Will the Fastest Women Marathoners Ever Beat the Fastest Men?

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We’ll explore “world best” marathon times for men and women over the years,
and discuss the possibilities for the future,
including a sub-two-hour marathon.

This activity is designed to familiarize students with graphing calculator technology, and also to help them analyze data in a “real-world” setting.

How many middle school math teachers are here?

How many high school math teachers are here?

How many science teachers are here?

How many administrators are here?

How many are familiar with graphing calculator technology?

Year	Marathon time (Men)	Year	Marathon time (Women)
1964	2:13:55	1964	3:27:45
1967	2:12:00	1967	3:15:22
1971	2:09:36	1971	3:01:42
1981	2:08:18	1981	2:35:15
1985	2:07:12	1985	2:22:43
1998	2:06:05	1998	2:20:47
2001	2:05:42	2001	2:18:47
2003	2:04:55	2003	2:15:25

What would be an efficient way to enter the years and times into the list feature of your calculator?

In list 1, enter the number of years after 1960. In list 2, enter the number of minutes for the marathon (men), and in list 3, enter the number of minutes for the marathon (women). Truncate the number of seconds.

L1	L2	L3
4	133	207
7	132	195
11	129	181
21	128	155
25	127	142
38	126	140
41	125	138
43	124	135

L1(8)=43

As you look at this data, think about how you might want to see it displayed – what sort of window would you use?

Xmin = -1

Xmax = 75

Xscl = 25

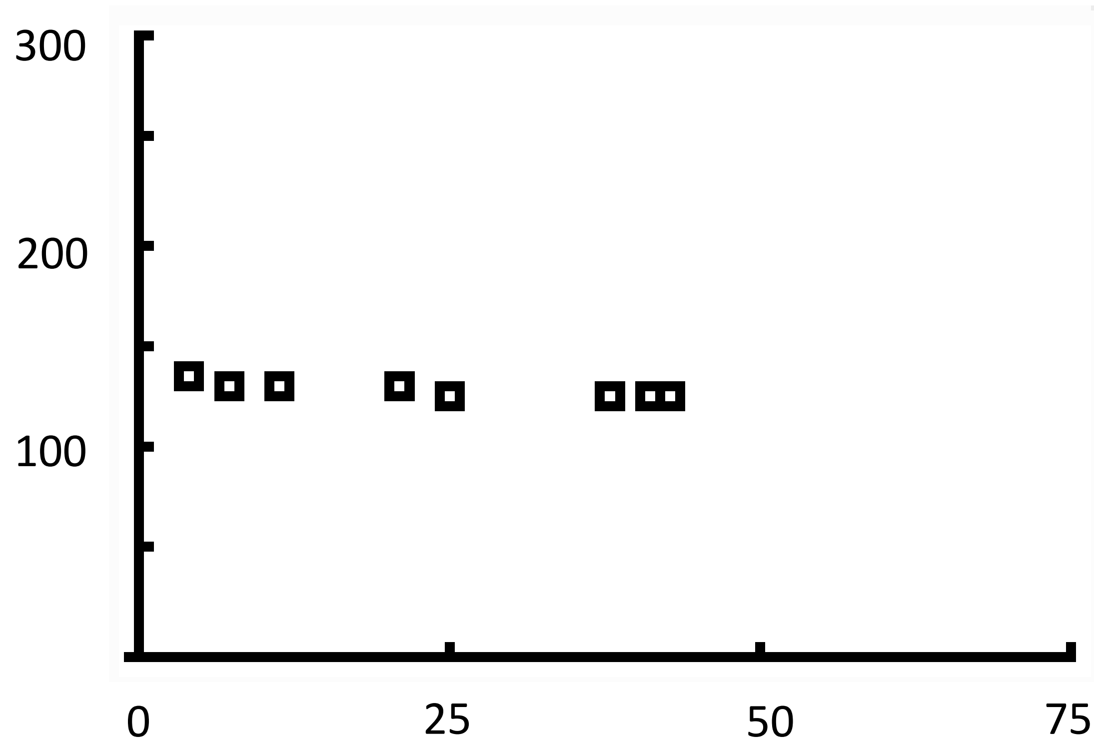
Ymin = -1

Ymax = 300

Yscl = 50

Men’s “world best” times for the marathon

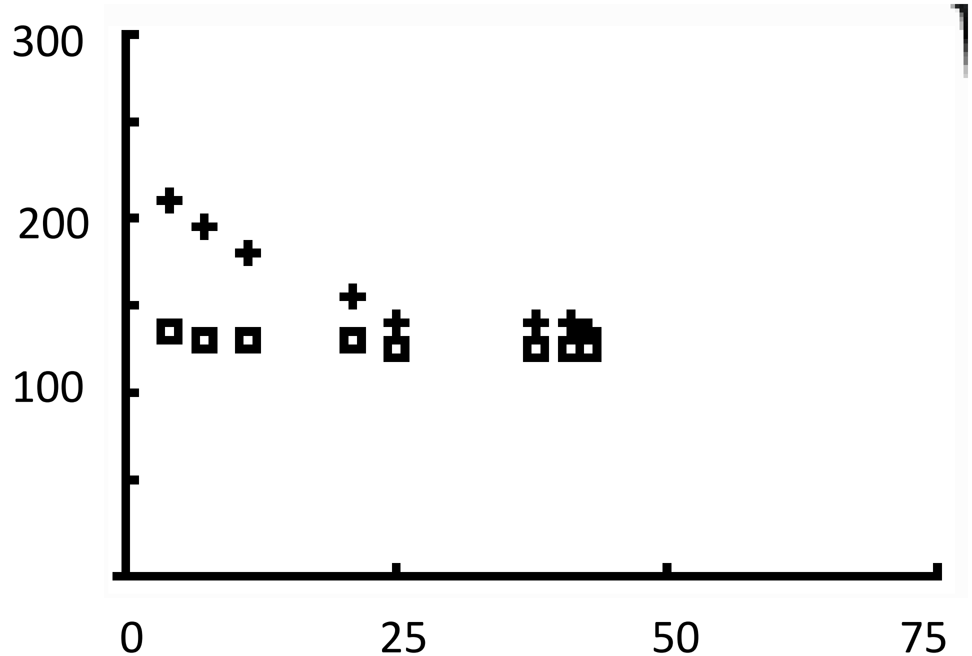
Number of minutes for the marathon (men)



Number of years after 1960

Men’s (▫) and women’s (+) “world best” times for the marathon

Number of minutes for the marathon



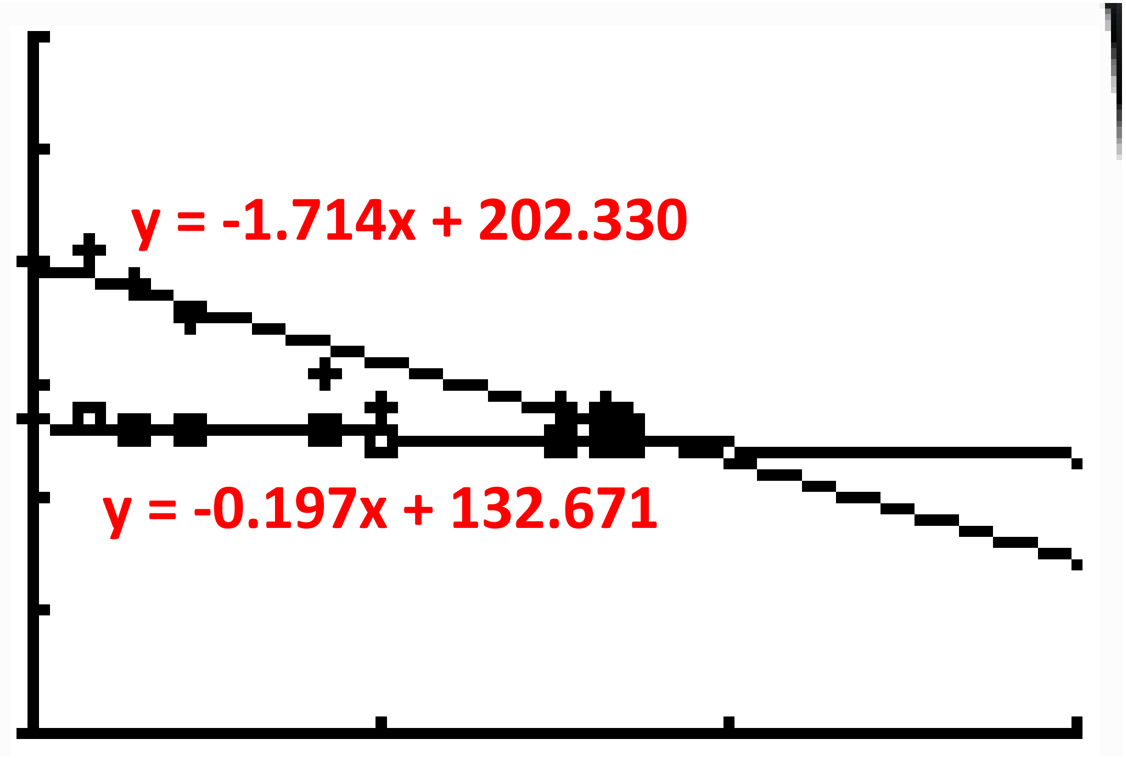
Number of years after 1960

```
LinReg
 y=ax+b
 a=⁻.1966734753
 b=132.670995
```

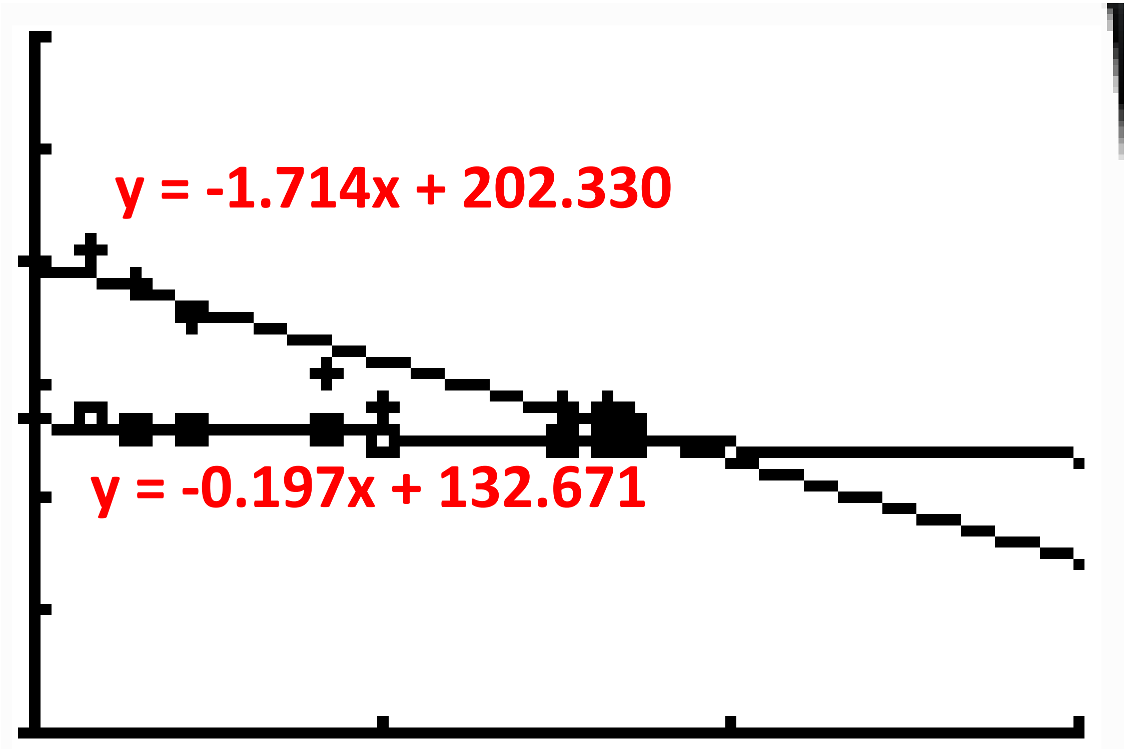
```
 Plot1  Plot2  Plot3
\Y1=█.1966734753
4287X+132.670995
03939
 :
```

LinReg
y=ax+b
a=⁻1.713889699
b=202.3298804

Plot1 Plot2 Plot3
\ Y_1 = ⁻.19667347534287X+132.67099503939
\ Y_2 = ⁻1.7138896994456X+202.32988036183

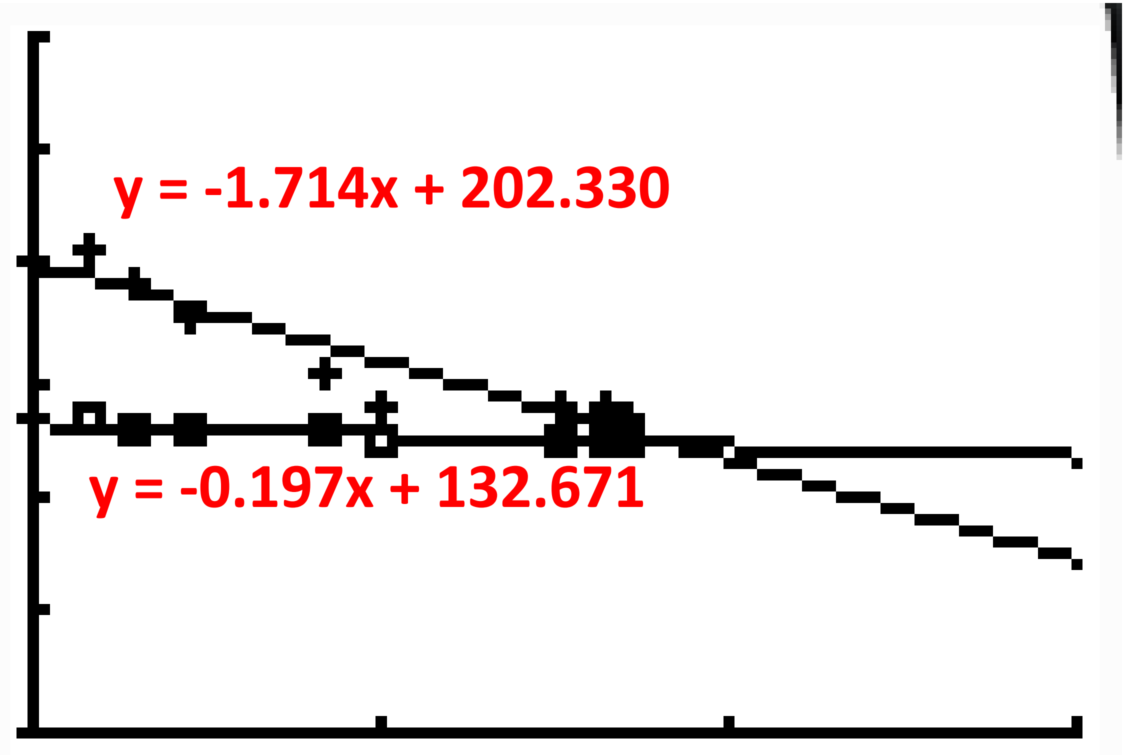


y = mx + b, where m is the slope and b is the y-intercept



What is the MEANING of the slope, in this context?

What is the MEANING of the y-intercept, in this context?



Calculate the point of intersection of the lines.

(45.9, 123.6)

(45.9, 123.6)

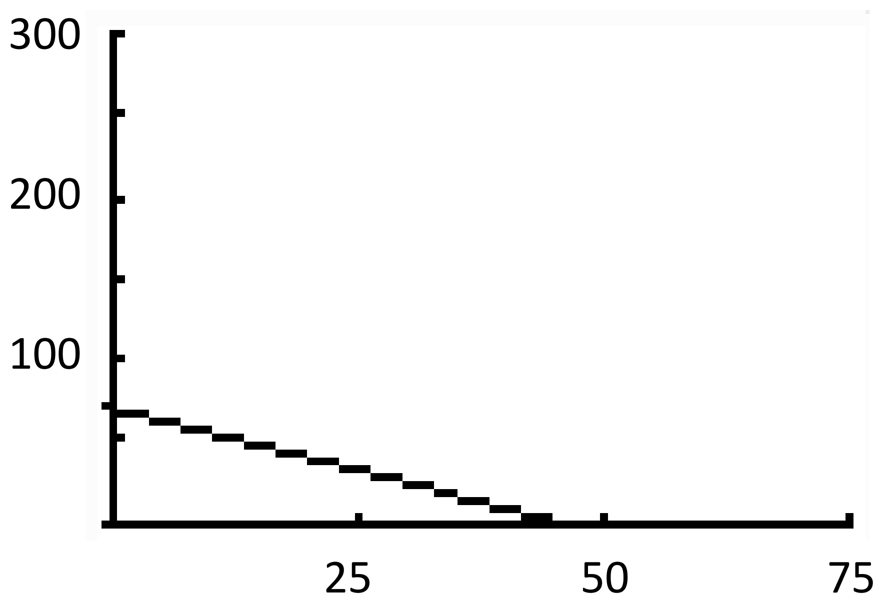
What is the MEANING of the point of intersection, in this context?

It means that 45.9 years after 1960
(in other words, late in 2005),
the world-best time for men will be
(would be) the same as the world-best
time for women, 123.6 minutes.

If we were to look at the gaps in times between men and women through the years, what would you expect to see?

Gap in marathon times, men vs. women

Gap (Number of minutes)



Number of years after 1960

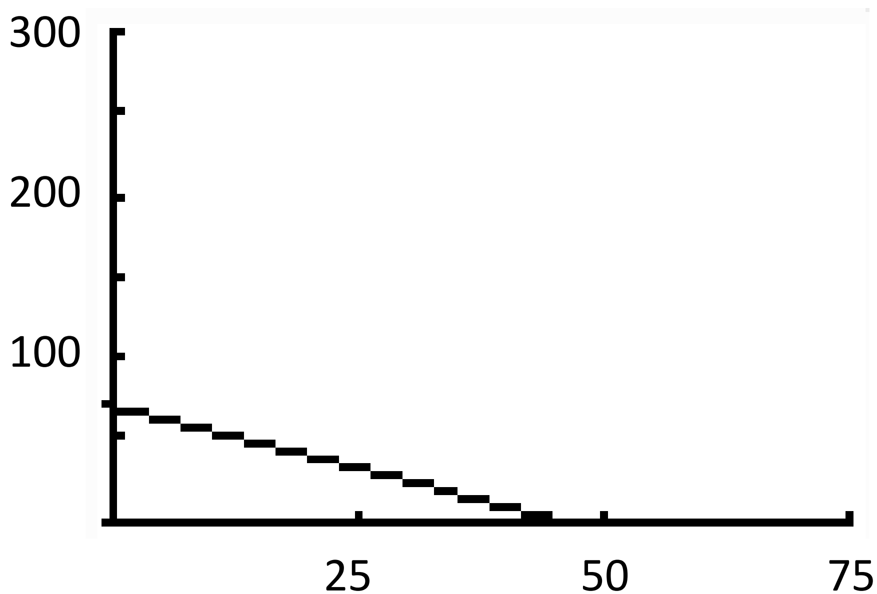
Number of years after 1960	Number of minutes for marathon (men)	Number of minutes for marathon (women)	Gap between men's and women's times (# of minutes)
L1	L2	L3	L4
4	133	207	74
7	132	195	63
11	129	181	52
21	128	155	27
25	127	142	15
38	126	140	14
41	125	138	13
43	124	135	11

L4(8) =11

LinReg
y=ax+b
a=⁻1.517216224
b=69.65888532

Gap in marathon times, men vs. women

Gap (Number of minutes)

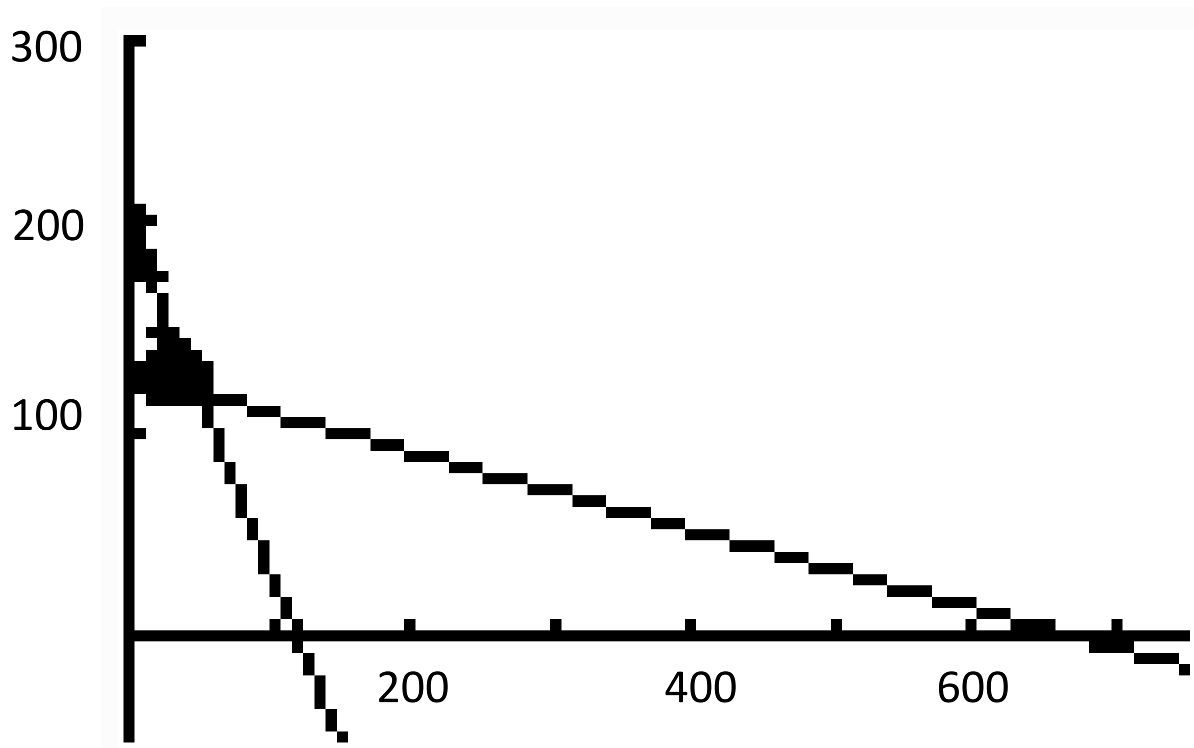


Number of years after 1960

Let’s look at the zeros of the graphs.
Think about what that means.

WINDOW
Xmin=-1
Xmax=750
Xscl=100
Ymin=-50
Ymax=300
Yscl=100

Number of minutes for the marathon



Number of years after 1960

Calculate the zeros of the graphs.
What do the zeros mean in this context?

For women, the zero is at (118.1, 0).

This means that 118 years after 1960 (or, in the year 2078), women will run the marathon in zero minutes.

Calculate the zeros of the graphs. What do they mean in this context?

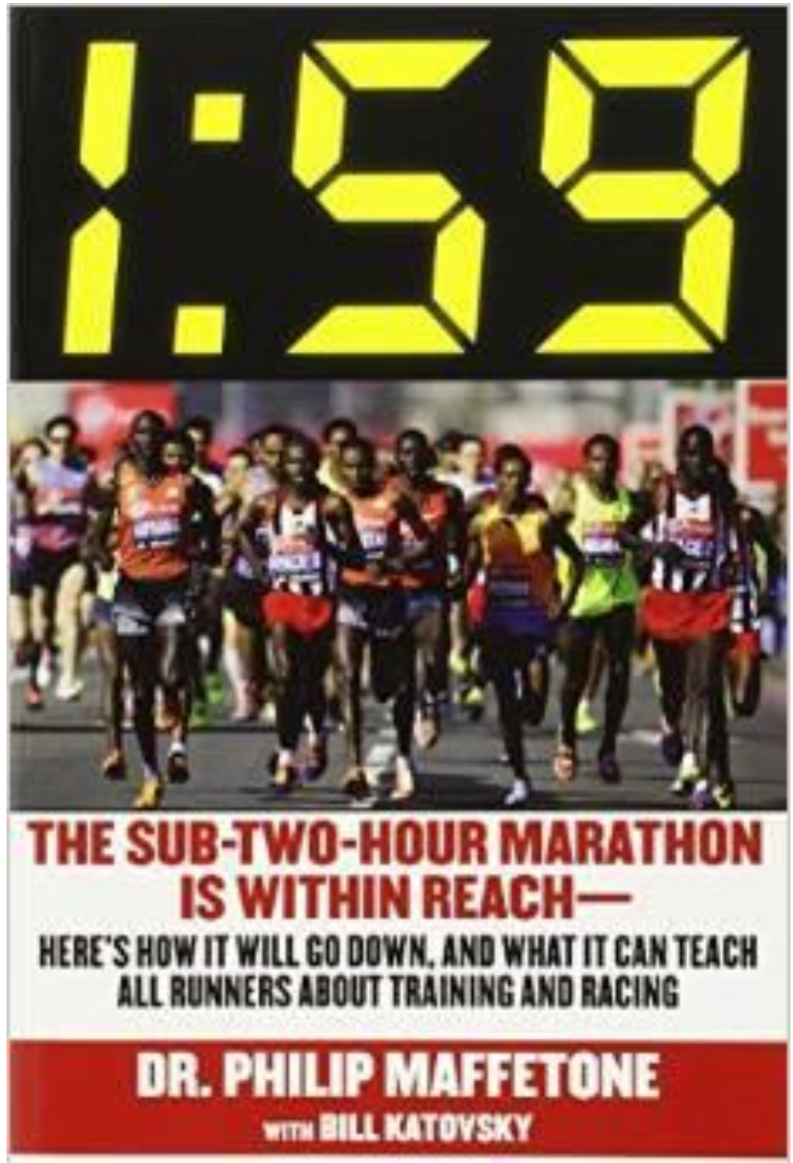
For men, the zero is at (674.6, 0).

This means that 674 years after 1960 (or, in the year 2634), men will run the marathon in zero minutes.

Comment on how accurate you think this model is.

Why do you have that opinion?

What might be a better model?


1:59
THE SUB-TWO-HOUR MARATHON IS WITHIN REACH—
HERE'S HOW IT WILL GO DOWN, AND WHAT IT CAN TEACH ALL RUNNERS ABOUT TRAINING AND RACING
DR. PHILIP MAFFETONE
WITH BILL KATOVSKY

The following quotes are from chapter 12, “Women”:

“When the modern Olympics began in Athens in 1896… distance running by women was thought to be un-ladylike, a violation of natural law. The common wisdom held that a woman was not physiologically capable of running mile after mile; that she wouldn’t be able to bear children; that her uterus would fall out; that she might grow a mustache…”

“… in 2014, Rita Jeptoo of Kenya became a three-time winner at the Boston Marathon by going 2:18:57, which beat the course record by almost two full minutes… she ran the 24th mile in 4:49…”

“(Women) are indeed physiologically capable of going sub-two hours.”

“In races longer than the marathon, women have outperformed men in winning overall. Ultra-marathoner Ann Trason has won several 150-mile events outright.”

“… studies show that their diaphragm muscle, which pulls air in and out of the lungs, is more resistant to fatigue compared to men”

“Studies have also shown that a female athlete’s muscular system has greater endurance capacity than men’s.”

“… don’t assume the current 10 to 12 percent lag time with male marathoners will continue indefinitely. Instead, expect women’s world-record times in the coming years to start decreasing at a faster rate than men’s.”

Implement tasks that promote reasoning and problem solving
Teacher and student actions

What are *teachers* doing?	What are *students* doing?
Motivating students' learning of mathematics through opportunities for exploring and solving problems that build on and extend their current mathematical understanding. Selecting tasks that provide multiple entry points through the use of varied tools and representations. Posing tasks on a regular basis that require a high level of cognitive demand. Supporting students in exploring tasks without taking over student thinking. Encouraging students to use varied approaches and strategies to make sense of and solve tasks.	Persevering in exploring and reasoning through tasks. Taking responsibility for making sense of tasks by drawing on and making connections with their prior understanding and ideas. Using tools and representations as needed to support their thinking and problem solving. Accepting and expecting that their classmates will use a variety of solution approaches and that they will discuss and justify their strategies to one another.

Pose purposeful questions Teacher and student actions	
What are *teachers* doing?	**What are *students* doing?**
Advancing student understanding by asking questions that build on, but do not take over or funnel, student thinking. Making certain to ask questions that go beyond gathering information to probing thinking and requiring explanation and justification. Asking intentional questions that make the mathematics more visible and accessible for student examination and discussion. Allowing sufficient wait time so that more students can formulate and offer responses.	Expecting to be asked to explain, clarify, and elaborate on their thinking. Thinking carefully about how to present their responses to questions clearly, without rushing to respond quickly. Reflecting on and justifying their reasoning, not simply providing answers. Listening to, commenting on, and questioning the contributions of their classmates.

Expectations for students	Teacher actions to support students	Classroom-based indicators of success
Most tasks that promote reasoning and problem solving take time to solve, and frustration may occur, but perseverance in the face of initial difficulty is important.	Use tasks that promote reasoning and problem solving; explicitly encourage students to persevere; find ways to support students without removing all the challenges in a task.	Students are engaged in the tasks and do not give up. The teacher supports students when they are "stuck" but does so in a way that keeps the thinking and reasoning at a high level.
Correct solutions are important, but so is being able to explain and discuss how one thought about and solved particular tasks.	Ask students to explain and justify how they solved a task. Value the quality of the explanation as much as the final solution.	Students explain how they solved a task and provide mathematical justifications for their reasoning.
Everyone has a responsibility and an obligation to make sense of mathematics by asking questions of peers and the teacher when he or she does not understand.	Give students the opportunity to discuss and determine the validity and appropriateness of strategies and solutions.	Students question and critique the reasoning of their peers and reflect on their own understanding.

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Conference Handouts and Resources

Marathon times