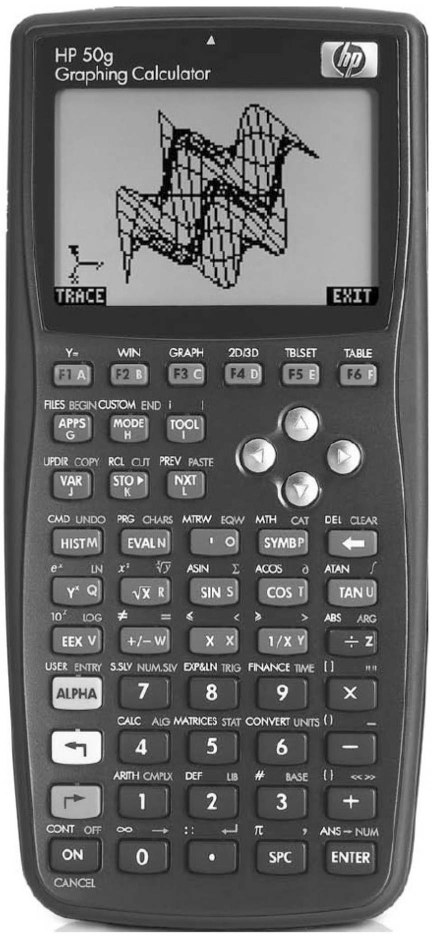
SUN

FOR HP 50g CALCULATORS



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Store the main program. Then store the subroutines in an accessible place to the main program. That is on the same level, or one directly above. SUN uses the calculator DATE. It also uses the observer's longitude (LONG) and latitude (LAT). These must be decimal numbers, not an integer with no decimal point. LONG and LAT also need to be stored in an accessible place, and in DD format. (See below for DD format.) Simply press the SUN key for the program to run.

This is an RPN program that finds sunrise, sunset times, as well as time and angle for meridian. It uses the observer's latitude and longitude, and reads the current date from the calculator. It also runs about a dozen subroutines. SUN is based on "Sunrise Equation" from Wikipedia, which is based on Paul Schlyter webpage "How to compute rise/set times and altitude above horizon" which in turn comes from Meeus, Jean. "Astronomical Formulae For Calculators." 4th ed. Willmann-Bell, Richmond VA, 1979.

SUN is accurate to within 2 min from -65 deg latitude to +65 deg. It drifts off the closer to the pole it gets. It might be possible to avoid this glitch by using polar coordinates, but that's another can of worms. I tried using Peter Duffett-Smith's book ("Practical Astronomy With Your Calculator." 3rd ed. Univ of Cambridge, 1988.) which is a pure joy to read and program. But for the big programs it gets rather confusing. Duffett-Smith's program worked for the dates around when the book was written, but when I went ahead 20 years, it failed. Even Schlyter's program was a bit difficult to follow from his webpage. When I finally stumbled onto the Wikipedia version, the result is this version.

I hope that you will not object to a small lesson in observational astronomy.

COORDINATE SYMBOLS

The major global coordinate system is the Geographic Coordinate System (GCS):

GCS Latitude ≡ Lat, φ, phi (Earth's equator)

Longitude ≡ Long, λ, lambda (N-S)

Symbols for degrees, minutes, and seconds:

- ° Degree
- ' Minute
- " Second

Three common formats:

DDD° MM' SS.S"	Degrees, Minutes, and Seconds	DMS	Most paper maps
DDD° MM.MMM'	Degrees, Decimal Minutes	DDM	Aircraft
DDD.DDDDD°	Decimal Degrees	DD	Most computer maps
			NWS, and calculators

Time:

HH.MMSSSh	Hours.MinutesSeconds	HMS	HP calculator TIME
HH.HHHHHh	Hours.Decimal Hours	HDD	Calculator Arithmetic

In astronomy:

Horizon – Sky observations

Altitude ≡ h in hours or degrees

Azimuth ≡ az or A in degrees

Equatorial – Telescopic observations

Right Ascension ≡ α or RA in hours

Declination ≡ δ or dec in degrees

Ecliptic – Solar system calculations

Latitude ≡ Lat, β, beta in degrees

Longitude ≡ Long, λ, lambda in degrees

Galactic – Galaxy navigation

Right Ascension ≡ α or RA in hours

Declination ≡ δ or dec in degrees

SIDEREAL TIME – (sideris Lat, - star) astronomers need a clock whose rate is such that any star observed will return to the same position after exactly 24 hours. Such a clock is called a sidereal clock (a star clock). This is a timekeeping system that astronomers use to keep track of the direction to point their telescopes to view a given star in the night sky. Briefly, sidereal time is a time scale that is based on Earth's rate of rotation measured relative to the fixed stars rather than the sun. Solar time is not the same as sidereal time because during the course of one solar day the earth moves nearly one degree along its orbit around the Sun. Hence, the Sun appears ahead by one degree against the background of stars when viewed from earth.

Imagine that we were keeping solar time, and suddenly the sun zoomed away into the distance. We could continue to keep solar time, but now the sun would cross the high point, the meridian, a little faster each day. We could now divide the day into 24 hours, but each hour would be about 10s faster. If our source of daylight was the same, sunrise and sunset would precess through the year, only coinciding exactly with sidereal time at the autuminal equinox. This would also be when the length of daylight and nighttime coincided. The advantage of this system is that the stars would always appear in the sky in the same location at the same time every night. With solar time, the stars will appear 4m earlier each night.

Sidereal time is used at astronomical observatories because sidereal time makes it very easy to work out which astronomical objects will be observable at a given time. Objects are located in the night sky using right ascension and declination relative to the celestial equator (analogous to longitude and latitude on Earth), and when sidereal time is equal to an object's right ascension the object will be at its highest point in the sky, or culmination, at which time it is usually best placed for observation, as atmospheric extinction is minimized.

There are about 365.25 solar days in the year. During this period, the earth makes about 366.25 revolutions, and there are this many sidereal days in a year. Each sidereal day is slightly shorter than the solar day. 24 hours of sidereal time corresponds to 23h 56m of solar time. Universal time and Greenwich sidereal time agree at one instant every year, the autumnal equinox (around 22 Sep). Thereafter, ST runs faster than UT until exactly one half year later, it is 12 hours displaced. After one year the times again agree.

Sidereal time, at any moment (and at a given locality defined by its geographical longitude), more precisely local apparent sidereal time (LAST), is defined as the hour angle of the vernal equinox at that locality. Local sidereal time at any locality differs from the Greenwich sidereal time by an amount that is proportional to the longitude of the locality. When one moves eastward 15° in longitude, sidereal time is larger by one sidereal hour.

Apparent sidereal time (local or at Greenwich) differs from mean sidereal time (for the same locality and moment) by the equation of the equinoxes: this is a small difference in right ascension (dRA) parallel to the equator, not exceeding about ±1.2 s, due to nutation, the complex 'nodding' motion of Earth's polar axis of rotation. It corresponds to the current amount of the nutation in (ecliptic) longitude ($d\psi$) and to the current obliquity (ε) of the ecliptic, so that $dRA = d\psi \cos \varepsilon$. (Wikipedia, “Sidereal Time”).

JULIAN DAY NUMBER – not to be confused with the Julian calendar. This is one of the foundations for astronomical calculations. Astronomers use Julian days (JD) in accordance with a system proposed in 1583 by the French classical scholar Joseph Scaliger. It is another form of UT.

A JD is the number of days that have elapsed since noon (GMT) 1 Jan 4713 BC. This date was chosen because no historical events had occurred before this time. For noon, 1 Jan 2000, this was 2,451,545. It is important to note that each new day begins at 12h 00m UT, half a day out of step with our calendar. (Obviously, because astronomers had a difficult time determining the exact time of midnight, not so for noon.) So, the beginning of each day is midday as measured on the Greenwich meridian (longitude) on January 1st of that year. This system will accommodate time through decimal days. So, midnight is actually 0.5 added to the integer date, with 6AM adding 0.75 to the date, etc.

In making this calculation there are a couple of modifications that must be noted. The Gregorian calendar is the one that we have used since 1582 when Pope Gregory XIII instituted it. In order to correct the advances that the Julian calendar had overlooked, the days from 5 Oct 1582 thru 14 Oct 1582 were skipped. This new calendar also skips a leap year for each century year divisible by 400, ie, 1600, 2000, etc. So, on these years, 1600, 2000, etc, Feb 1600 does not have a leap day, only 28 days. This keeps the calendar accurate within 1 day in 20,000 years.

The Christian era began with the year 1 AD. The year preceding this was 1 BC. There is no year 0. This has been accounted for in the Julian date program by adding 1 to the BC year, creating a year 0. However, it requires all BC years to be entered as negative numbers.

When given a date of 0.0 Jan 1980, enter this as 31.121979. Notice that fractions of days are permitted. This program rounds to the second decimal.

To run the SUN sunrise program, first, store your latitude and longitude in LAT and LONG, variables that you create. Then simply copy the RPN program SUN and all of the subroutines into your calculator, press SUN.