

The dates of Hanukkah are so irregular!

Hanukkah begins this year on Sunday evening, November 28th. This date seems really early compared to last year. Why isn't the date the same every year?

Actually, Hanukkah is always at the same date on the Hebrew calendar ... the 25th of Kislev. So maybe the real issue is the Hebrew calendar.

There are many calendars used in our world today. In the U.S. we use the Gregorian calendar. The Gregorian calendar deals only with the seasons and the Earth's revolution around the Sun. Many of the world's other calendars align the motion of the Sun and the Moon with the calendar. The Hebrew calendar is one of those. Calendars that align the motion of the Sun and the Moon are called luni-solar calendars. It is quite a mathematical feat to create a calendar that has months beginning with the rising moon and a year that coincides with one complete Earth revolution around the Sun.



Let's do some of the math.

- A synodic month is the measurement in time from new moon to new moon. It is **29.53 days** (29 days, 12 hours, 44 minutes, 2.8 seconds)
 - A solar year is 365 days 5 hours 48 minutes 46 seconds long or **365.242199** days.
1. Divide the number of days in a year (use the exact number given above) by the number of days in a lunar month (again use the exact figure) to determine how many lunar months there are in a year. Is that what you expected? Please explain.

If our calendar were arranged by lunar months alone (from new moon to new moon) there would be more than 12 months in a solar year but not 13 months.

The Gregorian calendar has only 12 months. The months have a range of numbers of days and we even add a day to the year every 4 years – during leap year.

Month	Days in a regular year	Days in a leap year
January	31	31
February	28	29
March	31	31
April	30	30
May	30	30
June	31	31
July	31	31
August	31	31
September	30	30
October	31	31
November	30	30
December	31	31
	total days = 365	total days = 366

So the Gregorian calendar has a 4-year cycle ... 3 regular years + 1 leap year.

2. How many days are in one whole 4-year Gregorian cycle?
3. How many months are in one 4-year cycle?
4. Using the above numbers, find the mean number of days in a Gregorian month.

5. How close is your answer to the last question to the synodic month calculation?

In the Hebrew calendar there are also 12 months ... usually. Instead of having a 4-year cycle with one leap year like the Gregorian calendar, the Hebrew calendar has a 19-year cycle with 7 leap years. On leap years, a month of 30 days is added and that is called the month of Adar I.

There is some variance in the number of days in each month. A year is deemed deficient, regular, or complete. The number of days per month in each sort of year is listed below.

- In a regular year the number of days alternates between 30 and 29.
- A complete year is created by adding a day to Heshvan.
- A deficient year is created by removing a day from Kislev.

The alternation of 30 and 29 ensures that when the year starts with a new moon, so does each month.

month	days in a regular year	days in a complete year	days in a deficient year	days in a leap year
ניסן — Nisan	30	30	30	30
אייר — Iyyar	29	29	29	29
סיון — Sivan	30	30	30	30
תמוז — Tammuz	29	29	29	29
אב — Av	30	30	30	30
אלול — Elul	29	29	29	29
תשרי — Tishri	30	30	30	30
חשוון — Cheshvan	29	30	29	29 or 30
כסלו — Kislev	30	30	29	30 or 29
טבת — Tevet	29	29	29	29
שבט — Sh'vat	30	30	30	30
אדר — Adar	29	29	29	Adar I 30
				Adar II 29
total days =	354	355	353	383, 384, or 385

In the Hebrew calendar's 19-year cycle there are leap years on the 3rd year, 6th, 8th, 11th, 14th, 17th, and 19th years.

This is Hebrew year of 5782. By this the Hebrews meant that the world was created 5,782 years ago. If I want to see where this year is in the 19-year cycle, I'll need to divide 5782 by 19 and pay attention to the division remainder.

6. Try to remember long division and do this mathematics by hand. Divide 5782 by 19 and show your remainder.

I got that the quotient was 304 with remainder of 6. According to what I've read I should treat that calculation as 304 cycles with a remainder of 6 years. So, there have been 304 cycles of 19 years completed and we are now in the sixth year of the 19-year cycle. It is a leap year and there will be 13 months in this Hebrew calendar year.

Here's the present nineteen-year cycle

Hebrew year	where in the 19-year cycle	number of months	days in the year
5779	$5779/19 = 304 + R = 3$ (So a leap year)	13	385
5780	$5780/19 = 304 + R = 4$	12	353
5781	$5781/19 = 304 + R = 5$	12	354
5782	$5782/19 = 304 + R = 6$ leap year	13	385
5783	$5783/19 = 304 + R = 7$	12	355
5784	$5784/19 = 304 + R = 8$ leap year	13	383

5785	$5785/19 = 304 + R = 9$	12	354
5786	$5786/19 = 304 + R = 10$	12	355
5787	$5787/19 = 304 + R = 11$ leap year	13	383
5788	$5788/19 = 304 + R = 12$	12	354
5789	$5789/19 = 304 + R = 13$	12	355
5790	$5790/19 = 304 + R = 14$ leap year	13	385
5791	$5791/19 = 304 + R = 15$	12	354
5792	$5792/19 = 304 + R = 16$	12	353
5793	$5793/19 = 304 + R = 17$ leap year	13	385
5794	$5794/19 = 304 + R = 18$	12	354
5795	$5795/19 = 304 + R = 19$ leap year	13	385
	Totals	235	6,941

I've totaled the number of months and days in the present 19-year cycle for you to use.

7. Calculate the average number of days in one month for the whole 19-year cycle.

8. How close is the Hebrew calendar's mean days per month to the synodic month calculation? Please explain your thoughts on how close the Hebrew calendar's approximation is to the moon's actual timing.

So, I guess Hanukkah's date only seems weird to me this year because I haven't been aware of the cycles of the Hebrew calendar. But now that I am, I'm going to look for patterns.

Hebrew year	1 st evening of Hanukkah, Gregorian	cycle year
5779	December 2, 2018	3 leap year
5780	December 22, 2019	4
5781	December 10, 2020	5
5782	November 28, 2021	6 leap year
5783	December 18, 2022	7
5784	December 7, 2023	8 leap year
5785	December 25, 2024	9
5786	December 14, 2025	10
5787	December 4, 2026	11 leap year
5788	December 24, 2027	12
5789	December 12, 2028	13
5790	December 2, 2029	14 leap year
5791	December 20, 2030	15
5792	December 10, 2031	16
5793	November 28, 2032	17 leap year
5794	December 17, 2033	18
5795	December 7, 2034	19 leap year
5796	December 26, 2035	1
5797	December 14, 2036	2
5798	December 3, 2037	3 leap year
5799	December 22, 2038	4
5800	December 12, 2039	5
5801	November 30, 2040	6 leap year

9. Above are the dates of Hanukkah for about the next 20 years. Do you see any patterns?

December 22, 2019		4
December 10, 2020		5
November 28, 2021		6 leap year
December 18, 2022		7

Usually each date is 10, 11, or 12 days sooner than the last year's date on the Gregorian calendar. Since every leap year you will be adding one 30-day month, the year that follows a leap year's date for Hanukkah falls 30 days later than is usual.

Students may have other valuable observations. Enjoy the discussions.

December 7, 2023		8 leap year
December 25, 2024		9
December 14, 2025		10
December 4, 2026		11 leap year
December 24, 2027		12
December 12, 2028		13
December 2, 2029		14 leap year
December 21, 2030		15
December 10, 2031		16
November 28, 2032		17 leap year
December 17, 2033		18
December 7, 2034		19 leap year
December 26, 2035		1
December 14, 2036		2
December 3, 2037		3 leap year
December 22, 2038		4
December 12, 2039		5
November 30, 2040		6 leap year
December 18, 2041		7

Happy Hanukkah to you all!

Sources:

<http://www.calendar-origins.com/calendar-origins.html>

http://www.jewishgen.org/infofiles/m_calint.htm

<http://www.fourmilab.ch/documents/calendar/>

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