

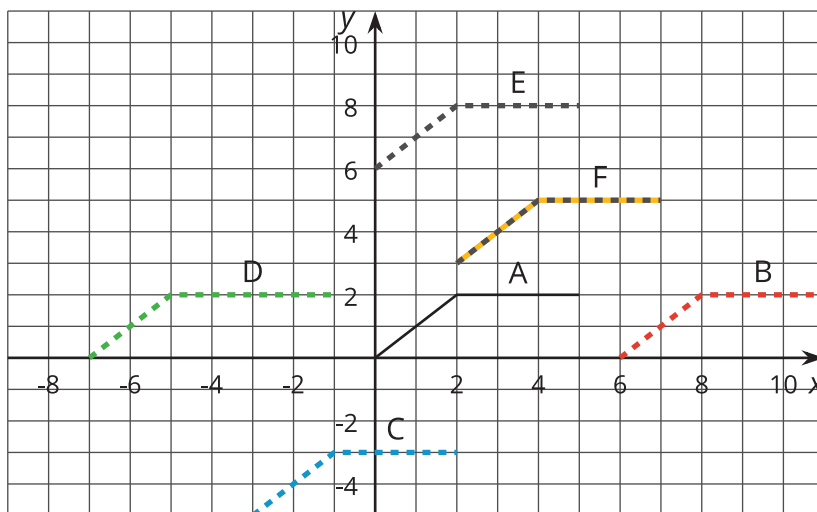


# More Movement

Let's translate graphs vertically and horizontally to match situations.

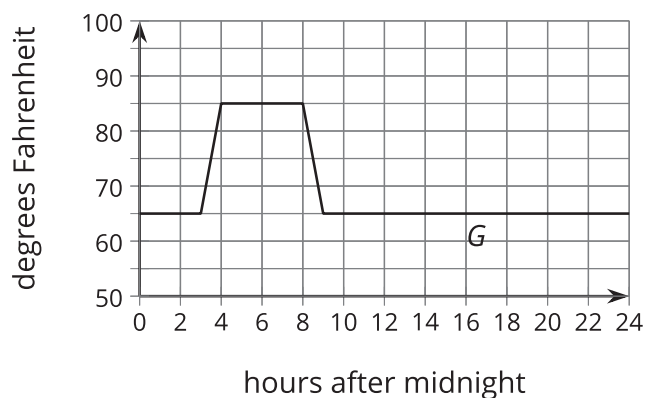
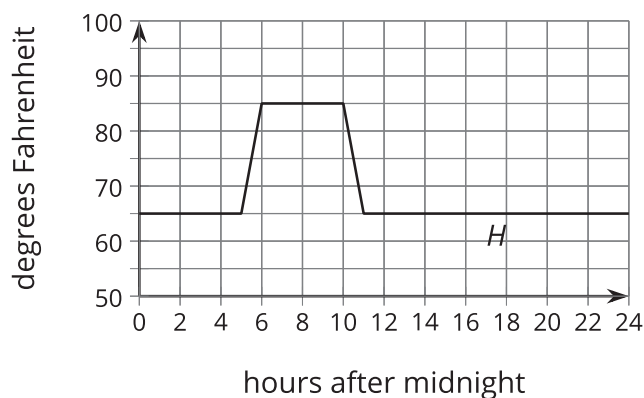
## 3.1 Moving a Graph

How can we translate the graph of A to match one of the other graphs?

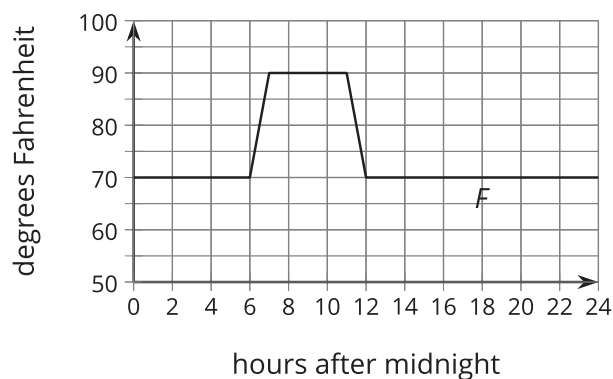


## 3.2 New Hours for the Kitchen

Remember the bakery with the thermostat set to  $65^{\circ}\text{F}$ ? At 5:00 a.m., the temperature in the kitchen rises to  $85^{\circ}\text{F}$  due to the ovens and other kitchen equipment being used until they are turned off at 10:00 a.m. When the owner decided to open 2 hours earlier, the baking schedule changed to match.



1. Andre thinks, "When the bakery starts baking 2 hours earlier, that means I need to subtract 2 from  $x$  and that  $G(x) = H(x - 2)$ ." How could you help Andre understand the error in his thinking?
2. The graph of  $F$  shows the temperatures after a change to the thermostat settings. What did the owner do?

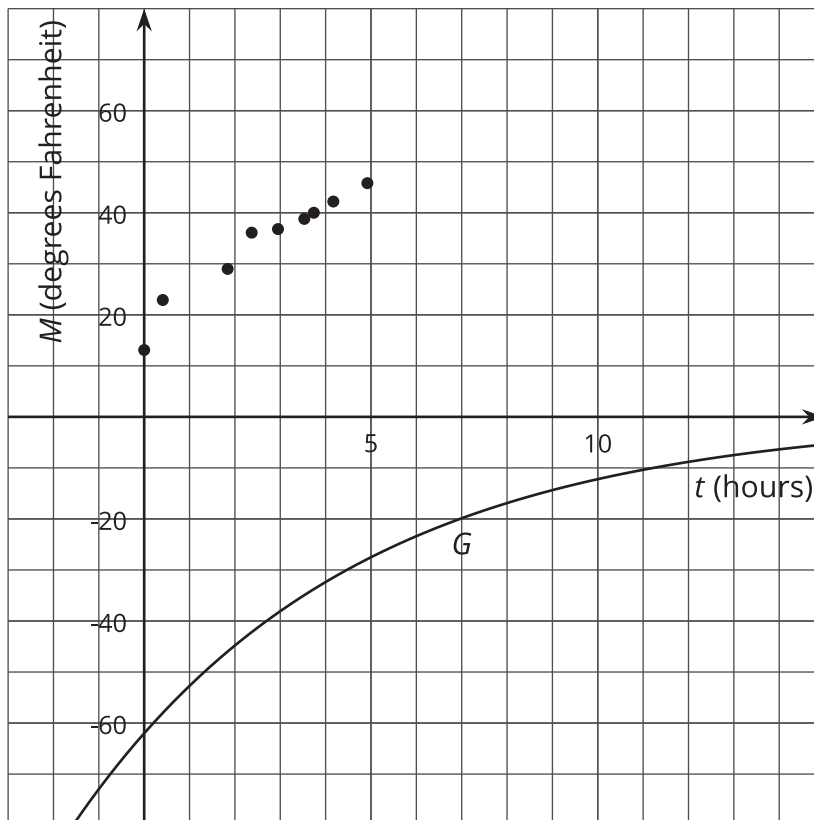


3. Write an expression for  $F$  in terms of the original baking schedule,  $H$ .

### 3.3 Thawing Meat

A piece of meat is taken out of the freezer to thaw. The data points show its temperature  $M$ , in degrees Fahrenheit,  $t$  hours after it was taken out. The graph  $M = G(t)$ , where  $G(t) = -62(0.85)^t$ , models the shape of the data but is in the wrong position.

| $t$  | $M$  |
|------|------|
| 0    | 13.1 |
| 0.41 | 22.9 |
| 1.84 | 29   |
| 2.37 | 36.1 |
| 2.95 | 36.8 |
| 3.53 | 38.8 |
| 3.74 | 40   |
| 4.17 | 42.2 |
| 4.92 | 45.8 |



Jada thinks changing the equation to  $J(t) = -62(0.85)^t + 75.1$  makes a good model for the data. Noah thinks  $N(t) = -62(0.85)^{(t+1)} + 68$  is better.

- Without graphing, describe how Jada and Noah each transformed the graph of  $G$  to make their new functions to fit the data.
- Use technology to graph the data,  $J$  and  $N$ , on the same axes.
- Whose function do you think best fits the data? Be prepared to explain your reasoning.

## Are you ready for more?

Elena excludes the first data point and chooses a linear model,  $E(t) = 21.32 + 5.06t$ , to fit the remaining data.

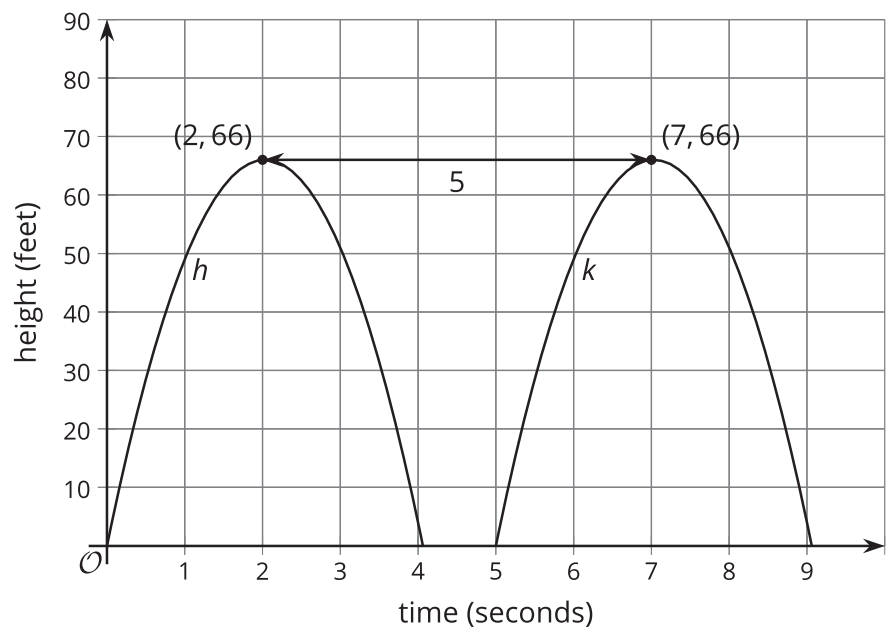
1. How well does Elena's model fit the data?
2. Is Elena's idea to exclude the first data point a good one? Explain your reasoning.

## Lesson 3 Summary

Remember the pumpkin catapult? The function  $h$  gives the height  $h(t)$ , in feet, of the pumpkin above the ground  $t$  seconds after launch.

Now suppose  $k$  represents the height  $k(t)$ , in feet, of the pumpkin if it were launched 5 seconds later. If we graph  $k$  and  $h$  on the same axes they look identical, but the graph of  $k$  is translated 5 units to the right of the graph of  $h$ .

Since we know the pumpkin's height  $k(t)$  at time  $t$  is the same as the height  $h(t)$  of the original pumpkin at time  $t - 5$ , we can write  $k$  in terms of  $h$  as  $k(t) = h(t - 5)$ .



Suppose there was a third function,  $j$ , where  $j(t) = h(t + 4)$ . Even without graphing  $j$ , we know that the graph reaches a maximum height of 66 feet. To evaluate  $j(t)$ , we evaluate  $h$  at the input  $t + 4$ , which is zero when  $t = -4$ . So the graph of  $j$  is translated 4 seconds to the left of the graph of  $h$ . This means that  $j(t)$  is the height, in feet, of a pumpkin launched from the catapult 4 seconds earlier.