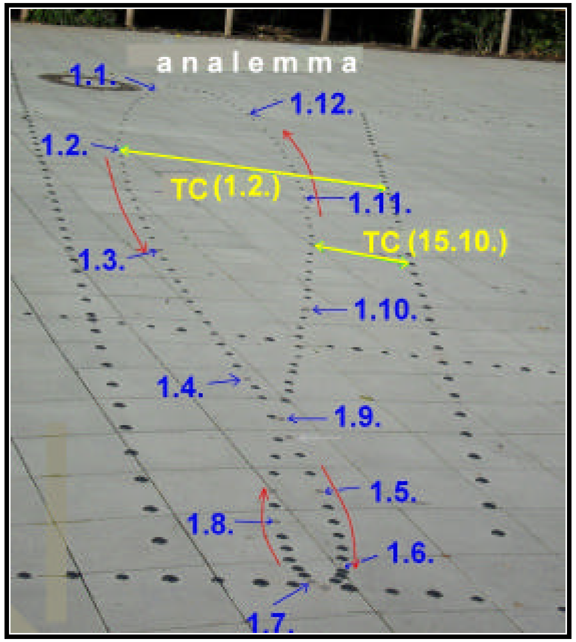

Fig. 4: Analemma

A uniqueness of this sundial are the **12 plates of metropolises**. Located around the pole they show directions and distances of selected world cities (Figure 5.and 6). For example, Wellington - the capital of New Zealand - is placed on the southern hemisphere of the earth. But a plane taking off from Cologne takes northeast direction to get there by the shortest path. This is amazing and is worth thinking about. These lines denoting the shortest distances around the globe are called **orthodromy.**

Fig. 5:Plate with the sign of Wellington


Fig. 6: Cities of the world rose

Finally some general remarks

The **Augustus' sundial** on the Mars field in Rome (for the lines system one in ancient Pompeii) was the *historical model* for our sundial. Our present calendar was designed by Julius Caesar and by Emperor Augustus. Until today the names of the months July and August remind us of this. The so-called Gregorian reform of the sixteenth century amended nothing substantial in the structure of this calendar. The reform has only made it more precise.

The sundial on the **Abraumhalde Hoheward** in the Ruhr area and the sundial on the **Theatre square in Aschaffenburg** are *modern models*.

Using the sundial you can determine the time by applying an ancient, laborious method. This may be interesting, but it is not its proper sense [1]. Activity with sundials might stimulate thoughts about problems associated with the measuring of time and its division as well as with the related calendar questions. But above all, it can clearly and concretely help to understand the problems, whose solution led **Copernicus**, **Tycho Brahe**, **Kepler** and **Galilei** to the creation of the heliocentric world view almost 400 years ago.

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translation: Dr. Helena Relke

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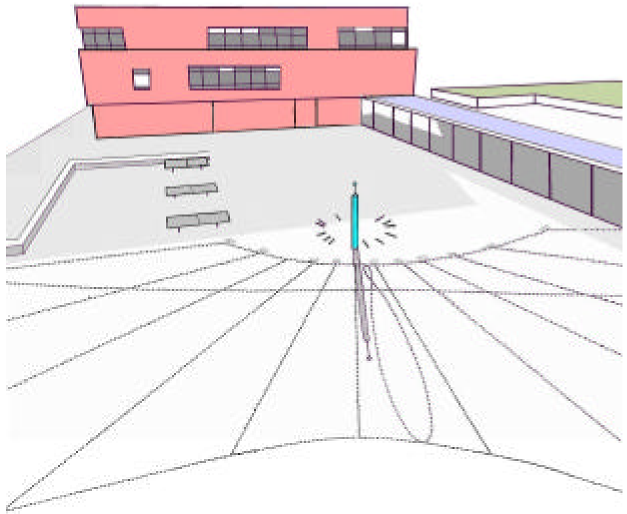
1) Each wrist-watch is more accurate, easier to read and especially independent of the weather conditions.

The schoolyard as a dial-plate



Brief introduction to the sundial of the Apostles' High School

When you stand in front of the sundial and try to determine the time using the shadow of the Gnomon, you will note that this time doesn't match the time shown by your wrist-watch. This introduction explains the reason of this mismatch and instructs us on how to calculate the wrist-watch time using the sundial time.

The sundial consists of following parts (see fig. 1):

1. the column with the sphere throwing the shadow, the **gnomon,**
2. the **lines of hours and dates,**
3. the **analemma** (figure-eight loop, see fig. 4)
4. and the **pole**, an imaginary point on the south of the gnomon. The line between the pole and the sphere of the gnomon forms the **polar axis**, which is parallel to the earth's axis.

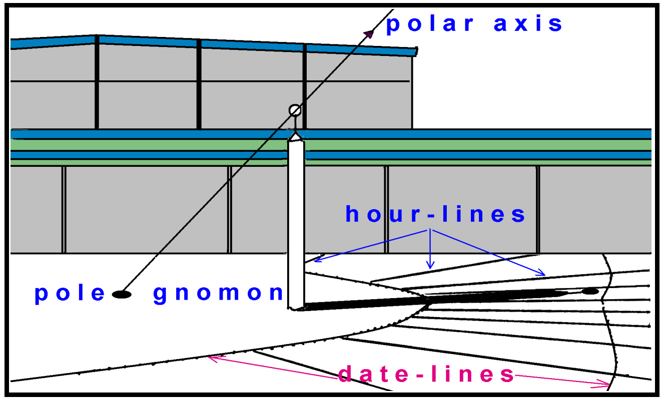


Fig. 1: Notations

The long straight lines (called hour-lines) show the solar time. They are marked with the Roman numerals (see sketch in fig. 2).

How do you read the solar time?

The point where the sphere's shadow falls shows the solar time. In fig. 2 it is 7 o'clock, because the shadow falls on number VII.

Why does the time displayed on the sundial not match the wrist-watch time?

Two reasons are responsible for this mismatch:

1. The time shown by the sundial is orientated towards the movement of the sun. This time is true only for the place where the sundial is located. So, for our school yard and for all places located exactly to the North and to the South of it, that is to say on the same longitude. All other places have a different solar time. This solar time is called the true local time (abbreviated **ST**) because it is related to the real daily sun path on the vault of heaven. The wrist-watch shows the Central European Time (**CET**). This time is the same in a wide strip from Spain in the West to Poland in the East. It is not a local time, but the time for a complete zone.

2. The motion of the sun is not uniform. The resulting inaccuracies can reach a maximum of 15 minutes. The analemma clearly shows these speed up and down of the sun movement. The time shown by a wrist watch - assuming technical correctness - goes uniformly.

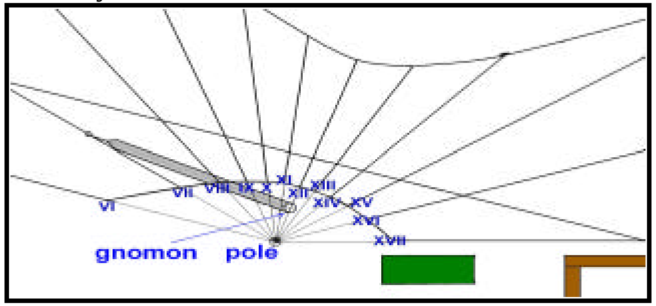


Fig. 2: The lines of hours and dates

How do you determine wrist-watch time (CET) or summer time (CEST) from a sundial reading (ST)?

To calculate the CET from the ST you must add the correction for the time (TC) to the sundial reading. This time correction takes into account the two reasons described earlier. There are the simple equations:

CET = ST + TC or **CET = ST - TC**

The TC depends not only on the place of observation. It also depends on the date of observation. Therefore the TC has a different value for every day. The table of time corrections (see fig. 3) contains the values of the time corrections in minutes for every day.

Fig. 3: The table of time correction (TC-table in minutes)

day	Jan	Feb	Mar	Apr	May	Jun
1	42	51	50	41	33	33
6	44	51	48	40	33	34
11	46	51	47	38	33	35
16	48	51	46	36	32	36
21	50	51	44	35	32	37
26	51	50	43	34	32	38
31	52		41		33	

day	Jul	Aug	Sep	Oct	Nov	Dec
1	39	42	37	27	21	28
6	40	42	36	25	21	30
11	41	41	34	24	22	32
16	41	40	32	23	23	34
21	42	39	30	22	24	37
26	42	38	29	21	26	39
31	42	37		21		42

Fig. 3. TC-table (During the summer time, it is marked in yellow, you must add one hour to the values from the table.)

An example with an explanation:
Date: **11 September**
The sundial reading (**ST**): **11:00**
Time correction from the TC- table **+ 00:34**

=> **Central European Time (CET): 11:34**
Correction for summer time: **+ 01:00**

=> **Central European Summer Time** (**CEST**):
12:34

You can also estimate the TC-value with the help of analemma and so calculate CET from ST without using the TC-table.

The following steps are necessary:

1. Read the hours shown by the sundial (ST).
2. Find out the actual date on the analemma. Every first day of the month is marked on the analemma.
3. The distance between the point of the actual date on the analemma and the XII-hour-line corresponds to the actual TC (Fig. 4 shows the TC for 1.2 and 15.10).
4. To get CET add this found TC to ST.

Since in this case the time correction (TC) must be estimated, this procedure is not so precise.