

## The winter solstice is over and the days are getting longer

Our days have started to get longer. We've passed the winter solstice, December 21<sup>st</sup>, which was our darkest day in the Northern Hemisphere.

1. Have you noticed a difference yet?

Answers will certainly vary.

2. How fast do the hours of daylight change? Will each day be about a minute longer? Two minutes longer? Five minutes longer? What's your guess?

Answers will certainly vary. Acknowledge different student's thoughts and maybe write some of their guesses on the board with their names = validation.

3. What else do you wonder?

Again, answers will vary. I wondered if days got equally longer every day or was there a different pattern to the daylight hours?

I've looked up the sunset and sunrise times for where I live to see how different the daylight hours are on the shortest day and the longest day.

Date	Sunrise	Sunset	Length of daylight
December 21, 2020	7:10 am	4:14 pm	9 hours + 4 minutes + 38 seconds
June 21, 2020	5:07 am	8:24 pm	15 hours + 17 minutes + 2 seconds

4. Fill in the last column of this table with the actual lengths of daylight on these two days.

5. What's the difference in daylight hours between the longest day and the shortest days of the year?

15 hrs. 17 min. – 9 hrs. 4 min. = 6 hrs. 13 min.

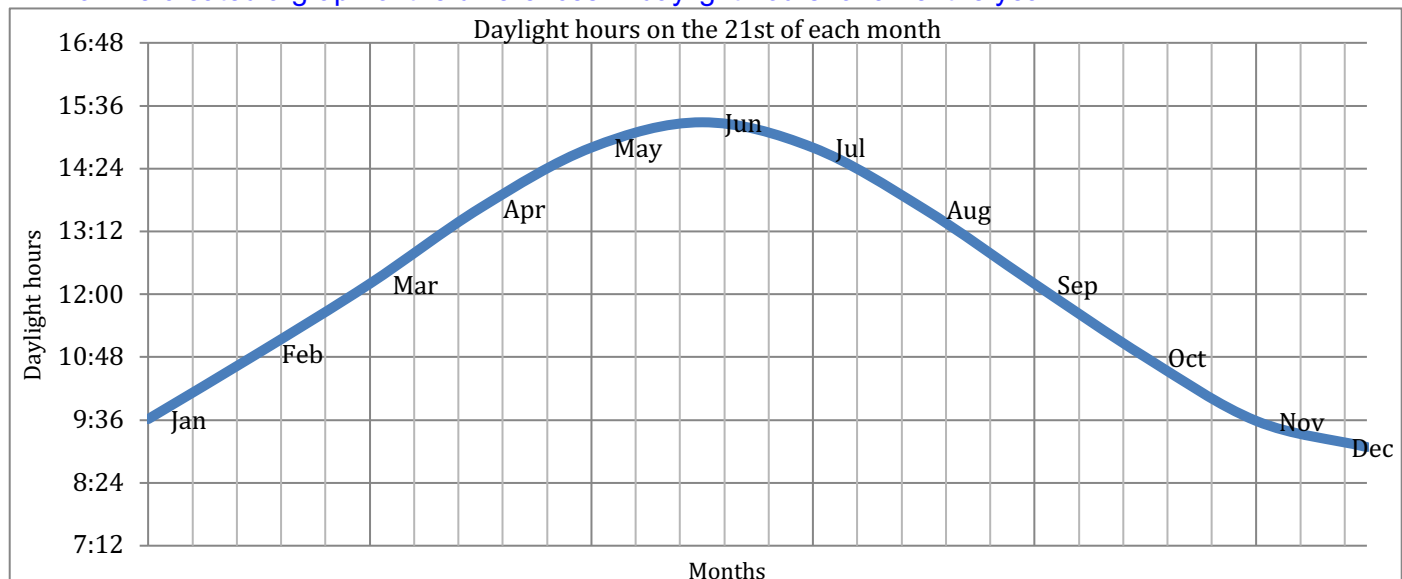
6. Using this information, on *average*, how much more daylight should we expect each day through June 21st?

The summer and winter solstices are 1/2 year apart. So in about  $365/2 =$  about 182 days the day length changes by 6 hours and 12 minutes =  $6 \times 60 + 12$  minutes = 372 minutes.

372 minutes divided by 182 days should be on average 2 minutes a day difference, ON AVERAGE!  
Hmmm.

7. Do you think the increase in daylight hours will be about the same every day = linear progression? Please explain.

No. We created a graph of the differences in daylight hours for an entire year.



8. We've looked up the daylight hours for where we live near Boston, MA, and created the chart below for just January and February. Either look up your own chart at the following website or use my Boston times to see what you can observe. <https://sunrise-sunset.org/us/boston-ma/2021/2>

Day	Sunrise	Sunset	Day length	Difference between this day and the previous day
Fri, Jan 1	7:13:25 AM	4:23:15 PM	9:09:50	
Sat, Jan 2	7:13:26 AM	4:24:09 PM	9:10:43	0:00:53
Sun, Jan 3	7:13:25 AM	4:25:05 PM	9:11:40	0:00:57
Mon, Jan 4	7:13:21 AM	4:26:03 PM	9:12:42	0:01:02
Tue, Jan 5	7:13:15 AM	4:27:01 PM	9:13:46	0:01:04
Wed, Jan 6	7:13:07 AM	4:28:02 PM	9:14:55	0:01:09
Thu, Jan 7	7:12:56 AM	4:29:03 PM	9:16:07	0:01:12
Fri, Jan 8	7:12:43 AM	4:30:06 PM	9:17:23	0:01:16
Sat, Jan 9	7:12:27 AM	4:31:11 PM	9:18:44	0:01:21
Sun, Jan 10	7:12:09 AM	4:32:16 PM	9:20:07	0:01:23
Mon, Jan 11	7:11:49 AM	4:33:23 PM	9:21:34	0:01:27
Tue, Jan 12	7:11:26 AM	4:34:31 PM	9:23:05	0:01:31
Wed, Jan 13	7:11:01 AM	4:35:39 PM	9:24:38	0:01:33
Thu, Jan 14	7:10:34 AM	4:36:49 PM	9:26:15	0:01:37
Fri, Jan 15	7:10:05 AM	4:38:00 PM	9:27:55	0:01:40
Sat, Jan 16	7:09:33 AM	4:39:11 PM	9:29:38	0:01:43
Sun, Jan 17	7:08:59 AM	4:40:23 PM	9:31:24	0:01:46
Mon, Jan 18	7:08:23 AM	4:41:36 PM	9:33:13	0:01:49
Tue, Jan 19	7:07:44 AM	4:42:50 PM	9:35:06	0:01:53
Wed, Jan 20	7:07:04 AM	4:44:04 PM	9:37:00	0:01:54
Thu, Jan 21	7:06:22 AM	4:45:19 PM	9:38:57	0:01:57
Fri, Jan 22	7:05:37 AM	4:46:35 PM	9:40:58	0:02:01
Sat, Jan 23	7:04:50 AM	4:47:51 PM	9:43:01	0:02:03
Sun, Jan 24	7:04:02 AM	4:49:07 PM	9:45:05	0:02:04
Mon, Jan 25	7:03:11 AM	4:50:24 PM	9:47:13	0:02:08
Tue, Jan 26	7:02:18 AM	4:51:41 PM	9:49:23	0:02:10
Wed, Jan 27	7:01:24 AM	4:52:58 PM	9:51:34	0:02:11
Thu, Jan 28	7:00:27 AM	4:54:16 PM	9:53:49	0:02:15
Fri, Jan 29	6:59:29 AM	4:55:34 PM	9:56:05	0:02:16
Sat, Jan 30	6:58:29 AM	4:56:52 PM	9:58:23	0:02:18
Sun, Jan 31	6:57:27 AM	4:58:10 PM	10:00:43	0:02:20
Mon, Feb 1	6:56:24 AM	4:59:28 PM	10:03:04	0:02:21
Tue, Feb 2	6:55:18 AM	5:00:47 PM	10:05:29	0:02:25
Wed, Feb 3	6:54:11 AM	5:02:05 PM	10:07:54	0:02:25
Thu, Feb 4	6:53:03 AM	5:03:24 PM	10:10:21	0:02:27
Fri, Feb 5	6:51:53 AM	5:04:42 PM	10:12:49	0:02:28
Sat, Feb 6	6:50:41 AM	5:06:00 PM	10:15:19	0:02:30
Sun, Feb 7	6:49:28 AM	5:07:19 PM	10:17:51	0:02:32
Mon, Feb 8	6:48:13 AM	5:08:37 PM	10:20:24	0:02:33
Tue, Feb 9	6:46:57 AM	5:09:55 PM	10:22:58	0:02:34
Wed, Feb 10	6:45:40 AM	5:11:13 PM	10:25:33	0:02:35
Thu, Feb 11	6:44:21 AM	5:12:30 PM	10:28:09	0:02:36
Fri, Feb 12	6:43:01 AM	5:13:48 PM	10:30:47	0:02:38
Sat, Feb 13	6:41:39 AM	5:15:05 PM	10:33:26	0:02:39
Sun, Feb 14	6:40:17 AM	5:16:22 PM	10:36:05	0:02:39
Mon, Feb 15	6:38:53 AM	5:17:39 PM	10:38:46	0:02:41
Tue, Feb 16	6:37:28 AM	5:18:56 PM	10:41:28	0:02:42
Wed, Feb 17	6:36:01 AM	5:20:12 PM	10:44:11	0:02:43
Thu, Feb 18	6:34:34 AM	5:21:28 PM	10:46:54	0:02:43
Fri, Feb 19	6:33:06 AM	5:22:44 PM	10:49:38	0:02:44
Sat, Feb 20	6:31:36 AM	5:24:00 PM	10:52:24	0:02:46
Sun, Feb 21	6:30:06 AM	5:25:15 PM	10:55:09	0:02:45
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Wed, Feb 24	6:25:29 AM	5:28:59 PM	11:03:30	0:02:47
Thu, Feb 25	6:23:55 AM	5:30:13 PM	11:06:18	0:02:48

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Sat, Feb 27	6:20:45 AM	5:32:41 PM	11:11:56	0:02:50
Sun, Feb 28	6:19:09 AM	5:33:54 PM	11:14:45	0:02:49

9. Were your guesses correct? Please explain.

Wow. I thought that the days would increase by about a minute a day. But in January many of the daylight measurements increase by only 4 seconds per day.

By January 10<sup>th</sup> they start increasing by only 3 or 4 seconds a day. The amount of daylight increase is slowing down.

By January 18<sup>th</sup> the increase is down to 2 or 3 seconds a day. By January 26<sup>th</sup> the increase is only 2 seconds per day.

By February 4<sup>th</sup> the increase is 1 or 2 seconds per day.

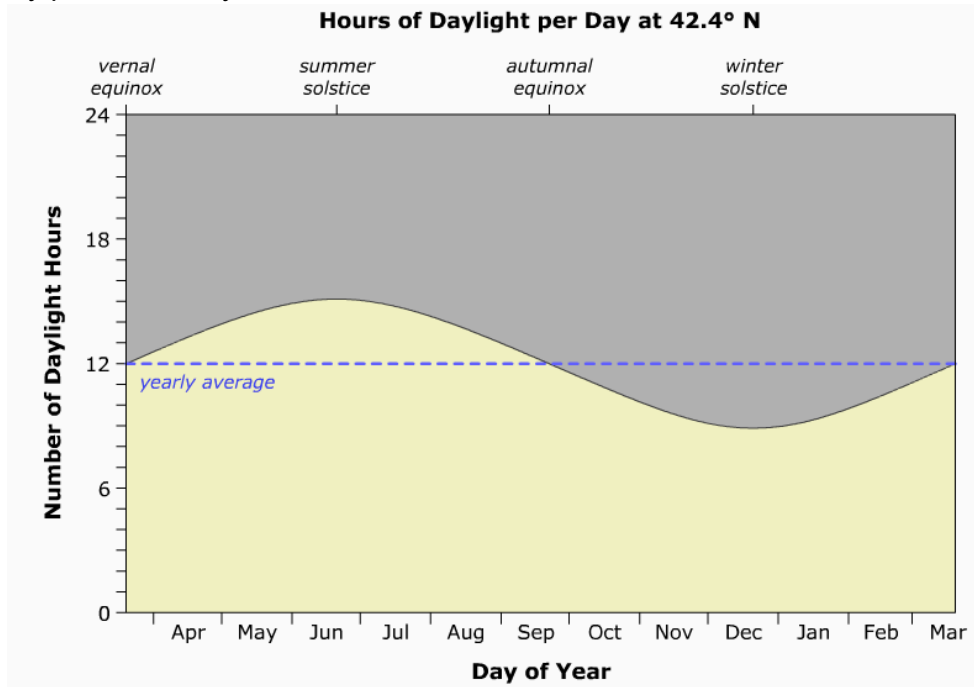
By February 11<sup>th</sup> the increase is only 1 second per day.

Starting February 19<sup>th</sup> the increase is often less than 1 second per day or one second every other day.

If the days on average have to increase about 2 minutes a day then there must be some serious changes in the number of daylight hours later in the year.

On the next page is a graph that shows the number of daylight hours throughout the year here in Boston. We are located near latitude 42.4° North.

10. Describe any patterns that you see.



There are probably many observations that your students will make. One that we noticed was that the change from day to day gets smaller and smaller through March. Actually, the change in daylight hours gets smaller until the Spring Equinox = March 20<sup>th</sup> or so. Then daylight change increments start getting longer until June 21<sup>st</sup> which is the summer solstice and the longest day. I'm very surprised that the increments of daylight increase are so small. I'm also surprised that at first their increments are larger and then become so much smaller.

11. Do you think that this is a linear progression? If not, how would you describe this variation. Please explain.

No. I think that since the change from day to day varies, it is definitely not linear. The graph looks a little like a sine wave. The hours of sunlight peak in the middle of June and are the lowest in the middle of December.

Sources: <http://www.timeanddate.com>  
<https://sunrise-sunset.org/us/boston-ma/2021/2>