АСТРОНОМИЧЕСКОЕ ОБЩЕСТВО | EURO–ASIAN ASTRONOMICAL SOCIETY

Round **Prac**

Group α β

XVII Международная астрономическая олимпиада
XVII International Astronomy Olympiad

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язык / language **English**

Practical round. Problem 7 to solve

Note. If you find somewhere in the problems an impossible situation, write in English «**impossible situation**».

7. Fireball. A fireball was observed from three different observing sites I, II, III. The position of the observing sites, the altitude and azimuth of start and end points of the fireball's trajectory are given in Table 1. Azimuth is measured eastward from the North direction, and altitude measured above the horizon, and both the angular measurements are in degrees. Following the steps below, find true trajectory and location on the surface of Earth of fallen debris of the fireball (meteorite).

Table 1. Observational Data for a Fireball

observing position			starting point (**A**)		end point (**B**)	
	longitude	latitude	azimuth	altitude	azimuth	altitude
I	127.3°E	+35.7°	17°	35°	77°	10°
II	128.5°E	+37.0°	235°	-	139°	-
III	128.5°E	+35.4°	325°	-	48°	-

7.1. You are provided by a scaled marked graph paper. Mark the 3 observing positions (I, II, III) and draw a projected trajectory of the fireball as seen on the surface of Earth.

7.2. Calculate the longitude and latitude of start (λ_A, φ_A) and end (λ_B, φ_B) points of the fireball and total length **L** of the trajectory projected on the earth surface.

7.3. Find the heights of starting point $\mathbf{h_A}$ and end point $\mathbf{h_B}$. of the fireball's trajectory above the surface of Earth.

7.4. Where can you find a meteorite, if it survives passage through the atmosphere and hits the ground? Calculate the longitude and latitude (λ_C, φ_C) of the location of the meteorite on the surface of Earth's.

Finally, redraw the table below to your answer-book and fill the empty cells with you results.

point	longitude λ	latitude φ	L (km)	h_A (km)	h_B (km)	You may find the meteorite at: longitude λ	You may find the meteorite at: latitude φ
A							
B							

Practical round. Problem 8 to solve

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8. Moon. The Korean Astronomy and Space Science Institute (KASI) publishes the Korean Astronomical Almanac every year. You have been provided with an astronomical table extracted from the Korean Astronomical Almanac of 2012 showing the Korean local time of Moon culmination. (See separate sheet, and you may fill the empty cells by necessary content.)

Date	Culmination of Moon		Date	Culmination of Moon		Date	Culmination of Moon	
Mar 2			April 1			May 1		

Also you are provided with a scaled marked graph paper to plot graphs.

8.1. Find the date in April 2012 when the Moon is closest to the Earth.
8.2. Find the date in March 2012 when the Moon is remotest from the Earth.
8.3. The scaled marked graph paper (a) shows the eccentric orbit of the Moon, the Earth being located at the center. Mark the positions of the Moon by the symbol **x** on April 19 and April 23 (with labels A19 and A23).
8.4. Calculate the ratio of the apparent angular sizes of the Moon (α_{Moon}) and the Sun (α_{Sun}) on July 1.
8.5. Draw on the scaled marked graph paper the geostationary orbit around the Earth in the given scale.

Практический тур. Таблица к задаче 8

Practical round. Table for Problem 8

Дата	Кульминация Луны		Дата	Кульминация Луны		Дата	Кульминация Луны	
Date	Culmination of Moon		Date	Culmination of Moon		Date	Culmination of Moon	
Mar 2	19 40		April 1	20 02		May 1	20 20	
3	20 31		2	20 52		2	21 10	
4	21 22		3	21 42		3	22 02	
5	22 14		4	22 33		4	22 57	
6	23 05		5	23 25		5	23 56	
7	23 56		6	-		6	-	
8	-		7	0 19		7	0 57	
9	0 48		8	1 16		8	2 01	
10	1 41		9	2 16		9	3 03	
11	2 36		10	3 17		10	4 04	
12	3 32		11	4 19		11	5 00	
13	4 31		12	5 19		12	5 52	
14	5 30		13	6 15		13	6 40	
15	6 29		14	7 08		14	7 26	
16	7 26		15	7 57		15	8 09	
17	8 20		16	8 43		16	8 52	
18	9 11		17	9 28		17	9 35	
19	9 59		18	10 10		18	10 18	
20	10 45		19	10 53		19	11 02	
21	11 29		20	11 36		20	11 48	
22	12 12		21	12 19		21	12 36	
23	12 55		22	13 04		22	13 24	
24	13 38		23	13 51		23	14 14	
25	14 22		24	14 39		24	15 03	
26	15 08		25	15 27		25	15 52	
27	15 54		26	16 17		26	16 40	
28	16 43		27	17 06		27	17 27	
29	17 32		28	17 55		28	18 14	
30	18 22		29	18 43		29	19 02	
31	19 12		30	19 31		30	19 51	

Элементы орбит.
Физические характеристики некоторых планет, Луны, Солнца и Эриды

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

Небесное тело, планета / Body, planet	Среднее расстояние от центрального тела / Average distance to central body		Сидерический (или аналогичный) период обращения / Sidereal period (or analogous)		Наклон орбиты, i / Orbital inclination, i	Эксцентриситет, e / Eccentricity e	Экваториальн. диаметр / Equat. diameter	Масса / Mass	Средняя плотность / Av. density	Ускор. своб. пад. у пов. / Grav. accelr. at surf.	Наклон оси / Axial tilt	Макс. блеск, вид. с Земли **) / Max. magn. From Earth **)	Альбедо / Albedo
	в астр. ед. / in astr. units	в млн. км / in 10^6 km	в тропич. годах / in tropical years	в средних сутках / in days	i	e	км / km	10^{24} кг / 10^{24} kg	г/см^3 / g/cm^3	м/с^2 / m/s^2			
Солнце Sun	$1,6 \cdot 10^9$	$2,5 \cdot 10^{11}$	$2,2 \cdot 10^8$	$8 \cdot 10^{10}$			1392000	1989000	1,409			$-26,74^m$	
Меркурий Mercury	0,387	57,9	0,241	87,969	7,00°	0,206	4 879	0,3302	5,43	3,70	0,01°		0,06
Венера Venus	0,723	108,2	0,615	224,7007	3,40	0,007	12 104	4,8690	5,24	8,87	177,36		0,78
Земля Earth	1,000	149,6	1,000	365,2564	0,00	0,017	12 756	5,9742	5,515	9,81	23,44		0,36
Луна Moon	0,00257	0,38440	0,0748	27,3217	5,15	0,055	3 475	0,0735	3,34	1,62	6,7	$-12,7^m$	0,07
Марс Mars	1,524	227,9	1,880	686,98	1,85	0,093	6 794	0,6419	3,94	3,71	25,19	$-2,0^m$	0,15
Юпитер Jupiter	5,204	778,6	11,862	4 332,59	1,30	0,048	142 984	1899,8	1,33	24,86	3,13	$-2,7^m$	0,66
Сатурн Saturn	9,584	1433,7	29,458	10 759,20	2,48	0,054	120 536	568,50	0,70	10,41	26,73	$0,7^m$	0,68
Эрида Eris	68,05			205 029	43,82	0,435	2 326	0,0167	2,52	0,7			0,96

**) Для Луны – в среднем противостоянии.
**) For Moon – in mean opposition.

Practical round. Problem 8 to solve

Note. If you find somewhere in the problems an impossible situation, write in English «**impossible situation**».

8. **Clusters.** Using the moving cluster method, the Hyades cluster is known to be 45 pc away. This open cluster is important as a standard candle, because we can use it to determine the distances of other clusters. However, the interstellar medium absorbs light making a star appear fainter and redder, which is called the interstellar extinction A_V and reddening $E_{(B-V)}$, both measured in stellar magnitudes. The true distance modulus can be computed using the relation

$$m - M = 5\log\mathbf{d} - 5 + A_V.$$

The empirical relation between A_V and $E_{(B-V)}$ is

$$A_V = 3 \cdot E_{(B-V)}.$$

In Tables I and II, you are provided with photometric data of the stars of the two open clusters, Hyades and NGC 2682.

8.1. Make the colour-magnitude diagrams of the Hyades cluster and NGC 2682 using the provided scaled marked graph paper (A). In the diagrams, draw the main sequence line of each cluster.
8.2. Plot the colour-colour diagrams of the Hyades cluster and NGC 2682 using the provided scaled marked graph paper (B).
8.3. Assuming that the interstellar reddening of Hyades cluster is negligible, derive the interstellar reddening, $E_{(B-V)}$ of NGC 2682.
8.4. Determine the distance to NGC 2682.
8.5. Find the absolute magnitude and colour index (B-V) of the main sequence turn-off star in each cluster, approximately.
8.6. Which cluster is older? (Write in English «**Hyades**» or «**NGC 2682**».)

Практический тур.
Таблицы к задаче 8

Practical round.
Tables for Problem 8

Таблица 1. Данные о Гиадах
Table 1. Hyades data

m_V	(B-V)	(U-B)	m_V	(B-V)	(U-B)
7.78	+0.62	+0.16	6.62	+0.42	-0.01
7.14	+0.51	+0.05	5.65	+0.28	+0.08
8.46	+0.72	+0.31	3.61	+0.99	+0.84
7.47	+0.57	+0.08	4.80	+0.16	+0.12
4.22	+0.14	+0.12	3.85	+0.96	+0.74
6.02	+0.34	+0.04	4.27	+0.12	+0.11
5.13	+0.21	+0.12	9.05	+0.84	+0.53
9.99	+1.06	+0.95	8.06	+0.64	+0.17

Таблица 2. Данные о NGC 2682
Table 2. NGC 2682 data

m_V	(B-V)	U-B	m_V	(B-V)	(U-B)
12.80	+0.79	+0.27	13.66	+0.55	+0.03
12.67	+0.68	+0.19	12.55	+0.41	+0.03
12.93	+0.93	+0.59	14.00	+0.61	+0.11
15.64	+0.89	+0.53	16.38	+1.00	+0.70
15.19	+0.80	+0.30	14.96	+0.76	+0.28
17.33	+1.19	+0.97	14.23	+0.64	+0.12
12.16	+1.02	+0.81	13.14	+0.45	+0.01
12.22	+0.42	+0.03	13.25	+0.52	+0.01