THE DAY AND THE DATE

Is there a simple formula to find what is the day (of the week) of any given calendar date? The answer is yes. The popular perception however, is that the formula is complex and only prodigies in mental arithmetic can find the answer quickly. The formula involves addition of four small numbers and division by 7, which can be done quickly in the head with some practice, in less than a minute. The formula is best illustrated with an example. It is valid for the 20th century.

What day was 15 August 1947 ?

(1) Take the last two digits of the year (47), divide by 7 (ignore the quotient 6) and note the remainder 5. 5 (a)

(2) Divide 47 by 4, note the **quotient** 11 (and ignore the remainder 3). 11(b)

(3) Divide the day of the month (15) by 7 and note the remainder 1. 1 (c)

(4) For the month August, pick the code number from the Table 1 below. 2 (d)

(5) Add the four numbers (5+11+1+2 = 19), divide the sum by 7 and note the remainder 5. This is the *key*. 5 (e)

The answer is "fifth (for 5) day of the week" counting *Monday as the first day*.
15 August 1947 was a Friday.

TABLE 1

Month	**Code No.**	**Month (renamed)**
January	0	JANUARY
February	3	FEB
March	3	MAR
April	6	APRILL
May	1	M
June	4	JUNE
July	6	JULIUS
August	2	AU
September	5	SEPTE
October	0	OCTOBER
November	3	NOV
December	5	DECEM

Memorizing the code numbers for the months is the only difficult part. I remember the codes by abbreviating/modifying the names of the month as shown in the last column of the Table. *The code is the number of letters in the month* (for example JULIUS for July and APRILL for April have six letters, so the code is 6). May is abbreviated to its first initial M. FEB, MAR, NOV are standard three-letter abbreviations and JUNE remains unchanged with code number 4. SEPTE and DECEM, with code number 5, remind us that in early times September was the seventh (SAPTA) and December the tenth (DASAM) month of the year. August may be visualized as a golden month (chemical symbol for gold is AU). July was in fact named after JULIUS Caesar. JANUARY and OCTOBER have seven letters, so the code is 7 or equivalently 0. Only April gets an additional letter to make it a six letter word (APRILL).

The above formula will work for all dates in the twentieth century (1900-1999) with one exception: *when the year is a leap year and the months are January or February, the key number has to be reduced by 1*. (Recall that a leap year is one that is exactly divisible by 4; and if the year is a multiple of 100, it should be exactly divisible by 400. For example 1948, 1996 are leap years; 1900 is not a leap year but 2000 is a leap year). In a sample of randomly picked dates, only one out of 24 dates will fall in this exceptional category.

Example: What day is 26 January 1996?

The year 96 gives the code numbers 5 (a) and 24 (b), the day gives 5 (c) and the month gives 0 (d). Adding 5, 24, 5, 0 gives 34 and dividing by 7 leaves remainder 6. Since 1996 is a leap year and the month is January, subtract 1. The key number is 5, which is Friday.

The formula can be applied for dates in other centuries too by adding to the key a number that depends on the century.

TABLE 2

Year	Add to key
1583 - 1599	0
1600 - 1699	6
1700 - 1799	4
1800 - 1899	2
1900 - 1999	0
2000 - 2099	6

For example 26 January is Friday in 1996, was a Sunday in 1896, Tuesday in 1796, Thursday in 1696 and again Friday in 1596. It will be Thursday in 2096. Every 400 years the day of the week will be the same. Therefore the number to add will be the same for two years 4 centuries apart. For example the number to add for 2100-2199 is 4. The Gregorian calendar now in use, started from the year 1582, with the rule to determine the leap year as described above, decreed by Pope Gregory XII.

To summarize: To find the weekday of a date in the twentieth century (1900-1999), add four numbers, the first two determined by the year (a,b), the others by the day (c) and the month (d). Divide the sum by 7 to find the remainder, which is the key. The key gives the day of the week (counting 1 as Monday). If the year is a leap year and the month January or February, subtract 1 from the key. Further, if the year is not in the twentieth century, then add to the key the number given in Table 2.

For practice, you can start with some randomly picked dates in this year's calendar and check the answers. Then one can move on to birthdays of family members, friends and the days on which national holidays and festivals occur. A short cut in the computation is to cast off multiples of 7 (that is dividing by 7 and taking the remainder) after every addition of two numbers.

How does the formula work?

What follows is mainly for the curious and the mathematically inclined. The formula is based on familiar facts about the calendar and one or two not so familiar.

(1) There are 7 days in the week.

(2) The non-leap year of 365 days is 52 whole weeks plus 1. So a given date in a given month would advance one day in the week from this year to the next. For example 11 September is a Sunday in 1994 and Monday in 1995. A leap year contributes an extra day: 11 September in 1996 is Wednesday.

(3) Some months have 30 days (April, June, September and November), February has 28 days in a non-leap year and 29 days in a leap year. Others have 31 days. Table 1 is based on this. For example the code for July is 2 more than the code for June, since 30 days of June is 4 weeks plus 2 days. In fact, all the code numbers for the months can be deduced simply by using the number of days in each month. Note that the code (Table 1) is the same for all years; the extra leap day in a leap year is accounted for in calculating b.

(4) 1 January 1900 is Monday. This is the reference day used in Table 1. It fixes the code for January as 0. The formula is merely counting the number of days from the reference date to the concerned date. Division by 7 and taking the remainder is casting off multiples of 7, the number of whole weeks.

(5) The last day of a century and the first day of the next century are consecutive days (for example 31 December 1999 and 1 January 2000). The correction to the key (the number to be added) in Table 2, follows from this elementary fact. (Hint: check the key numbers for the two

days). There is a 400-year cycle in the calendar. For example the calendar for 22nd century (2100-2199) will be the same as for the 18th century (1700-1799).

With some logical thinking, it is easy to figure out how the above facts are incorporated in the formula described.

A variety of interesting problems can be set, based on the formula. Here are some.

(a) Find the date in the third week of January 1928 that falls on a Tuesday.
(b) This year Gandhi Jayanthi falls on a Sunday. Will this happen again in this century?
(c) 29 February 1992 was Saturday. When will 29 February be again a Saturday ?
(d) I have old calendars dating back to 1985. Can I use any one of them for 1995 ?
(e) Which months have a fifth Saturday in the year 1995 ?
(f) Three baby girls were born last year (1993), on the same day of different months, but their births occurred on the same day of the week. A few years earlier, the same was true for three baby boys: they were born in the same year, on the same day of different months and on the same day of the week. But their months of birth were different from those of the girls born last year. In what months were the girls and boys born?

Answers:

(a) 17 January 1928.
(b) No. 2 October falls again on a Sunday in the year 2005.
(c) In the year 2020.
(d) Yes. The calendars for the years 1989 and 1995 are the same.
(e) April (29), July (29), September (30) and December (30).
(f) The girls were born in February, March and November in 1993, a non-leap year. The boys were born in January, April and July in a leap year (presumably 1988).

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(*NOTE: The paper 'Universal Calendar' is a non-technical presentation of calendar problems in this paper. It may be read as acompanion paper.)*