When the fast came too fast

How a 40-minute delay brought in Taanis Esther 5 hours early

Please note: The numbers in this article are approximate and intended for illustration purposes only.

Travelers from Tel Aviv to New York on the morning of Taanis Esther 5774 were informed by MyZmanim Air™ inFlight Zmanim that if the flight departs at 1:00 AM the fast begins at 10:25 AM, but if it departs at 1:40 AM the fast begins at 5:40 AM. Many wondered: Why would a *delay* in the time of takeoff cause the fast begin *earlier*? Also, how could a delay of only *40 minutes* account for a *5 hour* change in when the fast begins? In the following article we will explain why this is so.

Imagine that Reuven and Shimon are running in a marathon. Shimon runs 15 MPH (miles per hour) but Reuven runs only 9 MPH. Reuven is given a head-start and begins the marathon 32 miles ahead of Shimon.

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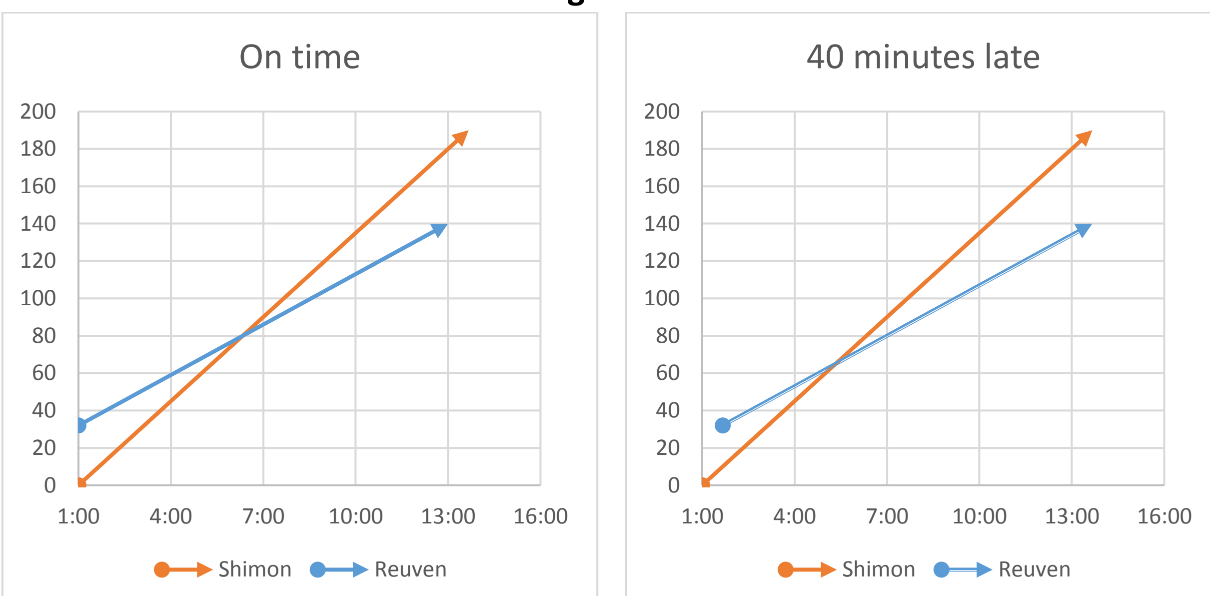
Using the graphs in **Figure #1**, you can check the distance covered by Reuven and Shimon at any moment. The moment at which Shimon passes Reuven is indicated by the point where the lines intersect.

For example, you can see that if Reuven begins running "on time" at 1:00 AM (the graph on the left) then by 4:00 AM he will have covered a total distance of about 60 miles (32 + 27 = 59). If Reuven begins running "40 minutes late" at 1:40 AM (the graph on the right) then by 7:00 AM he will have covered a total distance of 80 miles (32 + 48 = 80). Either way, by 1:00 PM Shimon will have run 180 miles (15 MPH x 12 hours).

Notice that when both begin running at 1:00 AM, Shimon passes Reuven at 6:20 AM. But when Reuven begins 40 minutes late, he is overtaken by Shimon at 5:22 AM.

Figure #1



Both begin running at 1:00 AM. Shimon passes Reuven at 6:20 AM.

Shimon begins at 1:00 AM, Reuven begins at 1:40 AM. Shimon passes Reuven at 5:22 AM.

On time

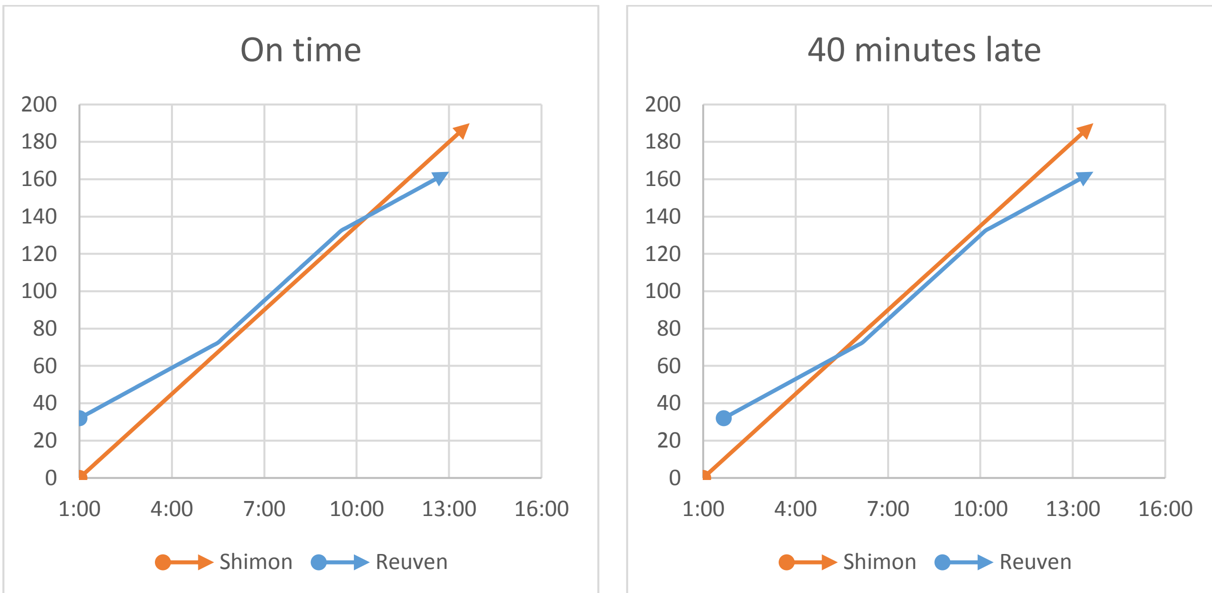
Timespan	Hours	Miles covered by **Reuven** (9 MPH)		Miles covered by **Shimon** (15 MPH)
Head start	0	32		0
1:00 to 6:20	$5.\overline{3}$	48		80
TOTAL		**80**	**=**	**80**

40 minutes late

Timespan	Hours	Miles covered by **Reuven** (9 MPH)		Miles covered by **Shimon** (15 MPH)
Head start	0	32		0
1:00 to 1:40	$0.\overline{6}$	0		10
1:40 to 5:22	3.7	~33.5		55.5
TOTAL		**65.5**	**=**	**65.5**

Now suppose, after running for 4.5 hours, Reuven gets a burst of adrenaline and is now running as fast as Shimon (15 MPH). 4 hours later, Reuven is no longer able to sustain this pace and slows back down to his initial 9 MPH. The graphs in **Figure #2** show that when they both start running at 1:00 AM Shimon passes Reuven at 10:18 AM. But when Reuven starts running 40 minutes late at 1:40 AM, he is overtaken by Shimon at 5:18 AM. Because Reuven began a mere **40 minutes** late, he will be overtaken **5 hours** earlier!

Figure #2



Both begin the marathon at 1:00 AM. Shimon passes Reuven at 10:18 AM.

Shimon begins at 1:00 AM, Reuven begins at 1:40 AM. Shimon passes Reuven at 5:18 AM.

On time

Timespan	Hours	Miles covered by **Reuven** (9,15,9)		Miles covered by **Shimon** (15 MPH)
Head start		32		0
1:00 to 5:30	4.5	40.5		67.5
5:30 to 9:30	4.0	60		60
9:30 to 10:18	0.8	~7		12
TOTAL		**139.5**	**=**	**139.5**

40 minutes late

Timespan	Hours	Miles covered by **Reuven** (9,15,9)		Miles covered by **Shimon** (15 MPH)
Head start		32		0
1:00 to 1:40	$0.\overline{6}$	0		10
1:40 to 5:18	$3.6\overline{3}$	~32.5		54.5
TOTAL		**64.5**	**=**	**64.5**

Keeping all numbers the same, let's replace Reuven and Shimon with an aircraft and the zman of Alos Hashachar, respectively. Alos Hashachar is "running" westbound at a rate of 15 degrees of longitude per hour. The aircraft is also traveling westbound, but at varying rates. During the beginning segment of the flight, the aircraft travels at a rate of 9° / hr (ie. 9 degrees of longitude per hour). During the middle segment its rate is 15° / hr, and during the final segment its rate returns to 9° / hr. The aircraft is given a "head start" by virtue of the fact that it departs from Tel Aviv which is geographically located 32 degrees "ahead" of the place where Alos Hashachar occurs at 1:00 AM.

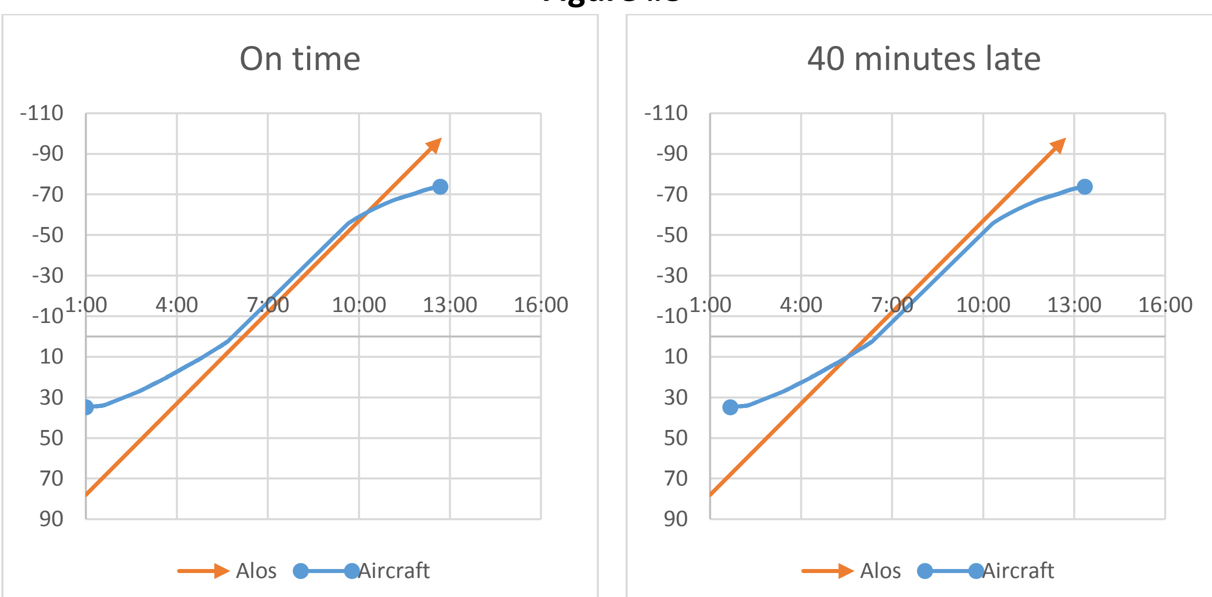
The moment at which Alos Hashachar "passes" the aircraft is when the fast begins for the passengers. Hence, if the takeoff is at 1:00 AM, the fast begins 10:18 AM. But if the flight is delayed 40 minutes, the fast begins 5:18 AM.

Finally, we must account for the fact that the change in travel rate occurs *gradually* rather than *abruptly*.

The graphs in **Figure #3** are based on actual data which MyZmanim™ collected for an arbitrary El Al flight. These graphs allow you to check the current longitude position of Alos Hashachar and our aircraft for any moment. For example, we can see that if takeoff was delayed 40 minutes, at 10:00 AM the aircraft will be at longitude -50°. In this figure, the first and final segments of the trip appear *curved* rather than *straight*. This reflects the reality that the aircraft travel rate transitions *gradually* from 9° / hr to 15° / hr and back to 9° / hr.

Also depicted is the fact that the fast beginsa at 10:25 AM if takeoff is on time, and at 5:40 AM if takeoff is delayed 40 minutes.

Figure #3



Takeoff is on time. Fast begins at 10:25 AM.

Takeoff is delayed 40 minutes. Fast begins at 5:40 AM.

You may be wondering: If the aircraft cruise speed remains a constant 600 MPH throughout its journey, why does its *degrees*-per-hour rate vary?

The answer lies in the fact that the aircraft's direction of travel varies throughout the journey. Lines of longitude are crossed only when traveling east and west but not when traveling north and south. Therefore, the same 600 miles covered each hour represents a greater longitude distance when traveling directly West (during the middle segment of the trip) than when traveling North-West and South-West (during the first and final segments of the trip).