13. *Sunlight and Moonlight Graphs*. The graphs on pages A153–A156 give data concerning the rising and setting of the Sun and Moon and the duration of twilight for high latitudes. These serve the same purpose as the tables given on the daily pages for lower latitudes. Graphs are given instead of tables for high latitudes because they give a clearer picture of the phenomena and of the attainable accuracy in any given case. In the regions of the graph that are difficult to read accurately, the phenomenon itself is generally uncertain.

The graph Semiduration of Sunlight gives for latitudes north of N.65° the number of hours from sunrise to meridian passage or from meridian passage to sunset. There is continuous daylight in an area marked “Sun above horizon," and no direct sunlight in an area marked “Sun below horizon." The figures near the top indicate, for several convenient dates, the local mean times of meridian passage; with the aid of the intermediate dots the LMT on any given day may be obtained to the nearest minute. The LMT of sunrise may be found by subtracting the semiduration from the time of meridian passage, and the time of sunset by adding.

Examples. On March 10 in latitude N.78° the semiduration of sunlight (page A6) is about $5^{\mathrm{h}}00^{\mathrm{m}}$. The time of meridian passage is $12^{\mathrm{h}}10^{\mathrm{m}}$, and hence the LMT of sunrise is $07^{\mathrm{h}}10^{\mathrm{m}}$, and of sunset $17^{\mathrm{h}}10^{\mathrm{m}}$. In latitude N.$80^\circ$ the Sun is continuously below the horizon until about February 20, and is continuously above the horizon after April 14.

The graph Duration of Twilight gives the interval from the beginning of morning civil twilight (Sun 6° below the horizon) to the time of sunrise or from the time of sunset to the end of evening civil twilight. In a region marked “No twilight or sunlight" the Sun is continuously below the horizon by more than 6°. In a region marked “Continuous twilight or sunlight" the Sun never goes lower than 6° below the horizon.

Adjacent to a region marked “No twilight or sunlight" is a region in which the Sun is continuously below the horizon, but so near to the horizon during a portion of the day that there is twilight. The value given by the graph in this region is the interval from the beginning of morning twilight to meridian passage of the Sun, or from meridian passage to the end of evening twilight, the total duration of twilight being twice the value given by the graph.

Examples. On March 10 in latitude N.78° the graph indicates the duration of twilight (page A6) as about $1^{\mathrm{h}}45^{\mathrm{m}}$. Applying this to the time of sunrise, $07^{\mathrm{h}}10^{\mathrm{m}}$, found in the preceding example, the beginning of morning twilight is $05^{\mathrm{h}}25^{\mathrm{m}}$ LMT. In latitude N.80° there is no sunlight nor twilight till about February 6, there is twilight but no sunlight from February 6 until February 20, sunlight and twilight till March 31, continuous twilight or sunlight till April 14, and then continuous sunlight. In latitude N.80° on February 14 twilight begins at about 09^{h} and ends at about 15^{h} LMT.

The graphs Semiduration of Moonlight give for the Moon the same data as the graph Semiduration of Sunlight gives for the Sun. The scale near the top gives the LMT of meridian passage. In addition, the phase symbols are placed on the graphs to show the day on which each phase occurs. Since the times of meridian passage and the semiduration change more rapidly from day to day for the Moon than for the Sun, special care will be required in reading the graphs accurately.

For most purposes in these high latitudes a rough idea of the time of moonrise or moonset is all that is required and this may be obtained by a glance at the graph.

Example. On 2004 January 15, the phase is found from page A6 to be near last quarter, and the Moon crosses the meridian at 06^{h} LMT. In latitude N.70° the semiduration of moonlight taken for the time of meridian passage is 5 hours, giving moonrise at 01^{h} LMT on January 15 and moonset at 11^{h}.

If greater accuracy is required it is necessary to read the graph for the UT of each phenomenon at the desired meridian. The dates indicated on the graph are for 00^h UT, and intermediate values of the UT may be located by estimation.

Example. It is required to improve the results obtained in the preceding example, assuming the observer to be in longitude W.90° (6^h) west.

The values found previously were:

			d h			d h
Time of meridian passage	2004	Jan.	15 06 LMT	=	Jan.	15 12 UT
Semiduration of moonlight			05			
Time of moonrise		Jan.	15 01 LMT	=	Jan.	15 07 UT
Time of moonset		Jan.	15 11 LMT	=	Jan.	15 17 UT

Returning to the graph (page A6) with these three values of the UT, the following results are obtained:

			d h m			d h m
Time of meridian passage	2004	Jan.	15 06 15 LMT	=	Jan.	15 12 15 UT
Semiduration for moonrise			04 30			
Time of moonrise		Jan.	15 01 45 LMT	=	Jan.	15 07 45 UT
Semiduration for moonset			04 00			
Time of moonset		Jan.	15 10 15 LMT	=	Jan.	15 16 15 UT

14. *Corrections for Height of Observer*. The times of sunrise, sunset and twilight given on pages A130–A145 are for an observer on the ground (at sea level). The corresponding times for an observer above the ground will be earlier for morning and later for evening phenomena. The graphs on pages A146–A150 enable these times to be found for heights up to 60 000 feet.

For a series of latitudes the graphs give the hour angle (HA) of the Sun when it reaches a particular depression; an auxiliary diagram on each page provides a correction to the depression to allow for the difference between the latitude of the observer and that of the diagram. The HA is determined by the intersection of the curve corresponding to declination with the level of depression, corrected, if necessary, for the difference of latitude; the time of reaching this depression is then obtained by applying the HA (*subtract* for *rising*, *add* for *setting*) to the time of meridian passage (Mer. Pass.). Table 1 on pages A151 and A152 gives the LMT of the Sun's Mer. Pass., together with the Sun's Dec. at 12^h UT on each day.

When the declination curve is completely above the depression required, it is "light" all night; when the declination curve is completely below the depression required, it is "dark" all day.

At a particular height above ground level the Sun will rise or set when, referred to the ground point vertically below, it reaches a particular depression below the horizon. Table 2 on pages A151 and A152 gives the depression of the Sun at rising or setting as seen from various heights. Owing to the corrections for refraction and semidiameter, the depression at rising and setting for an observer on the ground (at sea level) is $0^\circ.8$.

The duration of twilight (i.e., the time between sunset and a particular level of illumination) will rapidly diminish as the height increases. It is difficult, however, to give numerical values, to the depressions corresponding at various heights to illuminations associated with particular twilights at ground level, owing both to limitations of physical theory and to the variety of practical applications. A particular level of illumination will, however, always be associated at a particular height with a particular value of the depression; once the user has determined, from experience, the depression corresponding to the height and the conditions of illumination he requires, the times can be found from the graphs in the same way as for rising and setting.