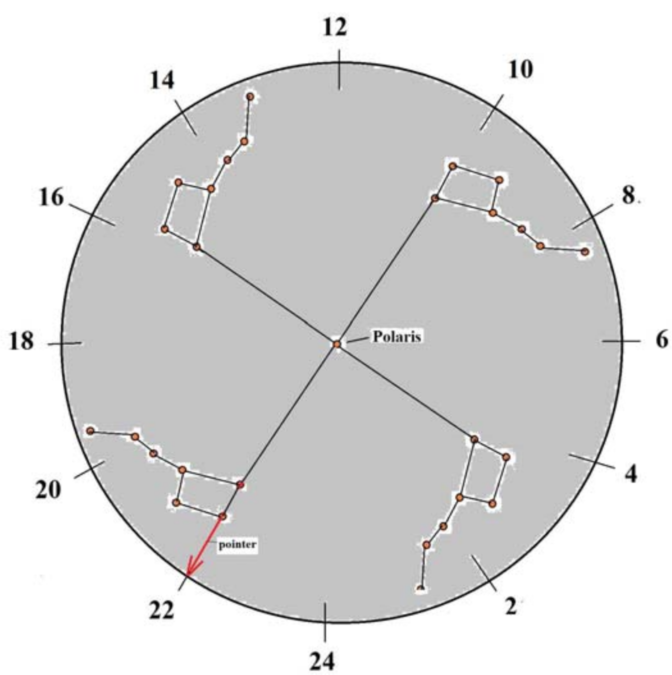
USING THE BIG DIPPER TO DETERMINE LOCAL TIME

If one looks at the night-sky on a cloudless night in the northern hemisphere you will see that all stars seem to rotate in a counter-clockwise manner in circles about the North Star Polaris at the rate of approximately one degree every four minutes. This becomes especially clear when looking at a time-lapse photo. Among the easiest of the star configurations to spot performing this rotation is the Big Dipper in Ursa Major. By extending a line from the two front stars (Dubhe and Merak) of the Big-Dipper by a factor of five one reaches Polaris. Tracking the red pointer arrow at the end of this imaginary Big-Dipper-Polaris line produces a 24 hour clock with a counter-clockwise moving indicator. Although this movement can only be spotted at night, it completes a complete circuit plus four minutes each day. The four minute addition stems from the fact that the earth not only rotates about its polar axis once a day but also moves once around the sun in one year. Note 360 deg/year=90deg/season=1degree/day=4 min/day. A schematic of the apparent rotation of the Big-Dipper about Polaris follows-

24 HOUR ASTRONOMICAL CLOCK



What we have here is a 24 hour astronomical clock where the red-pointer arrow moves in a counter-clockwise sense about a circle marked with hour intervals.

If one looks at the clock carefully it becomes clear that the four different orientations produced at six hour intervals (or by the four seasons at fixed local time) and their connecting lines to Polaris constitute an approximate swastika. Since the swastika symbol originated in ancient India it would not be unreasonable to speculate that it followed from night-sky observations of ancient Indian astronomers who were quite advanced in astronomy compared to the rest of the world at the time.

If one has a wristwatch available one should set the outer rotating disc containing the numbers to 24 at midnight. This way one can run the clock for several days before needing to reset it because of the daily variations in local noon and the daily 4 minute change due to the earth's movement about the sun. Also if no watch is available one can use the time of local noon, add 12 hours to this via hour-glass measurements, and then set the pointer to 24. Either way one will have an accurate astronomical clock. If one adjusts the pointer to 24 one evening at midnight, one can expect to see the red pointer arrow point to approximately 22 hrs the next evening at 10pm. The clock is particularly useful for measuring hour increments. Here there is no need for knowing the time of local noon or midnight. One just measures how long it takes for the pointer to move 15 degrees which is equivalent to one hour. One could also use these increments to calibrate a sundial without benefit of a mechanical or electronic timepiece.

To measure the angle of the imaginary Polaris-Big-Dipper line relative to the vertical one can use a plumb-bob attached by string to the center of the clock. The difference between the 24 hr pointer position and where the vertical plumb-bob line crosses the dial will give the pointer angle in hours. Multiplying this value by 15 yields the angle. Here one is simply using the number dial on the clock as a protractor.

If you want to quickly determine the approximate angle between two points in the night sky, you can check how many little finger widths it corresponds to. The rule of thumb is that one small finger width bent at the end of one's out-stretched arm subtends a one degree angle. In our own case the distance from my right eye to the bent little finger at the end of my outstretched right arm is $L=29$ inches and the width of the front of my little finger is $w= 0.55$ inches . Thus the angle θ subtended will be approximately $180w/(\pi L)=1.08$ degrees. Both the moon and sun have an apparent width of about one half degree as seen from earth and so can be covered by half the little finger width held at arms length. Since the width of a typical thumb is about one inch, the angle between two stars on the Celestial Sphere measured as two thumb widths will be separated by four degrees. Artists use such thumb measures in the painting of objects in order to get the right perspective.