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. **Earth and Moon.** The photo of the Earth and the Moon is taken from an artificial satellite of the Earth. Estimate the stellar magnitude of the Moon for an observer on this satellite.

2. **Sidereal period.** Estimate (at least roughly) the smallest and the largest possible orbital sidereal periods of bodies (any bodies, including artificial ones) of our Solar System.

3. **Marsset.** Estimate (at least roughly) the duration of Mars disk set for an observer at the mountain Koshka in Simeiz for Mars in Great opposition.

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 ($\alpha = 2^h32^m$, $\delta = 89°16'$ 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.

АСТРОНОМИЧЕСКОЕ ОБЩЕСТВО

EURO-ASIAN ASTRONOMICAL SOCIETY

Round Th

Group β

XII Международная астрономическая олимпиада
XII International Astronomy Olympiad

Крым, Симеиз 29. IX. – 07. X. 2007 Simeiz, Crimea

язык language	English

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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/m^2.

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/mm^3. 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 (C_2H_5OH).

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.)

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язык language	Русский
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Элементы орбит.
Физические характеристики некоторых планет, Луны и Солнца

Parameters of orbits.
Physical characteristics of some planets, Moon and Sun

Небесное тело, планета	Среднее расстояние от центрального тела		Сидерический период обращения		Эксцентриситет, *e*	Экваториальн. диаметр *км*	Масса 10^{24} *кг*	Средняя плотность $г/см^3$	Ускор. своб. пад. у пов. $м/с^2$	Макс. блеск, вид. с Земли **)	Альбедо
	в *астр. ед.*	в *млн. км*	в тропич. годах	в средних сутках							
Body, planet	Average distance to central body		Sidereal (or analogous) period		Eccentricity *e*	Equat. diameter *km*	Mass 10^{24} *kg*	Av. density g/cm^3	Grav. acceler. at surf. m/s^2	Max. magn. from Earth **)	Albedo
	in *astr. units*	in *mln. km*	in troph. years	in days							
Солнце Sun	$1{,}6\cdot10^9$	$2{,}5\cdot10^{11}$	$2{,}2\cdot10^8$	$8\cdot10^{10}$		1392000	1989000	1,409		$-26{,}8^m$	
Меркурий Mercury	0,387	57,9	0,241	87,97	0,206	4 879	0,3302	5,43	3,70	$-2{,}2^m$	0,06
Венера Venus	0,723	108,2	0,615	224,70	0,007	12 104	4,8690	5,24	8,87	$-4{,}7^m$	0,78
Земля Earth	1,000	149,6	1,000	365,26	0,017	12 756	5,9742	5,515	9,81		0,36
Луна Moon	0,00257	0,38440	0,0748	27,3217	0,055	3 475	0,0735	3,34	1,62	$-12{,}7^m$	0,07
Марс Mars	1,524	227,9	1,880	686,98	0,093	6 794	0,6419	3,94	3,71	$-2{,}0^m$	0,15
Юпитер Jupiter	5,204	778,6	11,862	4 332,59	0,048	142 984	1899,8	1,33	24,86	$-2{,}7^m$	0,66
Сатурн Saturn	9.584	1433,7	29,458	10 759,20	0,054	120 536	568,50	0,70	10,41	$0{,}7^m$	0,68

**) Для внешних планет и Луны – в среднем противостоянии.
**) For outer planets and Moon – in mean opposition.

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