

## 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.

10

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

### Задача 4.2.

10

$$r = 4t/9 + 9,$$
$$\varphi = \arccos(t/9), t = 7 \text{ с.}$$

### Задача 4.3.

10

$$r = \frac{15 \sin^2(t/3)}{\cos(t/3)},$$
$$\varphi = \frac{t}{3}, t = 1 \text{ с.}$$

### Задача 4.4.

10

$$r = \frac{12 \sin^2(t/14)}{\cos(t/14)},$$
$$\varphi = \frac{t}{14}, t = 10 \text{ с.}$$

### Задача 4.5.

10

$$r = 7(t/4 + 0.5)^{-3},$$
$$\varphi = (t/4 + 0.5)^3, t = 2 \text{ с.}$$

### Задача 4.6.

10

$$r = 15(t/10)^5,$$
$$\varphi = (t/10)^5, t = 9 \text{ с.}$$

### Задача 4.7.

10

$$r = -\frac{18 \cos(t/5)}{\cos(t/10)},$$
$$\varphi = \frac{t}{10}, t = 6 \text{ с.}$$

### Задача 4.8.

10

$$r = 16/t + 4,$$
$$\varphi = \arccos(t/4), t = 3 \text{ с.}$$

### Задача 4.9.

10

$$r = 15e^{-t/13},$$
$$\varphi = e^{t/13}, t = 10 \text{ с.}$$

### Задача 4.10.

10

$$r = 28/(1+t),$$
$$\varphi = \arccos(t/2), t = 1 \text{ с.}$$

### Задача 4.11.

10

$$r = 5 + 5 \operatorname{tg}^2(\pi t/19),$$
$$\varphi = \cos^2(\pi t/19), t = 6 \text{ с.}$$

### Задача 4.12.

10

$$r = 4t \cos(t/7),$$
$$\varphi = t, t = 6 \text{ с.}$$

**Задача 4.13.**

10

$$r = 6(t/2)^2,$$
$$\varphi = (t/2)^2, \quad t = 1 \text{ c.}$$

**Задача 4.14.**

10

$$r = 23/(1 + \frac{3}{4}t),$$
$$\varphi = \arccos(t/4), \quad t = 3 \text{ c.}$$

**Задача 4.15.**

10

$$r = 30/(1 + \frac{3}{7}t),$$
$$\varphi = \arccos(t/7), \quad t = 6 \text{ c.}$$

**Задача 4.16.**

10

$$r = 27/(1 + t/5),$$
$$\varphi = \arccos(t/5), \quad t = 2 \text{ c.}$$

**Задача 4.17.**

10

$$r = 6t \sin(t/9),$$
$$\varphi = t, \quad t = 5 \text{ c.}$$

**Задача 4.18.**

10

$$r = \frac{16 \sin^2(t/5)}{\cos(t/5)},$$
$$\varphi = \frac{t}{5}, \quad t = 1 \text{ c.}$$

**Задача 4.19.**

10

$$r = 21 \cos^2(\pi t/15),$$
$$\varphi = \cos^2(\pi t/15), \quad t = 9 \text{ c.}$$

**Задача 4.20.**

10

$$r = 22/(1 + \frac{4}{3}t),$$
$$\varphi = \arccos(t/3), \quad t = 2 \text{ c.}$$

**Задача 4.21.**

10

$$r = 8(t/10 + 0.5)^{-3},$$
$$\varphi = (t/10 + 0.5)^3, \quad t = 5 \text{ c.}$$

**Задача 4.22.**

10

$$r = 22/(1 + 2t/15),$$
$$\varphi = \arccos(t/3), \quad t = 1 \text{ c.}$$

**Задача 4.23.**

10

$$r = 19 \cos^2(\pi t/9),$$
$$\varphi = \cos^2(\pi t/9), \quad t = 6 \text{ c.}$$

**Задача 4.24.**

10

$$r = 6e^{-t/3},$$
$$\varphi = e^{t/3}, \quad t = 1 \text{ c.}$$

**Задача 4.25.**

10

$$r = 19 \cos^2(\pi t/9),$$
$$\varphi = \cos^2(\pi t/9), \quad t = 6 \text{ c.}$$

**Задача 4.26.**

10

$$r = 20(t/7)^2,$$
$$\varphi = (t/7)^2, \quad t = 6 \text{ c.}$$

**Задача 4.27.**

10

$$r = 6t \cos(t/8),$$
$$\varphi = t, t = 7 \text{ с.}$$

**Задача 4.28.**

10

$$r = 9t/10 + 10,$$
$$\varphi = \arccos(t/10), t = 9 \text{ с.}$$

**Задача 4.29.**

10

$$r = 5t \sin(t/6),$$
$$\varphi = t, t = 4 \text{ с.}$$

**Задача 4.30.**

10

$$r = \frac{29}{1 + \cos(t/12)},$$
$$\varphi = \frac{t}{12}, t = 9 \text{ с.}$$

**Задача 4.31.**

10

$$r = 7(t/4 + 0.5)^{-2},$$
$$\varphi = (t/4 + 0.5)^2, t = 2 \text{ с.}$$

**Задача 4.32.**

10

$$r = 9t/7 + 7,$$
$$\varphi = \arccos(t/7), t = 3 \text{ с.}$$

**Задача 4.33.**

10

$$r = 6t \cos(t/5),$$
$$\varphi = t, t = 4 \text{ с.}$$

**Задача 4.34.**

10

$$r = \frac{24}{1 + 0.4 \cos(t/7)},$$
$$\varphi = \frac{t}{7}, t = 5 \text{ с.}$$

## Полярные координаты

№	$\rho$	$\dot{\rho}$	$\varphi$	$\dot{\varphi}$	$v_\rho$	$v_\varphi$	$v$	$v_x$	$v_y$	Кривая
1	11.189	-0.167	9.000	1.000	-0.167	11.189	11.190	-4.459	-10.263	
2	12.111	0.444	0.680	-0.177	0.444	-2.141	2.187	1.691	-1.386	Улитка Паскаля
3	1.699	3.468	0.333	0.333	3.468	0.566	3.514	3.092	1.670	Циссоида
4	6.815	1.545	0.714	0.071	1.545	0.487	1.620	0.848	1.380	Циссоида
5	7.000	-5.250	1.000	0.750	-5.250	5.250	7.425	-7.254	-1.581	Гиперболическая спираль
6	8.857	4.921	0.590	0.328	4.921	2.906	5.715	2.470	5.153	Архимедова спираль
7	-7.903	3.525	0.600	0.100	3.525	-0.790	3.612	3.355	1.338	Строфоида
8	9.333	-1.778	0.723	-0.378	-1.778	-3.528	3.950	1.000	-3.822	Конхоида Никомеда
9	6.951	-0.535	2.158	0.166	-0.535	1.154	1.272	-0.664	-1.084	Гиперболическая спираль
10	14.000	-7.000	1.047	-0.577	-7.000	-8.083	10.693	3.500	-10.104	Гипербола
11	16.714	8.460	0.299	-0.151	8.460	-2.531	8.830	8.830	0.075	Гиперболическая спираль
12	15.710	0.026	6.000	1.000	0.026	15.710	15.710	4.415	15.077	
13	1.500	3.000	0.250	0.500	3.000	0.750	3.092	2.721	1.469	Архимедова спираль
14	7.077	-1.633	0.723	-0.378	-1.633	-2.675	3.134	0.544	-3.086	Гипербола
15	8.400	-1.008	0.541	-0.277	-1.008	-2.330	2.538	0.336	-2.516	Гипербола
16	19.286	-2.755	1.159	-0.218	-2.755	-4.208	5.030	2.755	-4.208	Парабола
17	15.822	5.997	5.000	1.000	5.997	15.822	16.921	16.874	-1.262	
18	0.644	1.298	0.200	0.200	1.298	0.129	1.304	1.246	0.384	Циссоида
19	2.005	2.585	0.095	0.123	2.585	0.247	2.597	2.550	0.492	Архимедова спираль
20	6.000	-2.182	0.841	-0.447	-2.182	-2.683	3.458	0.545	-3.415	Гипербола
21	8.000	-2.400	1.000	0.300	-2.400	2.400	3.394	-3.316	-0.723	Гиперболическая спираль
22	19.412	-2.284	1.231	-0.354	-2.284	-6.863	7.233	5.709	-4.441	Эллипс
23	4.750	5.744	0.250	0.302	5.744	1.436	5.920	5.210	2.812	Архимедова спираль
24	4.299	-1.433	1.396	0.465	-1.433	2.000	2.460	-2.219	-1.063	Гиперболическая спираль
25	4.750	5.744	0.250	0.302	5.744	1.436	5.920	5.210	2.812	Архимедова спираль
26	14.694	4.898	0.735	0.245	4.898	3.599	6.078	1.222	5.954	Архимедова спираль
27	26.922	-0.184	7.000	1.000	-0.184	26.922	26.922	-17.826	20.176	
28	18.100	0.900	0.451	-0.229	0.900	-4.152	4.249	2.620	-3.345	Улитка Паскаля
29	12.367	5.711	4.000	1.000	5.711	12.367	13.623	5.626	-12.406	
30	16.747	0.549	0.750	0.083	0.549	1.396	1.500	-0.549	1.396	Парабола
31	7.000	-3.500	1.000	0.500	-3.500	3.500	4.950	-4.836	-1.054	Гиперболическая спираль
32	10.857	1.286	1.128	-0.158	1.286	-1.717	2.145	2.102	0.426	Улитка Паскаля
33	16.721	0.737	4.000	1.000	0.737	16.721	16.737	12.173	-11.487	
34	18.430	0.530	0.714	0.143	0.530	2.633	2.686	-1.324	2.336	Эллипс

$N_0$	$\ddot{\rho}$	$\ddot{\varphi}$	$W_\rho$	$W_\varphi$	$a$	$W_x$	$W_y$	$ W_\tau $	$W_n$
1	-0.425	0.000	-11.614	-0.334	11.619	10.720	-4.483	-0.160	11.618
2	0.000	-0.039	-0.378	-0.625	0.731	0.099	-0.724	0.535	0.498
3	3.762	0.000	3.573	2.312	4.256	2.620	3.354	3.899	1.706
4	0.249	0.000	0.214	0.221	0.308	0.017	0.307	0.271	0.146
5	5.250	0.375	1.313	-5.250	5.412	5.127	-1.732	-4.640	2.784
6	2.187	0.146	1.234	4.520	4.685	-1.492	4.441	3.361	3.265
7	0.719	0.000	0.798	0.705	1.065	0.261	1.033	0.625	0.863
8	1.185	-0.162	-0.148	-0.168	0.224	0.000	-0.224	0.217	0.057
9	0.041	0.013	-0.150	-0.089	0.175	0.157	-0.076	-0.017	0.174
10	7.000	-0.192	2.333	5.389	5.872	-3.500	4.715	-5.601	1.764
11	7.337	0.022	6.954	-2.195	7.292	7.292	-0.048	7.291	0.110
12	-1.185	0.000	-16.895	0.053	16.895	-16.207	4.772	0.024	16.895
13	3.000	0.500	2.625	3.750	4.577	1.616	4.283	3.456	3.001
14	0.754	-0.162	-0.257	0.088	0.272	-0.251	-0.104	0.059	0.265
15	0.242	-0.128	-0.404	-0.516	0.656	-0.081	-0.651	0.634	0.166
16	0.787	-0.021	-0.131	0.802	0.812	-0.787	0.200	-0.599	0.549
17	0.937	0.000	-14.885	11.993	19.115	7.278	17.676	5.940	18.169
18	1.334	0.000	1.308	0.519	1.407	1.179	0.769	1.353	0.387
19	1.490	0.071	1.460	0.779	1.655	1.379	0.915	1.528	0.637
20	1.587	-0.179	0.387	0.878	0.960	-0.397	0.874	-0.925	0.254
21	0.960	0.060	0.240	-0.960	0.990	0.937	-0.317	-0.849	0.509
22	0.537	-0.044	-1.889	0.757	2.035	-1.343	-1.529	-0.122	2.031
23	2.315	0.122	1.881	4.051	4.467	0.820	4.391	2.807	3.474
24	0.478	0.155	-0.453	-0.667	0.806	0.578	-0.562	-0.278	0.756
25	2.315	0.122	1.881	4.051	4.467	0.820	4.391	2.807	3.474
26	0.816	0.041	-0.065	2.999	2.999	-2.058	2.182	1.723	2.455
27	-1.572	0.000	-28.494	-0.367	28.496	-21.240	-18.997	-0.173	28.496
28	-0.000	-0.109	-0.953	-2.380	2.563	0.180	-2.557	2.124	1.435
29	0.966	0.000	-11.401	11.423	16.139	16.097	1.162	5.590	15.140
30	0.085	0.000	-0.031	0.092	0.097	-0.085	0.046	0.074	0.062
31	2.625	0.125	0.875	-2.625	2.767	2.682	-0.682	-2.475	1.237
32	0.000	-0.012	-0.271	-0.535	0.600	0.367	-0.475	0.266	0.538
33	-2.390	0.000	-19.111	1.474	19.168	13.608	13.500	0.631	19.158
34	0.118	0.000	-0.258	0.151	0.299	-0.294	-0.055	0.097	0.283