

## 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, 2002.– 384 с. (с.144.)

### Задача 4.1.

4

$$r = 17e^{-t/12},$$
$$\varphi = e^{t/12}, t = 10 \text{ с.}$$

### Задача 4.2.

4

$$r = \frac{23}{1+0.8 \cos(t/5)},$$
$$\varphi = \frac{t}{5}, t = 1 \text{ с.}$$

### Задача 4.3.

4

$$r = \frac{28}{1+\cos(t/5)},$$
$$\varphi = \frac{t}{5}, t = 4 \text{ с.}$$

### Задача 4.4.

4

$$r = 5(t/4 + 0.5)^{-4},$$
$$\varphi = (t/4 + 0.5)^4, t = 2 \text{ с.}$$

### Задача 4.5.

4

$$r = 9 + 9t\text{g}^2(\pi t/22),$$
$$\varphi = \cos^2(\pi t/22), t = 7 \text{ с.}$$

### Задача 4.6.

4

$$r = 6(t/10 + 0.5)^{-5},$$
$$\varphi = (t/10 + 0.5)^5, t = 5 \text{ с.}$$

### Задача 4.7.

4

$$r = 21e^{-t/13},$$
$$\varphi = e^{t/13}, t = 9 \text{ с.}$$

### Задача 4.8.

4

$$r = -\frac{14 \cos(2t/15)}{\cos(t/15)},$$
$$\varphi = \frac{t}{15}, t = 10 \text{ с.}$$

### Задача 4.9.

4

$$r = 7(t/2)^3,$$
$$\varphi = (t/2)^3, t = 1 \text{ с.}$$

### Задача 4.10.

4

$$r = \frac{26}{1+5 \cos(t/5)},$$
$$\varphi = \frac{t}{5}, t = 4 \text{ с.}$$

### Задача 4.11.

4

$$r = \frac{15 \sin^2(t/11)}{\cos(t/11)},$$
$$\varphi = \frac{t}{11}, t = 9 \text{ с.}$$

### Задача 4.12.

4

$$r = \frac{26}{1+\cos(t/10)},$$
$$\varphi = \frac{t}{10}, t = 8 \text{ с.}$$

**Задача 4.13.**

4

$$r = \frac{28}{1+3\cos(t/7)},$$
$$\varphi = \frac{t}{7}, t = 6 \text{ c.}$$

**Задача 4.14.**

4

$$r = 7t \cos(t/9),$$
$$\varphi = t, t = 8 \text{ c.}$$

**Задача 4.15.**

4

$$r = \frac{26}{1+\cos(t/9)},$$
$$\varphi = \frac{t}{9}, t = 6 \text{ c.}$$

**Задача 4.16.**

4

$$r = \frac{22}{1+4\cos(t/8)},$$
$$\varphi = \frac{t}{8}, t = 7 \text{ c.}$$

**Задача 4.17.**

4

$$r = 15 \cos^2(\pi t/7),$$
$$\varphi = \cos^2(\pi t/7), t = 1 \text{ c.}$$

**Задача 4.18.**

4

$$r = 4(t/2 + 0.5)^{-2},$$
$$\varphi = (t/2 + 0.5)^2, t = 1 \text{ c.}$$

**Задача 4.19.**

4

$$r = 10(t/6 + 0.5)^{-4},$$
$$\varphi = (t/6 + 0.5)^4, t = 3 \text{ c.}$$

**Задача 4.20.**

4

$$r = \frac{22}{1+\cos(t/7)},$$
$$\varphi = \frac{t}{7}, t = 4 \text{ c.}$$

**Задача 4.21.**

4

$$r = 17 \cos^2(\pi t/13),$$
$$\varphi = \cos^2(\pi t/13), t = 9 \text{ c.}$$

**Задача 4.22.**

4

$$r = \frac{9}{5}t - \frac{90}{t},$$
$$\varphi = \arccos(t/10), t = 7 \text{ c.}$$

**Задача 4.23.**

4

$$r = 10t \sin(t/2),$$
$$\varphi = t, t = 9 \text{ c.}$$

**Задача 4.24.**

4

$$r = 6t/11 + 11,$$
$$\varphi = \arccos(t/11), t = 7 \text{ c.}$$

**Задача 4.25.**

4

$$r = 45/t + 9,$$
$$\varphi = \arccos(t/9), t = 8 \text{ c.}$$

**Задача 4.26.**

4

$$r = 3t \cos(t/4),$$
$$\varphi = t, t = 3 \text{ c.}$$

**Задача 4.27.**

4

$$r = \frac{16 \sin^2(t/7)}{\cos(t/7)},$$
$$\varphi = \frac{t}{7}, t = 3 \text{ c.}$$

**Задача 4.28.**

4

$$r = \frac{22}{1+4 \cos(t/11)},$$
$$\varphi = \frac{t}{11}, t = 10 \text{ c.}$$

**Задача 4.29.**

4

$$r = 9e^{t/8},$$
$$\varphi = e^{t/8}, t = 4 \text{ c.}$$

**Задача 4.30.**

4

$$r = \frac{30}{1+\cos(t/3)},$$
$$\varphi = \frac{t}{3}, t = 1 \text{ c.}$$

**Задача 4.31.**

4

$$r = t/2 + 6,$$
$$\varphi = \arccos(t/6), t = 4 \text{ c.}$$

**Задача 4.32.**

4

$$r = 5 + 5 \operatorname{tg}^2(\pi t/20),$$
$$\varphi = \cos^2(\pi t/20), t = 6 \text{ c.}$$

**Задача 4.33.**

4

$$r = 70/t + 7,$$
$$\varphi = \arccos(t/7), t = 6 \text{ c.}$$

**Задача 4.34.**

4

$$r = \frac{6}{7}t - \frac{21}{t},$$
$$\varphi = \arccos(t/7), t = 5 \text{ c.}$$

## Полярные координаты

№	$\rho$	$\dot{\rho}$	$\varphi$	$\dot{\varphi}$	$v_\rho$	$v_\varphi$	$v$	$v_x$	$v_y$	Кривая
1	7.388	-0.616	2.301	0.192	-0.616	1.417	1.545	-0.645	-1.404	Гиперболическая спираль
2	12.892	0.230	0.200	0.200	0.230	2.578	2.589	-0.287	2.573	Эллипс
3	16.503	1.395	0.800	0.200	1.395	3.301	3.583	-1.395	3.301	Парабола
4	5.000	-5.000	1.000	1.000	-5.000	5.000	7.071	-6.909	-1.506	Гиперболическая спираль
5	30.791	13.684	0.292	-0.130	13.684	-4.000	14.256	14.256	0.113	Гиперболическая спираль
6	6.000	-3.000	1.000	0.500	-3.000	3.000	4.243	-4.145	-0.904	Гиперболическая спираль
7	10.509	-0.808	1.998	0.154	-0.808	1.615	1.806	-1.135	-1.405	Гиперболическая спираль
8	-4.191	2.089	0.667	0.067	2.089	-0.279	2.107	1.814	1.072	Строфоида
9	0.875	2.625	0.125	0.375	2.625	0.328	2.645	2.564	0.653	Архимедова спираль
10	5.799	0.928	0.800	0.200	0.928	1.160	1.485	-0.186	1.474	Гипербола
11	11.691	3.126	0.818	0.091	3.126	1.063	3.301	1.361	3.008	Циссоида
12	15.324	0.648	0.800	0.100	0.648	1.532	1.664	-0.648	1.532	Парабола
13	9.447	1.033	0.857	0.143	1.033	1.350	1.699	-0.344	1.664	Гипербола
14	35.295	-0.419	8.000	1.000	-0.419	35.295	35.298	-34.859	-5.550	
15	14.559	0.560	0.667	0.111	0.560	1.618	1.712	-0.560	1.618	Парабола
16	6.173	0.665	0.875	0.125	0.665	0.772	1.018	-0.166	1.005	Гипербола
17	12.176	-5.263	0.812	-0.351	-5.263	-4.272	6.779	-0.523	-6.759	Архимедова спираль
18	4.000	-4.000	1.000	1.000	-4.000	4.000	5.657	-5.527	-1.205	Гиперболическая спираль
19	10.000	-6.667	1.000	0.667	-6.667	6.667	9.428	-9.212	-2.008	Гиперболическая спираль
20	11.949	0.501	0.571	0.143	0.501	1.707	1.779	-0.501	1.707	Парабола
21	5.486	3.841	0.323	0.226	3.841	1.240	4.036	3.250	2.394	Архимедова спираль
22	-0.257	3.637	0.795	-0.140	3.637	0.036	3.637	2.520	2.622	Строфоида
23	-87.978	-19.261	9.000	1.000	-19.261	-87.978	90.061	53.807	72.221	
24	14.818	0.545	0.881	-0.118	0.545	-1.746	1.830	1.694	-0.691	Улитка Паскаля
25	14.625	-0.703	0.476	-0.243	-0.703	-3.547	3.616	1.000	-3.475	Конхоида Никомеда
26	6.585	0.661	3.000	1.000	0.661	6.585	6.618	-1.584	-6.426	
27	3.038	2.098	0.429	0.143	2.098	0.434	2.142	1.728	1.267	Циссоида
28	6.362	0.528	0.909	0.091	0.528	0.578	0.783	-0.132	0.772	Гипербола
29	14.838	1.855	1.649	0.206	1.855	3.058	3.577	-3.193	1.611	Архимедова спираль
30	15.425	0.865	0.333	0.333	0.865	5.142	5.214	-0.865	5.142	Парабола
31	8.000	0.500	0.841	-0.224	0.500	-1.789	1.857	1.667	-0.820	Улитка Паскаля
32	14.472	6.258	0.345	-0.149	6.258	-2.162	6.621	6.620	0.085	Гиперболическая спираль
33	18.667	-1.944	0.541	-0.277	-1.944	-5.177	5.530	1.000	-5.439	Конхоида Никомеда
34	0.086	1.697	0.775	-0.204	1.697	-0.017	1.697	1.224	1.175	Строфоида

№	$\ddot{\rho}$	$\ddot{\varphi}$	$W_\rho$	$W_\varphi$	$a$	$W_x$	$W_y$	$ W_\tau $	$W_n$
1	0.051	0.016	-0.220	-0.118	0.250	0.235	-0.085	-0.020	0.249
2	0.235	0.000	-0.281	0.092	0.296	-0.294	0.034	0.067	0.288
3	0.507	0.000	-0.153	0.558	0.579	-0.507	0.279	0.455	0.358
4	6.250	0.750	1.250	-6.250	6.374	5.935	-2.325	-5.303	3.536
5	10.377	0.017	9.858	-3.033	10.314	10.314	-0.064	10.313	0.146
6	1.800	0.200	0.300	-1.800	1.825	1.677	-0.720	-1.485	1.061
7	0.062	0.012	-0.186	-0.124	0.224	0.190	-0.118	-0.028	0.222
8	0.275	0.000	0.294	0.279	0.405	0.059	0.400	0.254	0.315
9	5.250	0.750	5.127	2.625	5.760	4.760	3.244	5.413	1.969
10	0.477	0.000	0.245	0.371	0.445	-0.095	0.434	0.443	0.040
11	0.680	0.000	0.583	0.568	0.814	-0.016	0.814	0.735	0.350
12	0.118	0.000	-0.036	0.130	0.134	-0.118	0.065	0.106	0.083
13	0.354	0.000	0.161	0.295	0.336	-0.118	0.315	0.332	0.052
14	-1.643	0.000	-36.939	-0.838	36.948	6.203	-36.424	-0.399	36.946
15	0.122	0.000	-0.058	0.124	0.137	-0.122	0.062	0.099	0.095
16	0.213	0.000	0.116	0.166	0.203	-0.053	0.196	0.202	0.021
17	-3.768	-0.251	-5.267	0.635	5.305	-4.086	-3.384	3.689	3.813
18	6.000	0.500	2.000	-6.000	6.325	6.129	-1.559	-5.657	2.828
19	5.556	0.333	1.111	-5.556	5.666	5.275	-2.067	-4.714	3.143
20	0.153	0.000	-0.090	0.143	0.169	-0.153	0.072	0.112	0.127
21	0.704	0.041	0.424	1.963	2.008	-0.220	1.996	1.006	1.738
22	-0.525	-0.019	-0.520	-1.014	1.139	0.360	-1.081	-0.530	1.008
23	19.886	0.000	107.864	-38.522	114.537	-82.403	79.552	14.562	113.607
24	0.000	-0.011	-0.206	-0.298	0.362	0.099	-0.349	0.223	0.285
25	0.176	-0.114	-0.685	-1.328	1.494	0.000	-1.494	1.436	0.413
26	-1.434	0.000	-8.019	1.323	8.128	7.752	-2.441	0.515	8.111
27	0.806	0.000	0.744	0.599	0.955	0.427	0.854	0.850	0.436
28	0.125	0.000	0.072	0.096	0.120	-0.031	0.116	0.120	0.011
29	0.232	0.026	-0.398	1.147	1.214	-1.112	-0.486	0.774	0.935
30	0.930	0.000	-0.784	0.577	0.973	-0.930	0.288	0.439	0.869
31	0.000	-0.045	-0.400	-0.581	0.706	0.167	-0.686	0.452	0.542
32	4.773	0.015	4.450	-1.649	4.746	4.746	-0.045	4.745	0.105
33	0.648	-0.128	-0.788	-1.311	1.529	0.000	-1.529	1.504	0.277
34	-0.336	-0.043	-0.340	-0.697	0.775	0.245	-0.735	-0.332	0.700