

XII Международная астрономическая олимпиада
XII International Astronomy Olympiad

Крым, Сивеиз

29. IX. – 07. X. 2007

Simeiz, Crimea

ЯЗЫК	<i>English</i>
language	

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 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. **Galaxy.** The bolometric (total) stellar magnitude of a galaxy visible from a distance of $L_1 = 3$ Mpc is $m_1 = 6^m.88$. Find the bolometric stellar magnitude m_2 of this galaxy visible from a distance of $L_2 = 3$ Gpc.
2. **Space sail.** A space probe for research of the asteroid belt is sent to objects of researches by using a solar sail. The probe-system of mass $m = 1$ ton was moving around the Sun in a circular orbit of radius 1 a.u. Then such a sail (that was earlier a part of the probe-system) was opened and after half a revolution around the Sun the probe has reached Ceres. Estimate the area S and thickness d of this sail. Consider the sail is of mirror-type. The typical distances of the asteroid belt bodies from the Sun are 2.8 a.u. The constant of total solar irradiation is $A \approx 1.37$ kW/m².
3. **Alcohol in Universe.** Astronomers based at Britain's Jodrell Bank Observatory say they have spotted a cloud of alcohol in deep space that measures 288 billion miles (463 billion kilometres) across, a finding that could shed light on how giant stars are formed from primordial gas. Some nations even decided to send expeditions to this area to taste the cloud but... enthusiasm disappeared after learning that the cloud is so remote that it will take us many millions years to reach it on the modern techniques. The density of molecules in the cloud is large in comparison with the interstellar gas density but very small from our custom point of view, only about 10 atoms/mm³. Estimate the temperature such a cloud should have to be stable and not get dispersed in future (before the international expedition will reach the cloud). Suppose the alcohol is ethyl (C₂H₅OH).
4. **Photo.** In the photo given to you there is an airplane with the Moon in the background. Let us suppose that the photo was taken in Simeiz at the day of a solar eclipse (or at one of the days closest to a solar eclipse). Estimate how long later is (or how long time ago was) the solar eclipse. (Note: The answer «Будет-Will be» or «Было-Was» has to be written in English or Russian.) Will it be (or was it) possible to observe this eclipse in Simeiz? (Note: the answer «Да-Yes», «Может быть-May be» or «Нет-No» has to be written in English or Russian and a picture explaining your answer has to be included.)
5. **Visit.** Extraterrestrial animals (animaloids) decided to colonize the Earth. The navigation devices of the spacecrafts of vituloids (lat. vitulus = seal = тюлень) needs that sometimes after the landing the Polar star ($\alpha = 2^h32^m$, $\delta = 89^{\circ}16'$ at the epoch of starting the colonization) must be exactly in Zenith and the devices of crocodiloids needs that sometimes the Polar Star must be exactly on the Horizon. The devices are placed on the top of the spacecrafts and these can land on the Earth only in vertical positions. Also every device has to be invisible directly for the device of any other spacecraft. Estimate, how many spacecrafts of every type of animaloids can land on the Earth. Consider the Earth to be spherical, the spacecrafts' bottoms to be on its surface (may stay either on ground or on the water) and the height of every spacecraft is $h = 10$ m.

Data from the table of planetary data may be used for solving every problem.



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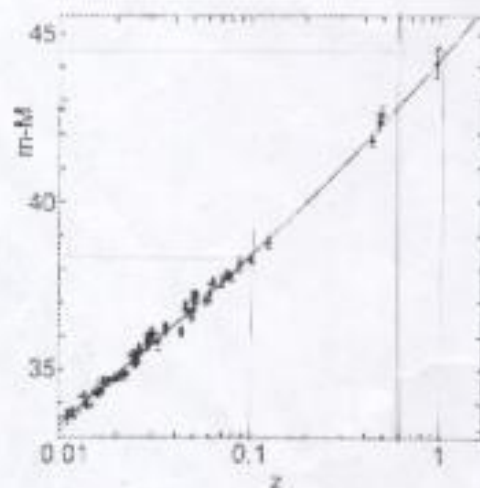
Simеiz, Crimea

Язык
language

English

Practical round. Problems to solve

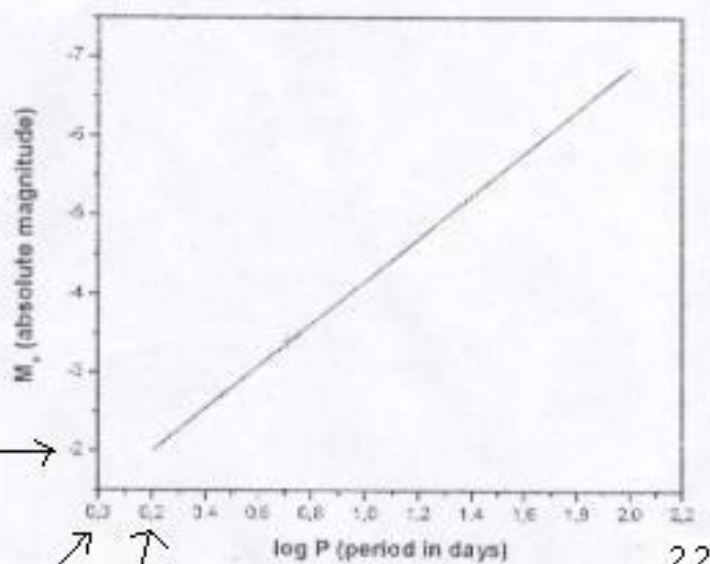
6. **Supernova.** A Hubble diagram is shown in the right plot. Find the apparent magnitude of a hypothetic Supernova of type Ia, if it exploded at a distance $2.5 \cdot 10^3$ Mpc, and it is known that all of the SN Ia have similar absolute magnitudes ($M = -19^m.5$).



7. **Radial velocity.** Imagine a cepheid whose position is on the border between the constellations of Sgr and Sct. This cepheid has a mean apparent magnitude of $6^m.2$. Spectroscopic observations of the H α line (laboratory wavelength is $\lambda = 6562.8 \text{ \AA}$) for this cepheid were carried out during 16 successive nights in the second part of September. The list of observations is given in the table. Make such a plot based on the data listed in this table which enables you to derive several important characteristics of this cepheid and to answer the question: Could this cepheid be seen by the first people on the Earth (about 2 million years ago)? (the answer should be written in English: **Yes** or **No**.) What was the apparent magnitude of this star at that time?

Supplementary information: Use the relation showed in the plot below (this relation is valid for cepheids - pulsating stars).

Recommendations: interstellar absorption, rotation of the Earth around its axis and possible changes of the cepheid mean luminosity during the last 2 million years can be ignored.



Moment of observations (in part of days)	Observed wavelength, \AA
0.9	6565,1
1.8	6565,1
2.9	6564,6
3.9	6564,4
4.9	6564,9
5.8	6565,1
6.8	6564,8
7.8	6564,5
8.8	6564,5
8.9	6564,6
9.8	6565,0
10.8	6565,0
11.9	6564,6
12.8	6564,4
13.8	6564,4
14.8	6564,7
15.9	6565,1



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Round Pr

Group B . . .

Пожалуйста, пишите текст только внутри очерченных границ!

Please, write text inside the marked borders only!

ЯЗЫК	
language	fill this cell as Russian
ЯЗЫК	Persian
language	fill this cell as English
ЯЗЫК	فارسی
language	fill this cell as Native

۶- ابرنو افره

نودان که مشاهده می کنید، نودار هابل است. ابرنو افره ی فرضی را از نوع Ia تصور کنید که مسافتش 2.5×10^3 مگاپارسک منفرجه است. با این فرض که تمام ابرنو افره های نوع Ia دارای قدر مطلق یکسان برابر $M = -19.5$ هستند، قدر ظاهری این ابرنو افره فرضی را بیابید.

۷- سرمتا شعاعی

طول موج شعاعی بیمب برسد	طول موج شعاعی A
0.9	6564.1
1.8	6565.1
2.9	6564.6
3.9	6564.4
4.9	6564.9
5.8	6565.1
6.8	6564.8
7.8	6564.5
8.8	6564.5
8.9	6564.6
9.8	6565.0
10.8	6565.0
11.9	6564.6
12.8	6564.4
13.8	6564.4
14.8	6564.7
15.9	6565.1

ستاره ای قیفاوروس را در نظر بگیرید که در روز صورتی مریخی

قوس Sgr در سپه Set قرار دارد. مقدار μ این ستاره

قدر ظاهری این قیفاوروس 6.2^m است. مشاهدات

طیف شعاعی خط H α (با طول موج 6563.3^{A})

در حدود این قیفاوروس در $\lambda = 6562.8^{\text{A}}$ است

سوالی در زمینه دویم سیستم اجرام زینتی است. فریب

دانه های رصدی در جدول دراصل مکان قرار می دهند.

رابطه مکانی دانه های فریب باشد. هر جدول کناری

نموداری رسم کنید که شماره قادر سازد برخی خصوصیات

تمام این قیفاوروس را معین نماید و به کمک آن تاریخ رصد μ را بداند



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Round **Pr**
Group **B.**

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language	fill this cell in English
ЯЗЫК	عربی
language	fill this cell in Native

★ راه سوال ۷ ★

— آیا این سیفاردی برای مردان لوله زمین (حدود ۲ میلیون سال قبل) قابل رویت بود؟ (پایخ باید به انگلیسی بصورت Yes یا No کاملاً مشخص باشد)

— در زمان این مردم لوله (۲ میلیون سال قبل) قدری طغری این ستار چه درون است؟

اصولت کنید:

از رابطه خطی که در نمودار مربوط به سوال ۷ در اختیاران قرار گرفته است استفاده کنید (این رابطه برای ستارگان پهنه (متغیر) سیفاردی معتبر است).

توصیه:

توانید از جذب میان ستارای، چرخش زمین حول محور خود و تغییرات مکان درخشندگی متغیر سیفاردی در ۲ میلیون سال گذشته استفاده کنید.

موفق باشید.