

## **Problem Statement**

Using just the four base operations (+, -, ×, ÷), the number of days in each month, and a calendar of October 2024, how would you make a set of instructions for anyone to be able to find the day of the week they were born on?

## **Process**

We first realized that it would be very helpful to find the date of one's birthday in the current year. We tried different strategies to figure this out, such as finding the number of days that the birthday was from October 1<sup>st</sup> (a date we already knew), but soon realized that it would be very complicated to do this. Instead, we decided on making a table that contained the day of the week of all the 1<sup>sts</sup> of the months (Jan, Feb, etc.). Once we had this, it was very easy to find the date of one's birthday in 2024. Then, we realized that it would be possible to find how many days of the week the birthday has changed over the years. This information led us to formulate a plan for finding one's birthday given just the above.

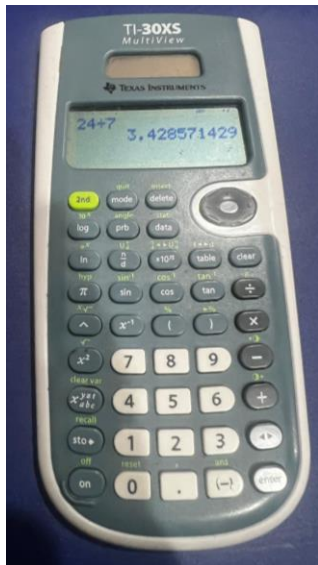
## **Solution**

Step 1: Using the table below,

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1 <sup>st</sup> of month	Mond ay	Thur sday	Friday	Mon day	Wednes day	Saturday	Mon day	Thurs day	Sunday	Tues day	Friday	Sunday

We can determine the day of the week of your birthday this year. To do this, we should first find the 1<sup>st</sup> of the month you were born. For example, if you were born in October, you would see that October 1<sup>st</sup> fell on a Tuesday in 2024. Next, you would take the number of the day you were born, subtract 1, and find the remainder when dividing by 7. For example, if you were born on October 25<sup>th</sup>, you would find the remainder of 25 minus 1, which is 24, and then divide by 7.

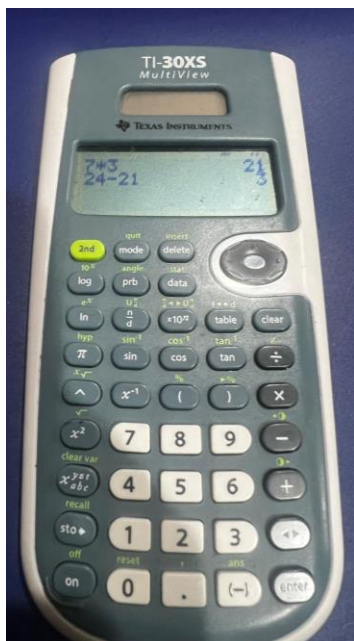
We can use the calculator to do this. First, we should type  $24 \div 7$  into the calculator like so (click [enter \[bottom right\]](#) to get the answer):



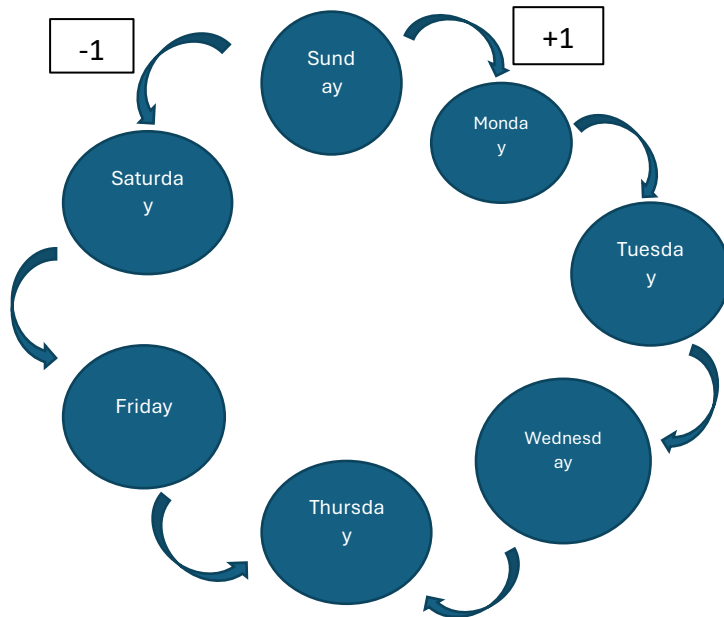
You can see that we got the answer  $3.428571429$ . Now, we should only use the number to the left of the “.” or decimal point. In this case, that’s “3”. If, for example, the answer we got was  $307.8019$ , the number we would use is “307”.

What we can do now, is  $7 \times 3$  which gives 21.

Finally, we can do  $24 - 21$  to get our remainder of 3.



Now, we can add this **remainder** to the date of the 1<sup>st</sup> of October, or Tuesday (**1<sup>st</sup> of October is the example we used. You should put the 1<sup>st</sup> of your birth month here**). To do this, look at the circle below.



Follow the arrows to add one or go the opposite direction to subtract one. If we want to add **3** to Tuesday, we start at Tuesday and then go Tuesday --> Wednesday, Wednesday --> Thursday, and Thursday --> Friday (traveling through 3 arrows).

In this example, this means that October 25<sup>th</sup>, 2024, is a Friday.

Step 2: Find 2024 minus your birth year. Then, take this answer and divide it by 4. **If you get a number without a “.”, then move directly to step 3 with the number you got.**

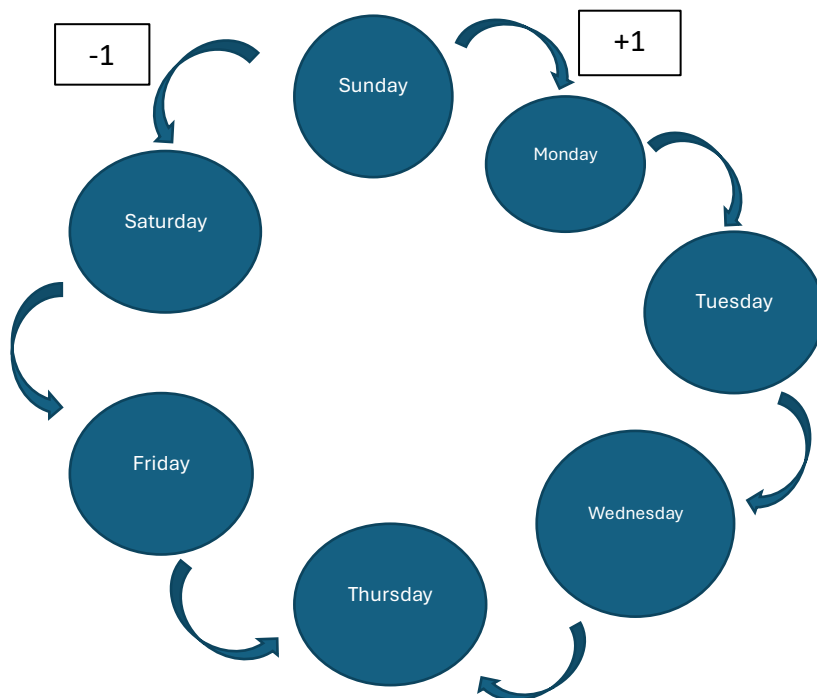
**Otherwise, continue reading this step.** If you were born after February 29<sup>th</sup> (from March

1<sup>st</sup> beyond), take the number to the left of the “.” and add 1 to it (so if you get 6.xxxx, do  $6 + 1 = 7$ ). If you were born before February 29<sup>th</sup>, only take the number to the left of the “.” and do nothing to it.

Step 3: Subtract your birth year from 2024 and then add this value to the number you found in step 2.

Step 4: As we did in step 1, find the remainder when you divide the answer in step 3 by 7. (So, if we get 20, we get  $20/7$  which gives us a remainder of 6).

Step 5: Subtract that number to the day of the week that your birthday falls on in 2024.



Use this cycle (the same as Step 1) and subtract the remainder you got in step 4 from the day of your birthday this year.

For example, if you got the number 6 in step 4 and your birthday this year is on a Tuesday (calculated in step 1), go 6 in the opposite direction of the arrows (Tuesday to Monday, Monday to Sunday, Sunday to Saturday, Saturday to Friday, Friday to Thursday, and then Thursday to Monday), which gives Monday.

Whatever answer you get from this step is the day of the week you were born on!

### **Extensions**

1. Given the day of the week you were born, find the day of the week your birthday will be in the current year.
  - The easiest way to do this is to notice that our solution only cares about 2024 dates. What this means is we can find what day one's birthday will fall on in 2024 and then do the same process that we did previously.
2. Predict what day of the week people born before 1900 were born on.
  - This can be addressed quite simply by reducing the number we have in step 3 by 1, since 1900 was not a leap year even though it is a multiple of 4.
  - However, this case only works for people born after 1800. In reality, we would have to account for the fact that years that are multiples of 100 skip the leap year, with the exceptions being multiples of 400. Years that are multiples of 400 (such as 2000) do NOT skip the leap year. This would mean

the number we have in step 3 would have to be reduced by the number of multiples of 100 that happened after the birth year, and then the number of multiples of 400 would have to be added back to the number.

3. Given the day of the week your birthday falls on in 2024, find what your birthday will fall on in 2050.
  - We can essentially just reverse engineer our original process in order to get this solution, since our current process only goes backwards