Theoretical round. Problems to solve

1. **Noon at the Olympiad.** Yesterday, on October 16, 2015, the upper culmination of the Sun at the venue of the Olympiad was at 11:29:43 local time. Calculate as accurate as possible at what time the upper culmination of the Sun will be (or was) today.
   Estimate the difference Δh in the height of the Sun at the culminations yesterday and today.

2. **Eclipse on the Poles.** The White Bear and the Penguin from the previous International Astronomy Olympiads returned to their poles (North and South respectively), and decided to observe an annular solar eclipse. The Penguin was lucky to see an amazing picture: at the maximum phase of the eclipse the centres of both discs, solar and lunar, appeared just on the visible horizon. And what did the Bear observe at this time? Draw what the White Bear saw at that moment, and also contour by dotted line the true positions of the Sun and the Moon. Assume that the Earth is spherical. The drawing should include an artistic picture with an image of the Bear on North Pole; necessary sizes or angular sizes should be pointed out in the picture. Recollect for yourself the necessary information about the animals.

3. **Close conjunction.** Some time after the events described in the previous problem (nobody knows even the order of magnitude how long after – minutes, or hours, or days, or years ...), Venus at the point of eastern elongation came to close conjunction with Mars, which was located near the aphelion of its orbit. At the same time a total lunar eclipse occurred on the Earth.
   3.1. Draw the corresponding scheme.
   3.2. Explain, which animal (sitting at the same poles) may see this lunar eclipse. (At the very end of your explanation write as answer **B+** or **B–** for the Bear and **P+** or **P–** for the Penguin.) An artistic picture of the observations of the animals is welcome.
   3.3. Calculate in which constellation the eclipsed Moon was observed.
   3.4. Estimate minimal possible time passed from the situation of the previous problem to the situation of the current one.

4. **Constellation of White Leopard.** According to an ancient legend of Middle Volga there was a constellation called White Leopard (Белый Барс – Pardus Album) in the sky in the very past, in which the number of stars were exactly equal to the number of letters in the Greek alphabet, and the stars had magnitudes α PaA – $+0.10^m$, β PaA – $+0.20^m$, γ PaA – $+0.30^m$, δ PaA – $+0.40^m$, and so on with adding 0.10^m till ω PaA. Calculate the total magnitude of the stars of this constellation.

5. **Spiral galaxy.** A spiral galaxy consisting mainly of A7-A8 spectral class stars was discovered in the Southern Cross (Crux) constellation. The galaxy may be seen as oval of about 40 by 30 arcsec in the sky. The broadened Hα line is observed at wavelengths approximately from 7054 Å to 7057 Å in the spectrum of the galaxy. Other lines in the spectrum are also shifted and broadened proportionally. Estimate the number of stars in the galaxy.