Problem Restatement:

Create a set of steps that allow a person to find the day of the week they were born in, considering they were born in the year 1901 or after. It should not use any mathematical ability besides using a basic four-function calculator. Your only tool is the calendar of the current month.

OCTOBER 2024						
SUN	MON	TUE	WED	THU	FRI	SAT
		1	2	3	4	5
6	7	8	9	10	11	12
13	14 Columbus Day	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31 Halloween		

Process:

At first, we were trying to find a pattern for the day of the week using one of our group members' birthdays. We've noticed that every year, the day of the week would be shifted by 1 (ex: if October 1st, 2022, is a Saturday, then October 1st, 2023, is a Sunday). We also noticed that the difference in the years we are comparing (considering the date is the same) is related to the number of days we need to go back to find out the day of the date. However, we realized this rule doesn't apply when the difference between the years involves a leap year. We needed to subtract an extra day (depending on if the date was before or after the leap year). We ended up finding out that every 28 years (7 days in a week and 4 years per leap year play into this), the pattern of days a date will land on repeats. This proved to not have any effect on our solution, but it's we think it's a cool fact.

We knew that 7 (days of the week) and 4 (years per leap year) would be numbers needed in our solution. Mrs. Burns helped us to account for leap years as we usually had a few days off with our algorithm. Using this, we were able to apply the concept of modular arithmetic (in mod 7) and division by 4 (to find the number of leap years from the birthday to now) to come up with our solution.

For our solution to work, we first needed a reference day. We chose January 1, 2024, to be our reference day because all birthdays can be calculated easily from that day as it's the

first day in the year. To determine what day January 1, 2024, would be, we used our October 2024 calendar. Knowing October 25, 2024, is a Friday, we found the number of days between October 25 and January 1, which was 299 days. We then divided by 7 and found the remainder, which was 5. Counting backwards 5 days from Friday, we found that January 1, 2024, was a Monday.

Using this technique, we were able to come up with our solution. If we use January 1, 2024, as a reference day, for our solution to work the person first needs to figure out was day January 1 was on the year they were born. This can be done by finding the number of times the day has shifted (how many years have passed, accounting for leap years) and dividing this number by 7 to find the remainder. This remainder would then be how many days backwards you must move to find the day of January 1 in the birth year. Then, to figure out the day they were born on, a similar technique is used. By finding the number of days between January 1 and the birthday and dividing by 7 to find the remainder, we find the number of days forward the birthday will have shifted from January 1 by using this remainder as it shows how far along the week cycle has been completed.

Solution:

1. Subtract your birth year from 2024.

2. Take this difference and divide it by 4. Round down the answer if the result is a decimal. This is done to find the number of leap years you have lived through.

3. Add the answers from step 1 and step 2.

Ex)

Step 1: 2024 – 2006 = 18

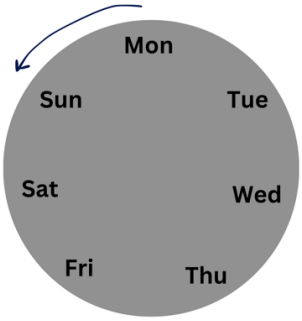
Step 2: 18/4 = 4.5→4

Step 3: 18+4 = 22

4. Divide the answer from step 3 by 7 and take the remainder

5. Count backwards from Monday based on the remainder

Refer to the days of the week cycle below:



Ex)

Step 4: 22/7 = 3 remainder 1

Step 5: One day backwards from Monday is Sunday. Using this, we get Sunday.

6. Figure out the number of days between January 1st and your birthday in the year you were born, not including your actual birthday day. If you were born in a year that was a leap year, account for the extra day in February.

Refer to the chart:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31	28*	31	30	31	30	31	31	30	31	30	31

*Feb has 29 on a leap year

Ex) January 1, 2006 – March 6, 2006

Step 6: 31+28+5= 64 days

7. Divide this number by 7 and find the remainder

8. Based on the remainder found in step 7, count forward that many days from the day determined in step 5

Ex)

Step 7: 64/7 = 9 remainder 1

Step 8: 1 day forward from Sunday is Monday

9. The day you got in step 8 is the day you were born on!

Extensions:

Imagine a fantasy land where January 1st, 2001, is a Monday. But every subsequent year is one day shorter (Year 2001 + *n* is 365 - *n* days long). 2001 is 365 days, and there are no leap years. Which year is only one day long, and what day of the week is it on that day?

Solution:

Let the sum of all days until the world ends be S.

S = 365 + (365 – 1) + (365 – 2) + (365 – 3) + … + (365 – 363) + (365 – 364)

This can be rearranged to:

S = 1 + 2 + 3 + 4 + … + 364 + 365

The sum of the first n natural numbers, where n is the number of terms, is:

(n / 2) * (n + 1)

S = (365 / 2) * (365 + 1) = 66795

Taking the total number of days mod 7 would give how many days after Monday the last day is.

66795 % 7 = 1

1 day after Monday is Tuesday. Thus, the last day is a **Tuesday**.

This would be the year **2365** because after 364 years, the years would only be one day long. The starting year (2001) plus the number of years that passes (364) is 2365.