

Uji CobaАСТРОНОМИЧЕСКОЕ  
ОБЩЕСТВОEURO-ASIAN  
ASTRONOMICAL SOCIETY

X Международная астрономическая олимпиада

X International Astronomy Olympiad

Китай, Пекин

25.X. – 2.XI. 2005

Beijing, China

## Задачи теоретического тура

## Theoretical round. Problems to solve

язык	<b>English</b>
language	

*Groups  $\alpha$   $\beta$* 

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

1. **The Bear.** The White Bear (whom was already met in the texts of the VII, VIII and IX International Astronomy Olympiads) has returned from Crimea to the North Pole and decided to observe a sunset. Calculate how long this sunset lasts. The solution has to include a picture with an image of the Bear on the North Pole; necessary sizes or angular sizes should be in the picture. Assume that the Earth is spherical. Recollect for yourself the necessary information about the White Bear.

But can the Bear prolong the observation of sunset, not moving from the Pole? For what time?

2. **Sun.** In one of the ancient models of the Universe the centre of solar system is the Earth rotating around its own axis, The stars are not moving around the Earth. The Moon and the Sun are orbiting the Earth. Mercury and Venus are orbiting the Sun. Mars, Jupiter and Saturn moves around invisible objects which are orbiting the Earth.

Consider the explanation of the system Earth-Moon to be correct in this model and the mass of Sun to be negligible in comparison with the mass of the Earth-Moon system. Find (by two different ways of solution) the distance between the Earth and the Sun in such a model.

~~Find the absolute stellar magnitude of such a Sun.~~

3. **Andromeda nebula.** We hope that you are familiar with the object Andromeda nebula (M31, NGC 224). Its stellar magnitude  $m = 4.4^m$  and its distance from us is 0.7 Mpc. To what distance from this object should we move, if it were to shine as the full Moon? What would the (approximate) angular size of this object be in that case?

При решении каждой задачи можно использовать данные прилагаемой «Таблицы данных о планетах». Data from the «Table of planetary data» may be used for solving every problem.

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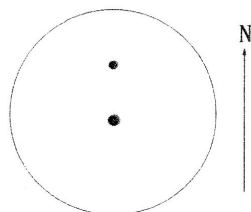
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#### Group $\alpha$

- $\alpha 4$ . **Sunspots.** At the day of the winter solstice we observe the Sun in Quito, the capital city of Ecuador in South America ( $78^\circ\text{W}$ ,  $0^\circ\text{S}$ ). The resulting image is seen in figure 1. There are two sunspots on the Sun. At the same time it is sunrise in Alaska ( $60^\circ\text{N}$ ) and sunset in Windhoek, the capital city of Namibia in Africa ( $17^\circ\text{E}$ ,  $23^\circ\text{S}$ ). Are these sunspots to be seen in Alaska and Windhoek. (Note: answer «**Да-Yes**» or «**Нет-No**» has to be written in English or Russian.) Draw the images of the observations of the Sun at that time as they are seen in Alaska and Windhoek.



a few minutes  
before after  
before sunset

East

West

- $\alpha 5$ . **Cluster.** Astronomers find a "star" which position in the Hertzsprung-Russell diagram is about  $8^m$  higher than the corresponding stars of the main sequence. Assume that the "star" is a cluster of similar stars and estimate the number of stars in the cluster.

- $\alpha 6$ . **Earth transit.** At November 7, 2005, the Mars opposition will occur. During this event Mars will be situated at 0.47 a.u. from the Earth, being quite close to the ecliptic line ( $27'$  south of it) as observed from the Earth. For this event the Martian Space Agency is planning the near-Mars space mission with astronauts onboard purposed to observe the Earth transit the centre of the solar disk. To diminish expenses the space mission will follow the optimal way – to observe the transit from the minimum possible distance from Mars. In what constellation will Mars be observed from the station in the middle of the Earth transit?

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Group  $\beta$ 

- $\beta$ 4. Pole star.** It is known, that the altitude of the Pole star above the horizon is numerically equal to the geographic latitude of the place of observation, and the direction to it is the direction to North. However there are some errors in these rules. Find the maximum errors (in  $^{\circ}$  and  $'$ ) while using this way to find the latitude of the place ( $\Delta\varphi$ ) and the direction to North ( $\Delta\beta$ ). The observations are carried out in the observatory Xinglong (Синьлун) near Beijing. The declination of the Pole star is equal to  $89^{\circ}10'$ . The approximate latitude of Beijing is  $\varphi = 40^{\circ}$ .
- $\beta$ 5. Cluster.** Astronomers find a "star" of the spectral class **A0** which position at the Hertzsprung-Russell diagram is about  $-7^m - 8^m$ ! (I.e. it is very much higher than the main sequence). Assume that the "star" is a cluster that consists of many similar stars and estimate the possible number of stars in the cluster.
- $\beta$ 6. Earth transit.** At November 7, 2005, the Mars opposition will occur. During this event Mars will be situated at 0.47 a.u. from the Earth, being quite close to the ecliptic line ( $27'$  south of it) as observed from the Earth. For this event the Martian Space Agency is planning the near-Mars space mission with astronauts onboard purposed to observe the Earth transit on the solar disk (at least transit through the edge of the Sun) and to investigate the Earth's atmosphere. What minimum orbital period of motion around Mars must this space station have?

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