Birthday Day POW: - The trials and **ERRORS.**

Problem Statement:

If you wanted to find the day of the week you were born, you may have to scroll back in calendars for a large amount of time. To combat this, we created a mathematical equation that finds the day of the week you were born, based on your numerical birthday, for any birthday occurring on/after Jan. 1 1900.

Process

We initially thought to analyze the relationship between the same dates in different months, e.g. To get from Oct. 5th, 2025, to Sept. 5th, subtract 30. We determined 30 for subtraction as there are 30 days in September. Additionally, we realized that the days in the months are mod(z), z being the given amount of days per month. However, we realized that mod(z) would be dependent on month days, which is inconsistent across the year, and thus inefficient. We instead switched to looking at a year as a whole, rather than per month.

We also tried to base our answer based on the current year, however this is guaranteed to change as time passes, making it an ineffective solution. Therefore we used the minimum year required (1900) as our "starting point".

We realized this did not account for leap years, which would throw off our answer significantly. We then tried to find the number of leap years that would have occurred between 1900 - birth years by dividing by 4. However, during testing, this left us with a fractional number (e.g. 1971 would be 17.25). This was not applicable as either the leap day had occurred, or it had not. (See solution for modular solution for this).

As we tested more dates, we noticed an issue that arose with dates before and of the leap day on leap years (Feb 29). The equation would not output the correct number for the day of the week. To find a solution, we tested a variety of dates to see if we could find a pattern. We found that the output of our equation for these special birthdays would produce the correct number *after* we add one. (See solution to see how we fixed this issue)

Solution

$$(365y + \frac{y-(y\%4)}{4} + B_t)\ \%7 = \text{Day Born}$$

(*above: subtract 1 if your birthday falls on a special birthday day**)

$$y = B_y - 1900$$
$$B_t = B_d + D_c$$

B_y = Birth year
B_t = Total # of days since birthday
D_c = Corresponding number based on month born (see Chart 1)
B_d = Day of month born
% = Mod
*= Special birthdays are birthdays that fall before or on the leap day of a leap year (Feb 29th).

For our solution, we've narrowed the process down to three simple equations, which is shown in the space above. First we solved for y, your birth year minus 1900. Let's take Michelle Obama's birthday; January 17, 1964.

$$y_O = 1964 - 1900 = 64.$$

Keep in mind that this equation only solves the birthday days of people born *after* 1900. Additionally, since we are solving for the birthday days after 1900, our first leap year is a multiple of four.

Next, we multiplied y by 365 to convert from years to days. To calculate additional days from leap years, we found mod 4 of B_y - 1900, to identify any leftover years that were not yet enough for an additional day (e.g. 1971: 71 mod 4 = 3). We then subtracted the excess from the total and divided it by 4. This found the number of leap years that had passed, which was equivalent to the number of leap days, as one leap year = one leap day. Finally, add your B_d found using the chart below. On leap years, any birthdays before February 29th must have to subtract one from the found leap days, as the leap day for that birth year had not yet passed. Since Michelle Obama was born before Feb 29, we subtracted one from hers (17 - 1 = 16).

$$365 * y_O = 23360$$

$$23360 + \frac{y_o - (y_o \% 4)}{4} + 16 = 23392$$

Finally, find mod(7)23378 = 5

This output can be translated into a day of the week using Chart 2. As you can see, 5 correlates to Friday. We 0-indexed our chart based on what day of the week Jan. 1st, 1900 was (Sunday).

Chart 1: Finds the number of days till your birthday from January 1st of the same year.

	Total Days To Add (Expanded)	Total Days to Add (Condensed)
January	x	x
Feburary	31 + x	31 + x
March	31 + 28 + x	59 + x
April	31 + 28 + 31 + x	90 + x
May	31 + 28 + 31 + 30 + x	120 + x
June	31 + 28 + 31 + 30 + 31 + x	151 + x
July	31 + 28 + 31 + 30 + 31 + 30 + x	181 + x
August	31+ 28 + 31 + 30 + 31 + 30 + 31 + x	212 + x
September	31+ 28 + 31 + 30 + 31 + 30 + 31 + 31 +x	243 + x
October	31+ 28 + 31 + 30 + 31 + 30 + 31 + 31 + 30 + x	273 + x
Novemeber	31+ 28 + 31 + 30 + 31 + 30 + 31 + 31 + 30 + 31 + x	304 + x
December	31+ 28 + 31 + 30 + 31 + 30 + 31 + 31 + 30 + 31 + 30 + x	334 + x

$B_t = B_d + D_c$
$B_d = x$ *within this chart*

Chart 2: Key for interpreting the equation

Corresponding Day	Output
Sunday	0
Monday	1
Tuesday	2
Wednesday	3
Thursday	4
Friday	5
Saturday	6

Extension

1. How would the equation change if it was to account for years before 1900?
2. Create an equation to calculate the number of days, hours, minutes, seconds someone has been alive for from their birthday date and year.
3. Find the day that someone was born in terms of months or years rather than days.
4. How can we account for special birthdays in the equation?