AIAA

AEROSPACE MICRO-LESSON

Easily digestible Aerospace Principles revealed for K-12 Students and Educators. These lessons will be sent on a bi-weekly basis and allow grade-level focused learning. - AIAA STEM K-12 Committee.

HOW LONG IS A YEAR?

The definition of a year is the amount of time that it takes the Earth to move once around the Sun. How long is this? The answer seems obvious; a year is 365 and a quarter days long. This is not an exact figure, though; calculating a more accurate number can be as simple or as complicated as you care to make it.

GRADES K-2

A regular year is 365 days long. Because it takes a little longer than 365 days for the Earth to go around the Sun, every four years our calendars include a "leap year" which has an extra day. This day is always added to the end of February. You can bring a 2016 calendar to show the students the 29th day of February. If you have a calendar from 2015, or if you get a 2017 calendar (they start coming out in a month or two), you can show the students that February in 2015 or 2017 only has 28 days.

There is a short rhyme that people use to remember the number of days in every month:

"Thirty days hath September,
April, June, and November;
All the rest have thirty-one,
Excepting February alone,
And that has twenty-eight days clear,
And twenty-nine in each leap year."

There are several variations on this rhyme.

GRADES 3-5

It may be a fun exercise in addition to add all the numbers of days of the month together and show that the total is 365 (or 366 for a leap year). You can do this by adding each month's number of days to a running total or by adding a whole stack of numbers at once; if you like, you can do it both ways to show that the answer is the same.

The kids may want to figure out how many "leap days" they have lived through. Leap days are February 29 in leap years. Every year in the past century with a number divisible by four is a leap year, so the relevant ones will be 2008, 2012, and 2016. Students born in 2008 will

GRADES 3-5 (CONTINUED)

need to figure out whether they were born before, on, or after February 29. If you want to be more visual in letting the kids spot the leap years, you can find calendars for multiple years on the Internet.

Between leap years and the seven days of the week, there are fourteen different calendar arrangements possible. Except for glitches around the turns of the centuries, the calendar repeats exactly every 28 years.

In addition to the "Thirty days hath September" rhyme, there is a visual way to remember how many days each month has. It is called the "knuckle rule." Hold a fist out in front of you and use a finger from your other hand to count out the four knuckles and valleys between the knuckles. Call out the months as you count, starting with "January" on the first knuckle. When you reach the fourth knuckle, start over back at the first one. (You will reach "December" on the third knuckle.) Every month that lands on a knuckle has 31 days; all the others have 30 days except for February; you will just have to remember that February has 28 days. (Note that the linked web site says that February has "28 or 30 days"; this is incorrect. February has 28 or 29 days.)

GRADES 6-8

The position of the Earth in its orbit around the Sun controls the seasons. When a hemisphere is tilted towards the Sun, that hemisphere is having its spring and summer; when a hemisphere is tilted away from the Sun, it is having its autumn and winter. Because of this, people wanted the calendar to match the revolution of the Earth around the Sun so that the change from one season to the next would always happen on the same calendar day.

The ancient Romans realized that each year is about 365.25 days long. The Roman emperors Julius Caesar and his successor Augustus Caesar established a calendar that was very accurate. (They named the months "July" and "August" after themselves. February has only 28 days because each emperor wanted his month to have 31 days and so they each took a day from February.) This calendar is called the "Julian calendar." Under the Julian calendar, every year is 365 days long, except for leap years which have an extra day. Every year that is divisible by four is a leap year.

GRADES 6-8 (CONTINUED)

By the fourth century, astronomers had figured out that the Julian calendar was not quite right. The seasons were shifting by about three days every 400 years so that the winter solstice, for example, was now happening around December 21 instead of December 25 where Julius Caesar had fixed it. By the sixteenth century, the discrepancy from the fourth century had grown to ten days so the winter solstice was happening around December 11.

To bring the calendar back in line with the seasons, people simply dropped ten days out of the calendar. Different countries did this at different times, so in some places they needed to drop eleven days. To keep the calendar from drifting away again, they also established a new calendar with slightly different rules for declaring a leap year. This new calendar is called the "Gregorian calendar," after Pope Gregory XIII who first promulgated it. Under the Gregorian calendar, every year divisible by four is a leap year unless it is divisible by 100 and not divisible by 400. Thus the year 2016 is a leap year; the year 2100 will not be a leap year; and the year 2000 was a leap year.

You can find more information here.

GRADES 9-12

The question of "how long is a year" gets even more complicated when one considers how to define a year. Yes, a year is how long it takes the Earth to move around the Sun, but the simplest definition (exactly one revolution in its orbit) is not the most useful. In fact, there are four different definitions of a year:

- The "sidereal year" is the amount of time it takes for the Earth to revolve 360 degrees around the Sun. This is 365.256366 days (365 days, 6 hours, 9 minutes, 10.0 seconds) long.

- The "tropical year" is the average amount of time from the start of a season (an equinox or a solstice) to the start of the same season the next year. This differs from the sidereal year because the Earth's axis precesses, making a full precession every 25,800 years or so. One tropical year is 365.2421988 days (365 days, 5 hours, 48 minutes, 45.98 seconds) long. The ratio of a sidereal year to a tropical year is 1 + 1 / 25,800. Because the calendar is tied to the seasons, it follows the tropical year. One leap year in four adds 0.25 days to the year; removing one leap year per century

GRADES 9-12 (CONTINUED)

subtracts 0.01 days; and adding one leap year every four hundred years adds 0.0025 days to the year. The result is that a year in the Gregorian calendar is 365.2425 days long, which differs from the tropical year by 0.0003 days. There will not need to be a special one-day adjustment for about 3,000 years.

- The "vernal equinox year" is the amount of time from one spring equinox (in the Northern Hemisphere) to the next. It is 365.242374 days (365 days, 5 hours, 49 minutes, 1.1 seconds) long. It differs from the tropical year because the Earth's orbit is elliptical.

- The "anomalistic year" is the amount of time the Earth takes to return to the perihelion in its orbit (the position in its orbit at which it is closest to the Sun). The anomalistic year is 365.259636 days (365 days, 6 hours, 13 minutes, 52.6 seconds) long. This is longer than the sidereal year because the perihelion of Earth's orbit precesses around the Sun. (This precession of the perihelion is completely unrelated to the precession of the Earth's axis of rotation.)

A handy mnemonic for the number of seconds in a year is that one nanocentury is about π seconds. This is good to one part in two hundred.

Sixty Years Ago in the Space Race:

August 8, 1956: The Redstone Test Stand, which was the largest United States test stand for rocket motors, was completed in Alabama for the purposes of testing the Jupiter missile.