

Полярные координаты

Задан закон движения точки в полярных координатах: $\rho = \rho(t)$ (в метрах), $\varphi = \varphi(t)$. В указанный момент времени найти скорость и ускорение точки в полярных, декартовых и естественных координатах.

Кирсанов М.Н. **Решебник. Теоретическая механика**/Под ред. А. И. Кириллова.– М.: ФИЗМАТЛИТ, 2008. — 384 с. (с.144.)

Задача К4.1.

7

$$r = 48(1 - (t/6)^2)/t,$$
$$\varphi = \arccos(t/6), t = 4 \text{ с.}$$

Задача К4.2.

7

$$r = 22/(1 + \frac{3}{8}t),$$
$$\varphi = \arccos(t/8), t = 7 \text{ с.}$$

Задача К4.3.

7

$$r = 24(1 - (t/8)^2)/t,$$
$$\varphi = \arccos(t/8), t = 3 \text{ с.}$$

Задача К4.4.

7

$$r = 17(t/11)^2,$$
$$\varphi = (t/11)^2, t = 10 \text{ с.}$$

Задача К4.5.

7

$$r = 9t \cos(t/9),$$
$$\varphi = t, t = 8 \text{ с.}$$

Задача К4.6.

7

$$r = 21(1 - (t/7)^2)/t,$$
$$\varphi = \arccos(t/7), t = 4 \text{ с.}$$

Задача К4.7.

7

$$r = 10 + 10t \operatorname{tg}^2(\pi t/19),$$
$$\varphi = \cos^2(\pi t/19), t = 6 \text{ с.}$$

Задача К4.8.

7

$$r = 11 + 11t \operatorname{tg}^2(\pi t/21),$$
$$\varphi = \cos^2(\pi t/21), t = 6 \text{ с.}$$

Задача К4.9.

7

$$r = \frac{3}{7}t - \frac{42}{t},$$
$$\varphi = \arccos(t/14), t = 9 \text{ с.}$$

Задача К4.10.

7

$$r = \frac{27}{1 + 0.6 \cos(t/5)},$$
$$\varphi = \frac{t}{5}, t = 2 \text{ с.}$$

Задача К4.11.

7

$$r = 36/t + 12,$$
$$\varphi = \arccos(t/12), t = 10 \text{ с.}$$

Задача К4.12.

7

$$r = 13e^{t/12},$$
$$\varphi = e^{t/12}, t = 9 \text{ с.}$$

Задача К4.13.

7

$$r = \frac{17 \sin^2(t/9)}{\cos(t/9)},$$
$$\varphi = \frac{t}{9}, t = 5 \text{ с.}$$

Задача К4.14.

7

$$r = \frac{7}{5}t - \frac{70}{t},$$
$$\varphi = \arccos(t/10), t = 5 \text{ с.}$$

Задача K4.15.

7

$$r = \frac{2}{5}t - \frac{20}{t},$$
$$\varphi = \arccos(t/10), t = 8 \text{ c.}$$

Задача K4.16.

7

$$r = 22/(1 + \frac{3}{11}t),$$
$$\varphi = \arccos(t/11), t = 10 \text{ c.}$$

Задача K4.17.

7

$$r = 13e^{-t/4},$$
$$\varphi = e^{t/4}, t = 1 \text{ c.}$$

Задача K4.18.

7

$$r = \frac{22}{1 + \cos(t/10)},$$
$$\varphi = \frac{t}{10}, t = 6 \text{ c.}$$

Задача K4.19.

7

$$r = 30/(1 + t/15),$$
$$\varphi = \arccos(t/9), t = 6 \text{ c.}$$

Задача K4.20.

7

$$r = 16 \cos^2(\pi t/6),$$
$$\varphi = \cos^2(\pi t/6), t = 2 \text{ c.}$$

Задача K4.21.

7

$$r = \frac{12 \sin^2(t/15)}{\cos(t/15)},$$
$$\varphi = \frac{t}{15}, t = 10 \text{ c.}$$

Задача K4.22.

7

$$r = 8t \sin(t/5),$$
$$\varphi = t, t = 7 \text{ c.}$$

Задача K4.23.

7

$$r = 22/(1 + \frac{5}{11}t),$$
$$\varphi = \arccos(t/11), t = 10 \text{ c.}$$

Задача K4.24.

7

$$r = \frac{23}{1 + 4 \cos(t/8)},$$
$$\varphi = \frac{t}{8}, t = 7 \text{ c.}$$

Задача K4.25.

7

$$r = 11t \sin(t/4),$$
$$\varphi = t, t = 10 \text{ c.}$$

Задача K4.26.

7

$$r = 24(t/11)^2,$$
$$\varphi = (t/11)^2, t = 10 \text{ c.}$$

Задача K4.27.

7

$$r = 8t \cos(t/5),$$
$$\varphi = t, t = 4 \text{ c.}$$

Задача K4.28.

7

$$r = 40(1 - (t/10)^2)/t,$$
$$\varphi = \arccos(t/10), t = 5 \text{ c.}$$

К4 Ответы.
Полярные координаты

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№	ρ	$\dot{\rho}$	φ	$\dot{\varphi}$	v_ρ	v_φ	v	v_x	v_y	Кривая
1	6.667	-4.333	0.841	-0.224	-4.333	-1.491	4.583	-1.778	-4.224	Циссоида
2	6.069	-0.628	0.505	-0.258	-0.628	-1.567	1.688	0.209	-1.675	Гипербола
3	6.875	-3.042	1.186	-0.135	-3.042	-0.927	3.180	-0.281	-3.167	Циссоида
4	14.050	2.810	0.826	0.165	2.810	2.322	3.645	0.196	3.640	Архимедова спираль
5	45.380	-0.538	8.000	1.000	-0.538	45.380	45.383	-44.819	-7.136	
6	3.536	-1.741	0.963	-0.174	-1.741	-0.615	1.847	-0.490	-1.781	Циссоида
7	33.428	16.920	0.299	-0.151	16.920	-5.062	17.661	17.660	0.150	Гиперболическая спираль
8	28.297	10.616	0.389	-0.146	10.616	-4.127	11.390	11.389	0.205	Гиперболическая спираль
9	-0.810	0.947	0.873	-0.093	0.947	0.075	0.950	0.551	0.774	Строфоида
10	17.390	0.523	0.400	0.200	0.523	3.478	3.517	-0.872	3.407	Эллипс
11	15.600	-0.360	0.586	-0.151	-0.360	-2.352	2.379	1.000	-2.159	Конхоида Никомеда
12	27.521	2.293	2.117	0.176	2.293	4.855	5.370	-5.340	-0.562	Архимедова спираль
13	5.566	2.376	0.556	0.111	2.376	0.618	2.456	1.693	1.779	Циссоида
14	-7.000	4.200	1.047	-0.115	4.200	0.808	4.277	1.400	4.041	Строфоида
15	0.700	0.713	0.644	-0.167	0.713	-0.117	0.722	0.640	0.334	Строфоида
16	5.902	-0.432	0.430	-0.218	-0.432	-1.288	1.358	0.144	-1.351	Гипербола
17	10.124	-2.531	1.284	0.321	-2.531	3.250	4.119	-3.833	-1.508	Гиперболическая спираль
18	12.053	0.373	0.600	0.100	0.373	1.205	1.262	-0.373	1.205	Парабола
19	21.429	-1.020	0.841	-0.149	-1.020	-3.194	3.353	1.701	-2.890	Эллипс
20	4.000	-7.255	0.250	-0.453	-7.255	-1.814	7.478	-6.581	-3.552	Архимедова спираль
21	5.839	1.296	0.667	0.067	1.296	0.389	1.353	0.778	1.107	Циссоида
22	55.185	9.787	7.000	1.000	9.787	55.185	56.046	-28.877	48.034	
23	3.967	-0.325	0.430	-0.218	-0.325	-0.866	0.925	0.065	-0.922	Гипербола
24	6.453	0.695	0.875	0.125	0.695	0.807	1.065	-0.174	1.050	Гипербола
25	65.832	-15.448	10.000	1.000	-15.448	65.832	67.620	48.776	-46.834	
26	19.835	3.967	0.826	0.165	3.967	3.278	5.146	0.276	5.139	Архимедова спираль
27	22.295	0.983	4.000	1.000	0.983	22.295	22.316	16.230	-15.316	
28	6.000	-2.000	1.047	-0.115	-2.000	-0.693	2.117	-0.400	-2.078	Циссоида

К4 файл o4k7A

№	$\ddot{\rho}$	$\ddot{\varphi}$	a_ρ	a_φ	a	a_x	a_y	$ a_\tau $	a_n
1	1.500	-0.045	1.167	1.640	2.012	-0.444	1.963	-1.637	1.171
2	0.130	-0.120	-0.275	-0.407	0.491	-0.043	-0.489	0.480	0.104
3	1.778	-0.007	1.653	0.770	1.823	-0.094	1.821	-1.805	0.254
4	0.281	0.017	-0.103	1.161	1.166	-0.924	0.711	0.660	0.961
5	-2.113	0.000	-47.493	-1.077	47.505	7.976	-46.831	-0.513	47.502
6	0.656	-0.021	0.549	0.532	0.764	-0.122	0.754	-0.695	0.318
7	14.674	0.022	13.908	-4.390	14.584	14.584	-0.096	14.583	0.220
8	7.241	0.010	6.639	-2.815	7.211	7.211	-0.088	7.208	0.218
9	-0.115	-0.007	-0.108	-0.171	0.202	0.061	-0.193	-0.121	0.162
10	0.279	0.000	-0.417	0.209	0.466	-0.465	0.031	0.145	0.443
11	0.072	-0.034	-0.283	-0.426	0.511	-0.000	-0.511	0.464	0.215
12	0.191	0.015	-0.665	1.214	1.384	-0.692	-1.199	0.813	1.120
13	0.616	0.000	0.547	0.528	0.760	0.186	0.737	0.662	0.373
14	-1.120	-0.008	-1.027	-0.916	1.376	0.280	-1.347	-1.181	0.706
15	-0.078	-0.037	-0.098	-0.263	0.281	0.080	-0.269	-0.054	0.276
16	0.063	-0.104	-0.218	-0.425	0.477	-0.021	-0.477	0.472	0.071
17	0.633	0.080	-0.410	-0.813	0.910	0.663	-0.624	-0.389	0.823
18	0.078	0.000	-0.043	0.075	0.086	-0.078	0.037	0.059	0.063
19	0.097	-0.020	-0.379	-0.122	0.398	-0.162	-0.364	0.231	0.324
20	4.386	0.274	3.564	7.676	8.463	1.554	8.319	-5.319	6.583
21	0.194	0.000	0.168	0.173	0.241	0.025	0.240	0.210	0.117
22	-1.664	0.000	-56.849	19.574	60.124	-55.719	-22.592	9.346	59.393
23	0.053	-0.104	-0.136	-0.270	0.302	-0.011	-0.302	0.301	0.032
24	0.222	0.000	0.121	0.174	0.212	-0.056	0.205	0.211	0.021
25	-8.521	0.000	-74.353	-30.897	80.517	45.579	66.374	-13.093	79.445
26	0.397	0.017	-0.145	1.639	1.646	-1.304	1.004	0.932	1.356
27	-3.187	0.000	-25.482	1.965	25.558	18.143	18.000	0.841	25.544
28	0.640	-0.008	0.560	0.416	0.697	-0.080	0.693	-0.665	0.209