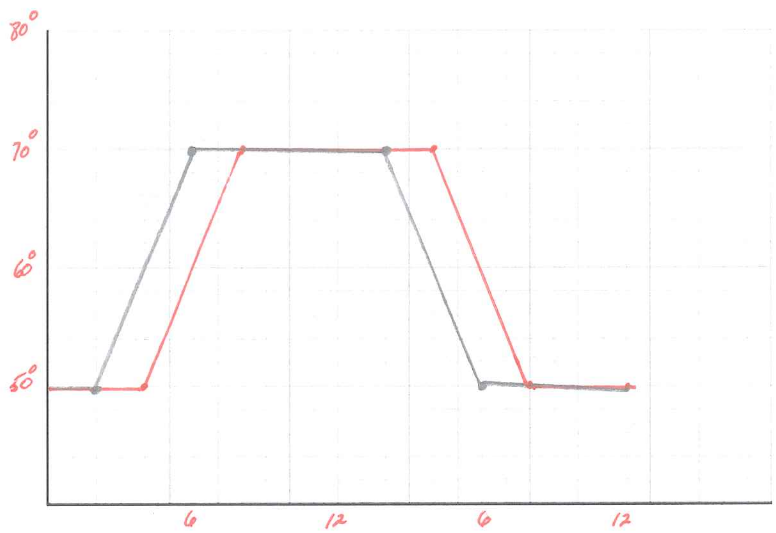
OLD TEMP: $H(t)$

NEW TEMP: $H(t) + 5$

$\boxed{N(t) = H(t) + 5}$

Example 3: The superintendent then changes the original heating schedule to start two hours earlier. The building now begins to warm at 2 am instead of 4 am, reaches 70°F at 6 am instead of 8 am, begins cooling off at 2 pm instead of 4 pm, and returns to 50°F at 6 pm instead of 8 pm. How are these changes reflected in the graph of the heating schedule?

a. Graph the original heating schedule. See previous example for info.
b. Graph the new heating schedule from Example 3.
c. Write an equation that relates the original heating schedule with the new one.
d. Can you write an equation that would relate the new heating schedule in Example one and Example two at the same time?



$H(t)$ = original schedule

$N(t) = H(t+2)$

$N(2) = H(2+2)$

↑

New Schedule at 2:00 = Old Schedule at 4:00

HW: pg 229-233 #3-54 (m/3)
Describe transformations in 15,18,21, and 24 but do not graph.
Skip 42c.