

XXI Международная астрономическая
олимпиада

XXI International Astronomy Olympiad

Болгария, Пампорово-Смолян

5 – 13. X. 2016

Pamporovo-Smolyan, Bulgaria

язык	<u>English</u>
language	

Practical round

6. Comet observer. Table 1 shows 20 observations (ephemerides) of the comet P/2007 R2 (Gibbs), taken in equal time intervals of 121 days and 18 hours, so that there are 3 measurements per year. The orbit's inclination angle is $i = 1.4339^\circ$ and can be neglected. The following notations are used:

- N – number of observation.
- Date (UT) – date of observation, HR and MN are hour and minutes
- R. A. (hh:mm:ss) and DEC (deg:mm:ss) – right ascension and declination of comet's centre, respectively.
- T-mag – the comet's approximate apparent total magnitude.
- Delta – the distance of comet's centre with respect to the observer at the observation moment, measured in au (astronomical units)
- S-O-C (Sun-Observer-Comet) – Sun-Observer-Comet angle in degrees (the comet's apparent *solar elongation*, in the range $0^\circ - 180^\circ$).
- Column /r – the comet's apparent position relative to the Sun in the observer's sky.
/T indicates that the comet *trails* the Sun (the comet rises and sets *after* the Sun),
/L indicates that the comet *leads* the Sun (the comet rises and sets *before* the Sun), as shown on Figure 1.

Fig. 1: The Earth's orbit around the Sun, as seen from the north ecliptic pole. The direction of Earth's orbital motion is shown with an arrow.

Use the data from the table to:

6.1. Draw the comet's orbit on the provided graph paper as seen from the north ecliptic pole. Denote the points (comet's positions) with their relevant numbers **N**. Assume that the Earth moves with constant orbital speed.

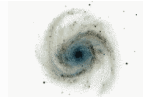
6.2. Calculate the values of the orbit's semi-major axis **a** and eccentricity **e**.

6.3. Without using any additional data (such as the mass of the Sun or Kepler's Third Law), estimate the comet's orbital period **T**.

6.4. Without using any additional data (such as the mass of the Sun), calculate the orbital speed of the comet in perihelion V_p and aphelion V_a .

6.5. Calculate the solar mass **M**. The gravitational constant is $G = 6.67 \cdot 10^{-11} \text{ N} \cdot \text{m}^2 / \text{kg}^2$.

6.6. Calculate the orbital velocity **V** and the escape velocity V_e at the position with $N = 7$.



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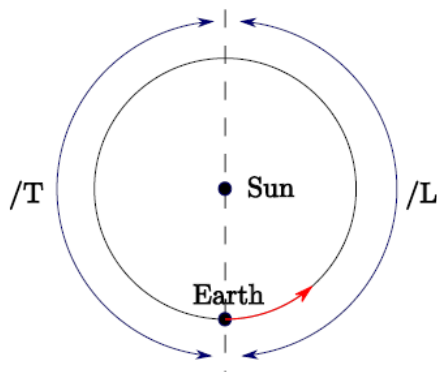


Fig.1.

Рис.1.

N	Date (UT)	HR:MN	R. A.			DEC			T-mag	Delta	S-O-C	/r
1	2004-09-30	00:00	12	26	37.40	-02	35	00.4	33.12	6.485	0.271	/T
2	2005-01-29	18:00	13	28	32.58	-09	15	06.5	32.32	4.967	105.966	/L
3	2005-05-31	12:00	12	38	34.29	-04	26	57.7	31.77	4.493	120.555	/T
4	2005-09-30	06:00	13	29	55.02	-09	49	15.1	31.82	5.715	17.327	/T
5	2006-01-30	00:00	15	07	52.88	-18	16	04.6	30.60	4.419	80.257	/L
6	2006-05-31	18:00	14	28	41.00	-15	54	56.7	28.80	2.940	149.891	/T
7	2006-09-30	12:00	15	08	57.98	-18	38	54.3	28.09	3.884	42.866	/T
8	2007-01-30	06:00	18	31	38.72	-24	18	09.1	25.77	3.252	32.669	/L
9	2007-06-01	00:00	23	02	49.26	-07	42	38.0	21.35	1.464	86.189	/L
10	2007-09-30	18:00	03	31	15.59	+20	03	36.3	18.62	0.649	131.671	/L
11	2008-01-30	12:00	03	43	46.19	+21	38	57.9	23.18	1.616	108.756	/T
12	2008-05-31	06:00	06	55	11.41	+23	55	34.8	27.27	3.724	32.564	/T
13	2008-09-30	00:00	09	38	45.54	+15	09	48.2	29.09	4.234	45.116	/L
14	2009-01-29	18:00	09	57	24.96	+13	53	18.2	29.55	3.204	163.127	/L
15	2009-05-31	12:00	09	31	40.74	+15	30	19.4	31.20	4.845	70.213	/T
16	2009-09-30	06:00	11	04	18.66	+06	35	02.1	32.13	5.854	22.454	/L
17	2010-01-30	00:00	11	42	42.32	+02	32	28.1	31.90	4.447	134.801	/L
18	2010-05-31	18:00	10	57	35.25	+07	03	49.9	32.45	5.196	92.885	/T
19	2010-09-30	12:00	12	04	42.28	-00	18	36.2	33.00	6.407	5.875	/L
20	2011-01-30	06:00	12	58	53.76	-06	12	50.7	32.40	4.920	113.868	/L

Table 1. Таблица 1.