NUMB3RS Activity: The Dating Game
Episode: "Convergence"

Topic: Algorithms for calculating dates **Grade Level**: 8 - 10
Objectives: To calculate the day of the week and to study patterns in the calendar.
Time: About 30 minutes
Materials: graphing calculator

Introduction

Measuring time has been around since the beginning of civilization. In just about every culture, you can find records and methods about how time was recorded and measured using the Sun, Moon, stars, and planets. The evolution of the calendar reveals that not only can you measure time, you can also predict the day of the week when a date will occur or has already occurred.

During the episode "Convergence", Charlie talks about calendars and refers to them as "mathematical tools". Your students have undoubtedly noticed patterns in the days of the week from year to year—when certain holidays are celebrated, or when their birthdays fall during the week. This activity is designed to have students think about the many patterns that arise when you study how the day of the week for a particular date (say October 11) changes from one year to the next.

Discuss with Students

Do you know what day of the week your birthday is on this year? Was it on the same day last year? Will it be on the same day next year?

It may seem impossible to predict what day of the week a certain date will fall on, but it can be done. Because the calendar repeats, it can be predicted, but it is not necessarily easy to do so. On a small scale, you probably do this all the time with simple addition: If this Friday is the 14th of the month, then you know that next Friday will be the 21st, and the Saturday after that will be the 22nd. In this way, you can predict the day of the week for dates that are not distant. But what if you wanted to know what day your birthday will fall on next year, or the year after? What day will your birthday fall on when you turn 30? This activity will explore some calendar patterns and you will have the opportunity to use a formula for determining the day of the week for any date you want. You can start planning your 30th birthday party!

Student page answers:
1.

Date	***Day of the week***
November 6, 1955	*Sunday*
November 12, 1955	*Saturday*
November 19, 1955	*Saturday*
December 5, 1955	*Monday*
January 5, 1956	*Thursday*
February 5, 1956	*Sunday*

***Trivia**: Back to the Future **2.** Answers will vary. **3.** October 11, 2005 was a Tuesday **4.** July 4, 2076 will be a Saturday.*

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Name: _____ Date: _____

NUMB3RS Activity: The Dating Game

1. Given that November 5, 1955 was a Saturday, find the day of the week for each of the dates in the table below:

Date	Day of the week
November 6, 1955	
November 12, 1955	
November 19, 1955	
December 5, 1955	
January 5, 1956	
February 5, 1956	

Trivia: In a 1985 movie, the main character travels through time in a sports car where the date November 5, 1955 played an important role. What is the name of the movie?

That may have been a little tiresome to work through. Luckily, there are many mathematical methods (*formulas*) to find the day of the week for any date.

The formula used here involves three numbers: the day code (*D*), the month code (*M*), and the year code (*Y*). The day of the week is determined by adding the numbers representing the month, day, and year and then dividing by 7. The remainder tells us the day of the week.

The month codes given below will be used in the formula. Note that in a *leap year*, the codes for January and February are different. A leap year occurs every four years and you can tell if it is a leap year by dividing the year by 4. If 4 goes in evenly then it is a leap year. Century years like 1900, 2000, and 2100 are leap years if they're evenly divisible by 400.

Table 1: The Month Codes

Month	Code (non-leap year)	Code (leap years)
January	1	0
February	4	3
March	4	
April	0	
May	2	
June	5	
July	0	
August	3	
September	6	
October	1	
November	4	
December	6	

Calculate the Year Code *Y*

Step 1: Take the last two digits of the year and divide by 4. Make note of the quotient (i.e. how many times 4 goes into the number) and ignore the remainder.

Step 2: Take your result from Step 1 and add it to the last two digits of the year.

Step 3: Divide your number from Step 2 by 7 and note the remainder. This number is the year code *Y*.

Note: For dates in the 1700s, add 4 to your final value of *Y*.
For the 1800s, add 2. For dates in the 2000s, add 6.
For the 2100s, add 4.
Dates in other centuries will have unique corrections.

Find the Month Code *M*

The Month Code M is retrieved from Table 1 on the previous page.

Find the Day Code *D*

The value of *D* is simply the day number of the date.

Find the Day of the Week

Add *Y* + *M* + *D*. Divide the sum of *Y*, *M* and *D* by 7 and make note of the remainder. Now use the information in Table 2 to determine the day of the week.

Table 2: The Day of the Week			
Day of the Week	**Remainder**	**Day of the Week**	**Remainder**
Saturday	0	Wednesday	4
Sunday	1	Thursday	5
Monday	2	Friday	6
Tuesday	3		

Example: What day of the week was **October 11, 1952**?
Step 1: 19**52** 52/4 = 13
Step 2: 13 (from Step 1) + 52 = 65
Step 3: $65 \div 7 = 9\frac{2}{7}$ Or (7×9) + **2** = 65.
Y = 2
From Table 1, the Month Code for October is 1. ***M* = 1**
For October 11, ***D*** = 11.
Y + ***M*** + ***D*** = 2 + 1 + 11 = 14.
$14 \div 7 = 2$ The *remainder* is 0.
From Table 2, 0 = Saturday. **So, October 11, 1952 was a Saturday.**

2. On which day of the week were you born? _____

3. Without looking at a calendar, which day of the week did October 11, 2005 fall on? _____

4. On which day of the week will the USA celebrate its 3rd centennial on July 4th, 2076? _____

The goal of this activity is to give your students a short and simple snapshot into a very extensive math topic. TI and NCTM encourage you and your students to learn more about this topic using the extensions provided below and through your own independent research.

Extensions

For the Student

- In Step 1 of the calculations for determining *Y*, why do we divide by 4? What is the purpose of this step?
- In Step 2 of the calculations for determining *Y*, why do we add the quotient to the last two digits of the year? What is the purpose of this step?
- In Step 3 of the calculations for determining *Y*, why do we divide by 7? What is the purpose of this step?
- At first glance, the month codes do not appear to be in any order nor does there seem to be any underlying pattern to the numbers. But, as you might suspect, there is a simple and marvelous pattern to the codes. What is it?
- Explain the purpose of the calculations that are done in the final step.
- Why is it necessary to make adjustments for other centuries? For example, why do we add 6 to the year code for years between 2000 and 2099?

Additional Resources

An excellent discussion of how to develop a calendar algorithm appears in the wonderful book **In Code** written by Sarah Flannery and her father David. Additional information about calculating the day of the week can be found at the following web sites:

Mathematica and the Science of Secrecy:
http://www.wolfram.com/news/flannery.html

How to calculate the weekday for any date:
http://5dspace-time.org/Calendar/Algorithm.html

History and math behind different calendars:
http://astro.nmsu.edu/~lhuber/leaphist.html

Day of the week calculator:
http://www.travelfurther.net/dates/datesrus.asp

Calendar generator:
http://www.hyperinfo.ca/~HyperInfo.CA/Calendar.html

Practice your skills on the TI-83/84 Plus

For this, you will need to install the following programs (DATEGAME.8xP, RIGHT.8xP, TRYAGAIN.8xP, WRONG.8xP, DATES.8xP) onto your TI–83/84 Plus. To download the programs, go to http://education.ti.com/exchange and search for "date game" or "6156." Once the programs have been loaded onto your handheld, run the program **DATEGAME**. Find the day of the week for ten dates (either in your head or on paper) and then exit the program. The program will let you know how many dates you found correctly.

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