Why doesn't my sundial show the same time as my watch?

by Don Mickey

The reason is that the sundial and the watch have slightly different ideas of what time means. The sundial measures "apparent solar time." This means that noon on the sundial is when the sun is on the "meridian", the imaginary line that divides the east half of the sky from the west half. And noon the next day occurs the next time the sun is on the meridian. The length of a solar day varies a little from one part of the year to another. And the location of the meridian depends on exactly where on Earth you are standing.

A watch, on the other hand, measures time in seconds, minutes, and hours so that each day has 24 hours and on the average the sun is in the same position each day at a given time. Watches are set to time zones (generally an hour apart) so that everyone in a nearby area can set their watch to the same time. This is called "standard time."

So if you want to read your sundial and figure out how to set your watch, you have to do two things. The first is to know where you are on earth, compared to the standard longitude for your time zone. In Hawai'i, our standard longitude is 150 West, that is 150 degrees west of the zero longitude line. But the Hawaiian islands are farther west than the 150W line, so the sun appears to pass overhead later than noon on the watch. The correction is four minutes of time per degree of longitude. Hilo is about at longitude 156 W, so solar noon is 24 minutes after noon standard time, and Honolulu is about at 158 W, so solar noon is 32 minutes late.

There's a second effect that is a little smaller for us in Hawai'i. It is caused by two things: eccentricity (the Earth moves at a varying speed in its orbit around the sun), and obliquity (the Earth's equator is tilted compared to its orbit). This means we need another correction of up to about 15 minutes depending on the time of year. The correction can be calculated, but it's simplest to keep a little chart like the one below to read the correction from. The chart shows the effect of eccentricity as a blue line, the effect of obliquity as a green line, and the total correction as a red line.

Here's an example... Suppose you're in Honolulu, near the beginning of May, and your sundial tells you it's 10:00 in the morning. To get from this to standard time, first you need to correct for your location. You add 32 minutes for Honolulu, giving 10:32 AM. Then you read the "equation of time" correction from the red curve on the chart; it says the sundial is 3 minutes fast. Subtracting 3 minutes tells you standard time is 10:29 AM. That should agree with your watch (unless you just came from California or your battery has given out).

The equation of time chart

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