

**Theoretical round. Problems to solve**

**General note.** Maybe not all problems have correct questions. Some questions (maybe the main question of the problem, maybe one of the subquestions) may make no real sense. In this case you have to write in your answer (in English or Russian): «**impossible situation** – **ситуация невозможна**». Of course, this answer has to be explained numerically or logically.

**Data from the tables** (Planetary data, stars, constants, etc.) may be used for solving every problem.

The answers «**Да-Yes**» or «**Нет-No**» have to be written in English or Russian.

- 1. Dreams of the Polar Bear.** Terrestrial Polar Bear-observer, watching the lunar disk in the phase of the full moon, in his dreams became thousand times closer to it. What did the magnitude of the Moon become? The solution has to include an artistic picture with an image of the Bear-observer on the North Pole.
- 2. Great oppositions.** Now great oppositions of Mars happen every 15 or 17 years. To simplify colonization of Mars, to improve environmental conditions on it, and to increase the effect of the great oppositions, our civilization has conceived an ambitious project: to reduce by 6.0% the semi-major axis of this planet's orbit, while keeping the eccentricity of the orbit unchanged. How often will the great oppositions of Mars occur in the case of the new orbit?
- 3. Proxima Centauri.** Can the star Proxima Centauri be visible from the vicinity of Alpha Centauri by naked eye? («**да-yes**» or «**нет-no**»). Justify your solution by calculations of the corresponding apparent magnitude of Proxima Centauri.
- 4. Hydroplanet.** Hydroplanet consists of a rocky “core” of radius  $R$  and a thick layer of water surrounding it from all sides. Local humans live at the bottom of this world's ocean (i.e., on the surface of the “core”), and hydrosphere is an analogue of our atmosphere for them. Local scientists observe astronomical objects from the bottom of the ocean. Like on our Earth, the duration of day-night period on Hydroplanet is  $T = 24$  hours.
  - 4.1.** Find the minimum depth  $H$  of the ocean, for which celestial bodies will be visible at the horizon.
  - 4.2.** What will be the duration of the day for inhabitants of the planet's equator? The disk of the central star can be considered as a point source of light.
  - 4.3.** Calculate the value of “atmospherial” refraction at the horizon on such a planet.

Points of your solution have to include drawings with all necessary sizes or angular sizes. The outer surface of the ocean is smooth, no waves or ripples.
- 5. Argali.** Argali (mountain sheep, in Kyrgyz and Russian - Arkhar), who lives in the foothills near Cholpon-Ata, is interested in the fact that students from different countries came to the Issyk-Kul and are looking at the sky at night, and not just so, but using some tubes. Moreover, Argali found himself in the logo of the event, as well as learned that one of the constellations in the sky was named in his honor. Will Argali see the stars of this constellation in the sky tonight? («**да-yes**» или «**нет-no**»). At what time (Kyrgyz time) and at what altitude the brightest star of this constellation will culminate during the nearest day or night? The solution has to include an artistic picture with an image of Argali observing “his” constellation in the sky.
- 6. Brightest stars.** Which four stars will be the brightest in the night sky of Cholpon-Ata in the CL (150<sup>th</sup>) century AD? Consider that  $\sim 5^\circ$  of the sky above the horizon are blocked by mountains. Explain your answer and prove it by necessary drawings and calculations. Any names of stars write in Latin.