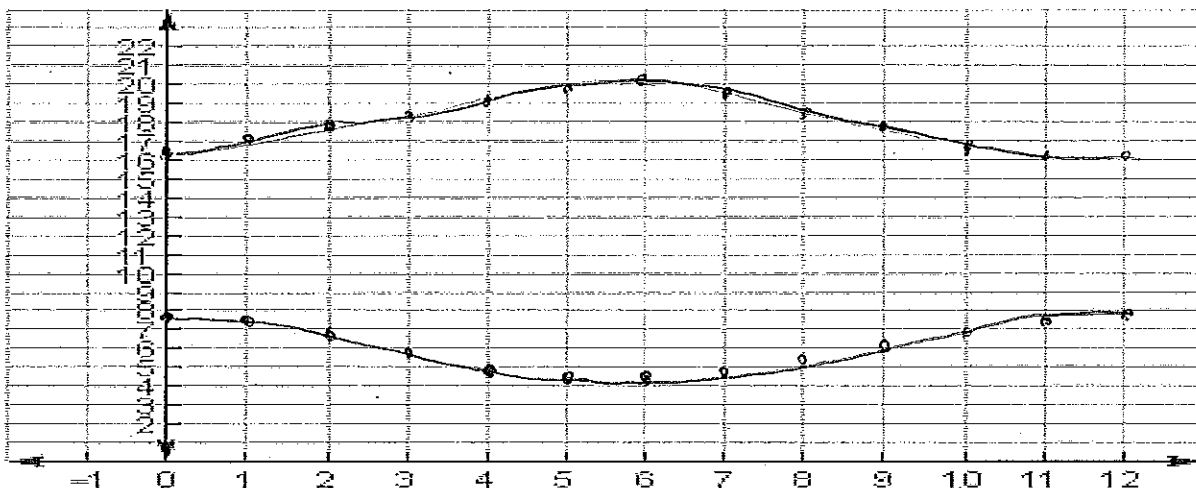Sunrise & Sunset

1.

The table below shows sunrise and sunset times for Portland. I removed the effect of daylight standard time.

Date *Start with 0!*	Sunrise	Sunset
Jan 1 = 0	7:50	4:38 = 16:38
Feb 1 = 1	7:31	5:19 = 17:19
Mar 1 = 2	6:48	5:58 = 17:58
Apr 1 = 3	5:50	6:39 = 18:39
May 1 = 4	4:58	7:18 = 19:18
Jun 1 = 5	4:25	7:52 = 19:52
Jul 1 = 6	4:26	8:03 = 20:03
Aug 1 = 7	4:55	7:38 = 19:38
Sep 1 = 8	5:32	6:47 = 18:47
Oct 1 = 9	6:09	5:50 = 17:50
Nov 1 = 10	6:50	4:57 = 16:57
Dec 1 = 11	7:30	4:28 = 16:28

Jan 1 = 12   ⟵ Year repeats with period = 12 mo.

Task: Write a function for f(x) and g(x), where f describes the sunrise time and g describes the sunset time. Define your variables. Graph your functions on the axes below.

$$\text{Period} = \frac{2\pi}{b}$$

$$12 = \frac{2\pi}{b}$$

$$12b = 2\pi$$

$$b = \frac{2\pi}{12}$$

$$b = \frac{\pi}{6}$$
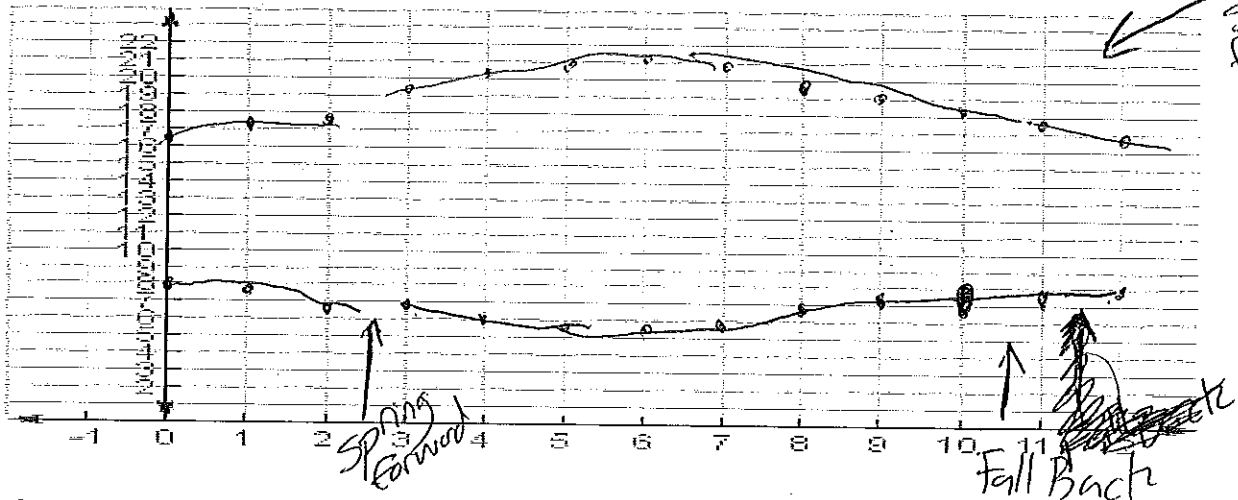
$$f(x) = +1.5\cos\left(\frac{\pi}{6}x\right) + 6$$

$$g(x) = -1.5\cos\left(\frac{\pi}{6}x\right) + 18$$

I used cosine because the graph starts above the midline.

I made cosine negative because the graph starts below.

2. But, in most states, we use Daylight Savings Time to maximize the hours of daylight during the time when you are awake. Look back at the table from part 1. Without Daylight Savings Time, the sun would rise at 4:25 am on June 1st, while everyone is still sleeping. In March, we "spring forward" and add an hour to the time. In November, we "fall back" and subtract an hour.

Add one hour to times from Apr→Nov.

a. Graph your sunset and sunrise functions and this time INCLUDE the effect of Daylight Savings
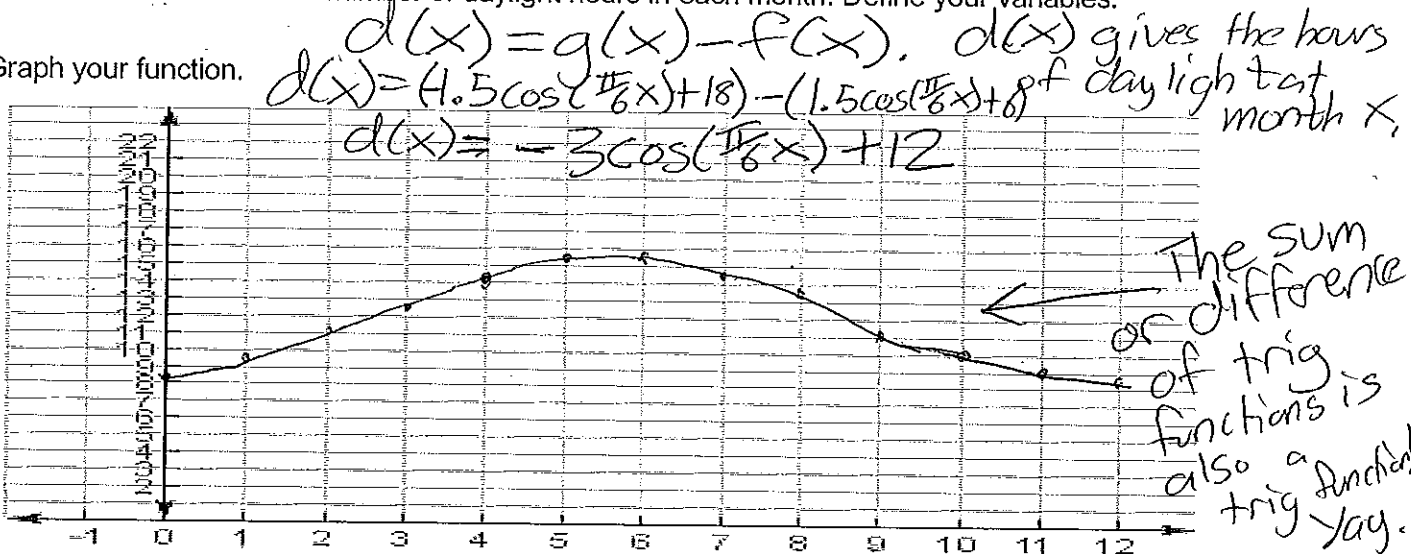
Hard to see the fall back. Sorry.

c. Can you write new functions for f and g that describe the sunrise and sunset data for the whole year? (Hint: break the functions up into pieces, and describe the function for each piece)

$$f(x) = \begin{cases} 1.5\cos(\frac{\pi}{6}x)+6 & \text{If } x \leq 2 \text{ or } x \geq 11 \\ 1.5\cos(\frac{\pi}{6}x)+7 & \text{If } 2 < x < 11 \end{cases}$$

Similar for g(x), just add 1 to k.

3. Obviously, changing to Daylight Savings Time doesn't change the total amount of sunlight per day, it just shifts the hours that are sunny or dark. Using your functions f and g, write a new function that describes the number of daylight hours in each month. Define your variables. Graph your function.

$$d(x) = g(x) - f(x). \quad d(x) \text{ gives the hours of daylight at month } x.$$

$$d(x) = (1.5\cos(\frac{\pi}{6}x)+18) - (1.5\cos(\frac{\pi}{6}x)+6)$$

$$d(x) = -3\cos(\frac{\pi}{6}x)+12$$

The sum or difference of trig functions is also a trig function! yay.

X	0	1	2	3	4	5	6	7	8	9	10	11
y	8.5	9.7	11.25	12.5	14.2	15.5	15.5	14.5	13.5	11	10	9