



XIX Международная астрономическая олимпиада

XIX International Astronomy Olympiad

Бишкек – Чолпон-Ата

12–21. X. 2014

Bishkek – Cholpon-Ata

ЯЗЫК

language

English

Theoretical round. Basic criteria. For work of Jury

Note. The given sketches are not full; the team leaders have to give more detailed explanations to students. But the correct solutions in the students' papers (enough for 8 pts) may be shorter.

Note. Jury members should evaluate the student's solutions in essence, and not by looking on formal existence the mentioned sentences or formulae. The formal presence of the mentioned positions in the text is not necessary to give the respective points. Points should be done if the following steps de facto using these positions.

$\alpha\beta$ -1. Dreams of the Polar Bear.

Solution: 7 pt in total, including:

Understanding about impossibility to use approximation of point-like objects – 3 pt.

Result approximately $\Omega_2/\Omega_1 = 40\,000$ – 2 pt.

Formula and final calculations $-12^m.7 - 2^m.5 \cdot \log(40000) \approx -24^m.2$ – 2 pt.

Note: for any solution based on calculations in approximation of point-like objects or any answer resulting in larger than the Sun brightness total mark (except mark for the picture) should not be larger:

1 pt for group α ,

0,5 pt for group β .

Artistic picture of the Bear – 1 pt.

$\alpha\beta$ -2. Great oppositions.

Correct using Kepler's III law and finding $T_1 = T_0 \cdot (A_1/A_0)^{3/2} = 1.713$ years – 3 pt.

Correct finding synodic period ~ 2.4 years – 2 pt.

Understanding that the great opposition is one of five, and result 12 years – 3 pt.

$\alpha\beta$ -3. Proxima Centauri.

Understanding to use formula $d = (x^2 + y^2 + z^2)^{1/2}$ – 1 pt.

Correct formulae for x, y and z – 3×1 pt.

Correct final calculation of d – 1 pt.

Correct comparing with the magnitude as seen from the Earth and result of magnitude from α Cen – 1,5 pt.

Final comparing with 6^m and answer «да-yes» – 1,5 pt.

$\alpha\beta$ -4. Hydroplanet.

Common part.

Understanding nature of effect, total reflection effect – 2 pt.

Correct drawing (also showing total reflection effect) – 1 pt.

Using refractive index of water $n = 1.334$, calculation $\sin \beta$, and β – 1,5 pt.

4.1. Answer: $H = 0.334 R$ – 1,5 pt.

4.2. Calculation and correct answer – 1 pt.

4.3. Picture, calculation and correct answer – 1 pt.

α-5. Argali.

Solution: 7 pt in total, including:

Argali means the constellation Aries – 1 pt.

Position of constellation in October, Aries now is perfectly visible at night – 1 pt.

Understanding that the brightest star in the constellation is Hamal, α Ari – 0,5 pt.

Correct calculation of the time of upper culmination – 3 pt, including:

Correct taking into account difference with Sep 23 (or other repere point) – 1 pt.

Correct taking into account: Cholpon-Ata is located in 13° to the West of the meridian 90° – 1 pt.

Correct using RA and final result – 1 pt.

Correct calculation of the altitude of upper culmination – 1 pt.

Correct calculation of the altitude of lower culmination – 0,5 pt.

Artistic picture of Argali – 1 pt.

β-5. Climate.

Understanding nature of the effect and conclusion synodic period is 1 year – 1 pt.

Calculation sidereal period = 0.5 years – 1 pt.

Radius of the orbit from the III Kepler's law – 1 pt.

Energy balances – 2 pt.

5.1. Temperature of the Sun – 1 pt.

5.2. $\Delta M = -5/2^m \cdot \lg(0.0464) \approx 3^m.3$ and from the HR-diagram spectral type K3 – 2 pt.

α-6. Brightest stars.

Understanding nature, precession – 1,5 pt.

Position of the North celestial pole after 13000 years 1 pt.

Region of sky never rise under the mountains – 1,5 pt.

Speculation about Sirius, Canopus, Toliman, Arcturus, Vega, Capella – 3 pt.

Final correct answer – 1 pt.

β-6. Sombrero Galaxy.

6.1. Spectra are redshifted, receding from us – 1 pt.

6.2. $z_{av} = (\Delta\lambda/\lambda)_{average} \approx 0.0035$ – 1 pt.

$V = cz = 0.0036 \times 300000 \text{ km/s} = 1050 \text{ km/s}$ – 1 pt.

6.3. $L = V/H = 1050 \text{ km/s} / 71 \text{ km/s/Mpc} \approx 15 \text{ Mpc}$ – 1 pt.

$R(\text{a.u.}) = 0.54 \times 15 \cdot 10^6 \approx 8 \cdot 10^6$ – 1 pt.

Other correct calculations and obtaining the mass of the galactic center – 3 pt.