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. **Alpha Centauri.** Calculate, which star emits more energy: the Sun or Alpha Centauri A+B.

5. **Motion of a satellite.** An artificial satellite, moving in equatorial, slightly elliptical orbit passed the perigee point at the height of H_P = 428.0 km from the sea level; and its speed at the point was 0.6% higher than the circumferential velocity of the given point. Find the time after which the satellite will reach the height H_1 = 498.0 km?