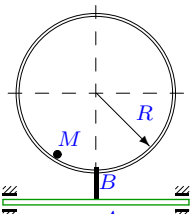


## Сложное движение точки, пространственная траектория

Геометрическая фигура вращается вокруг оси, лежащей в ее плоскости. По каналу, расположенному на фигуре, движется точка  $M$  по известному закону  $AM(t)$  или  $BM(t)$  (в см). Найти абсолютную скорость и абсолютное ускорение точки при  $t = t_1$ . Даны закон вращения фигуры  $\varphi_e(t)$  (или постоянная угловая скорость  $\omega_e$ ), время  $t_1$  и размеры фигуры. Углы даны в рад, размеры — в см. Длина  $BM$  или  $AM$  — длина отрезка прямой или дуги окружности,  $AB$  — длина отрезка прямой.

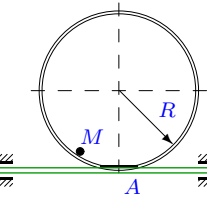
Кирсанов М.Н. **Решebник. Теоретическая механика**/Под ред. А. И. Кириллова.— М.:ФИЗМАТЛИТ, 2002.— 384 с. (с.202.)

**Задача 11.1.** 5



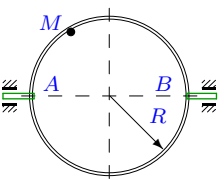
$\omega_e = 0.04 \text{ рад/с},$   
 $BM = \frac{\pi}{3}(t^2 + 51),$   
 $R = 55,$   
 $AB = 28,$   
 $t = 2 \text{ с}.$

**Задача 11.2.** 5



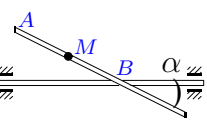
$\omega_e = 3.49 \text{ рад/с},$   
 $AM = \frac{\pi}{3}(t^2 + 2)t,$   
 $R = 3,$   
 $t = 1 \text{ с}.$

**Задача 11.3.** 5



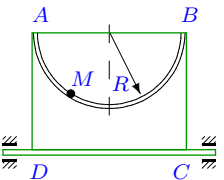
$\omega_e = 0.13 \text{ рад/с},$   
 $AM = \frac{3\pi}{4}(t^2 + 50),$   
 $R = 51,$   
 $t = 1 \text{ с}.$

**Задача 11.4.** 5



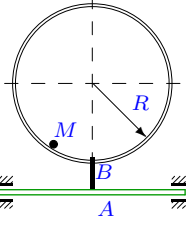
$\varphi_e = 0.03t^2,$   
 $AM = \frac{1}{2}(t^2 + 6t),$   
 $AB = 54,$   
 $\alpha = \pi/4,$   
 $t = 3 \text{ с}.$

**Задача 11.5.** 5



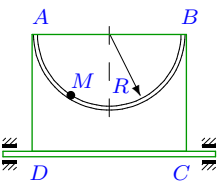
$\omega_e = 0.3 \text{ рад/с},$   
 $AM = \frac{3\pi}{4}(t^2 + 50),$   
 $R = 51,$   
 $AD = 52,$   
 $t = 1 \text{ с}.$

**Задача 11.6.** 5



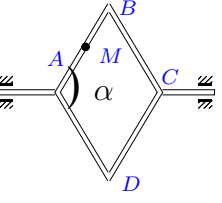
$\omega_e = 0.82 \text{ рад/с},$   
 $BM = \frac{\pi}{3}(t^2 + 4)t,$   
 $R = 39,$   
 $AB = 20,$   
 $t = 3 \text{ с}.$

**Задача 11.7.** 5



$\omega_e = 1.08 \text{ рад/с},$   
 $AM = \frac{5\pi}{6}(t^2 + 6t),$   
 $R = 27,$   
 $AD = 28,$   
 $t = 3 \text{ с}.$

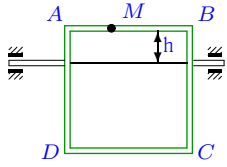
**Задача 11.8.** 5



$\varphi_e = 0.02t^2,$   
 $BM = \frac{1}{3}(t^2 + 6t),$   
 Ромб  $ABCD.$   
 $AB = 40,$   
 $\alpha = 2\pi/3,$   
 $t = 3 \text{ с}.$

**Задача 11.9.**

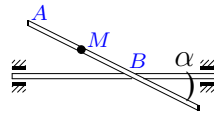
5



$$\begin{aligned} \varphi_e &= 0.09t^2, \\ AM &= \frac{5}{6}(t^2 + 51), \\ AB &= 28, \\ BC &= 28, \\ h &= 9, \\ t &= 2 \text{ с.} \end{aligned}$$

**Задача 11.10.**

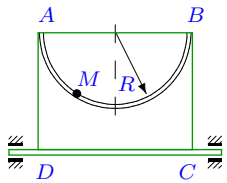
5



$$\begin{aligned} \varphi_e &= 0.71t^2, \\ AM &= \frac{3}{4}(t^2 + 2)t, \\ AB &= 6, \\ \alpha &= \pi/4, \\ t &= 1 \text{ с.} \end{aligned}$$

**Задача 11.11.**

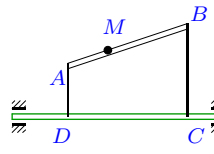
5



$$\begin{aligned} \omega_e &= 24.35 \text{ рад/с,} \\ AM &= \frac{\pi}{2}(t^2 + 4)t, \\ R &= 39, \\ AD &= 40, \\ t &= 3 \text{ с.} \end{aligned}$$

**Задача 11.12.**

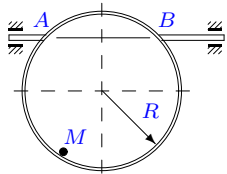
5



$$\begin{aligned} \varphi_e &= 0.1t^2, \\ AM &= \frac{1}{4}(t^2 + 2t), \\ AD &= 2, \\ BC &= 5, \\ DC &= 3, \\ t &= 1 \text{ с.} \end{aligned}$$

**Задача 11.13.**

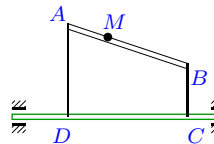
5



$$\begin{aligned} \omega_e &= 0.06 \text{ рад/с,} \\ AM &= \frac{2\pi}{3}(t^2 + 52), \\ R &= 61, \\ AB &= 61, \\ t &= 3 \text{ с.} \end{aligned}$$

**Задача 11.14.**

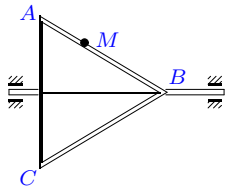
5



$$\begin{aligned} \varphi_e &= 0.02t^2, \\ AM &= \frac{2}{3}(t^2 + 52), \\ AD &= 33, \\ BC &= 16, \\ DC &= 53, \\ t &= 3 \text{ с.} \end{aligned}$$

**Задача 11.15.**

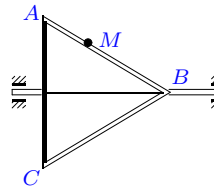
5



$$\begin{aligned} \varphi_e &= 0.15t^2, \\ AM &= \frac{2}{3}(t^3 + 4), \\ AB=BC=AC &= 62, \\ t &= 3 \text{ с.} \end{aligned}$$

**Задача 11.16.**

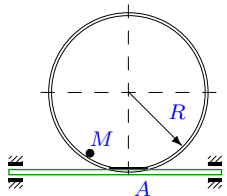
5



$$\begin{aligned} \varphi_e &= 0.38t^2, \\ AM &= \frac{5}{6}(t^2 + 3)t, \\ AB=BC=AC &= 28, \\ t &= 2 \text{ с.} \end{aligned}$$

**Задача 11.17.**

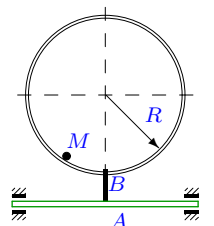
5



$$\begin{aligned} \omega_e &= 1.19 \text{ рад/с,} \\ AM &= \frac{\pi}{4}(t^2 + 6t), \\ R &= 27, \\ t &= 3 \text{ с.} \end{aligned}$$

**Задача 11.18.**

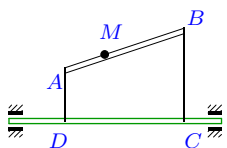
5



$$\begin{aligned} \omega_e &= 1.02 \text{ рад/с,} \\ BM &= \frac{\pi}{4}(t^3 + 3), \\ R &= 11, \\ AB &= 6, \\ t &= 2 \text{ с.} \end{aligned}$$

**Задача 11.19.**

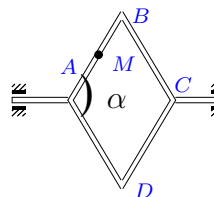
5



$$\begin{aligned} \varphi_e &= 0.15t^2, \\ AM &= \frac{5}{6}(t^3 + 3), \\ AD &= 4, \\ BC &= 9, \\ DC &= 10, \\ t &= 2 \text{ с.} \end{aligned}$$

**Задача 11.20.**

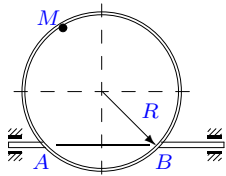
5



$$\begin{aligned} \varphi_e &= 0.01t^2, \\ BM &= \frac{2}{3}(t^2 + 52), \\ \text{Ромб } ABCD. \\ AB &= 92, \\ \alpha &= 2\pi/3, \\ t &= 3 \text{ с.} \end{aligned}$$

**Задача 11.21.**

5



$$\omega_e = 0.02 \text{ рад/с,}$$

$$AM = \frac{2\pi}{3}(t^2 + 50),$$

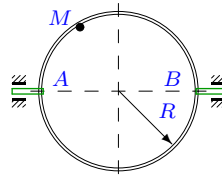
$$R = 51,$$

$$AB = 51,$$

$$t = 1 \text{ с.}$$

**Задача 11.22.**

5



$$\omega_e = 0.05 \text{ рад/с,}$$

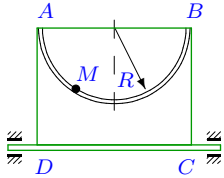
$$AM = \frac{2\pi}{3}(t^2 + 50),$$

$$R = 51,$$

$$t = 1 \text{ с.}$$

**Задача 11.23.**

5



$$\omega_e = 0.53 \text{ рад/с,}$$

$$AM = \frac{\pi}{4}(t^2 + 6t),$$

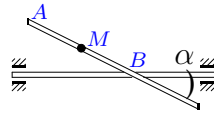
$$R = 27,$$

$$AD = 28,$$

$$t = 3 \text{ с.}$$

**Задача 11.24.**

5



$$\varphi_e = 0.03t^2,$$

$$AM = \frac{1}{2}(t^3 + 4),$$

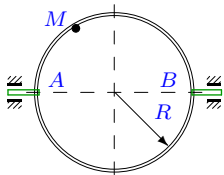
$$AB = 62,$$

$$\alpha = \pi/4,$$

$$t = 3 \text{ с.}$$

**Задача 11.25.**

5



$$\omega_e = 0.57 \text{ рад/с,}$$

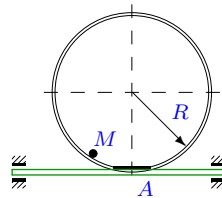
$$AM = \frac{\pi}{6}(t^3 + 3),$$

$$R = 11,$$

$$t = 2 \text{ с.}$$

**Задача 11.26.**

5



$$\omega_e = 0.91 \text{ рад/с,}$$

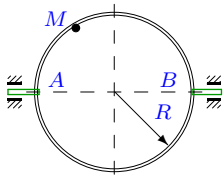
$$AM = \frac{\pi}{3}(t^3 + 4),$$

$$R = 31,$$

$$t = 3 \text{ с.}$$

**Задача 11.27.**

5



$$\omega_e = 2.62 \text{ рад/с,}$$

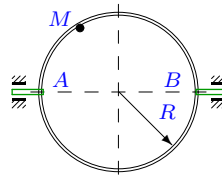
$$AM = \frac{5\pi}{6}(t^3 + 2),$$

$$R = 3,$$

$$t = 1 \text{ с.}$$

**Задача 11.28.**

5



$$\omega_e = 1.3 \text{ рад/с,}$$

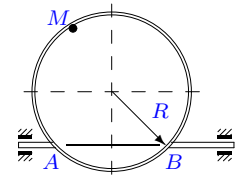
$$AM = \frac{\pi}{3}(t^2 + 3)t,$$

$$R = 14,$$

$$t = 2 \text{ с.}$$

**Задача 11.29.**

5



$$\omega_e = 0.05 \text{ рад/с,}$$

$$AM = \frac{3\pi}{4}(t^2 + 51),$$

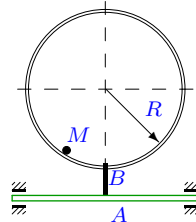
$$R = 55,$$

$$AB = 55,$$

$$t = 2 \text{ с.}$$

**Задача 11.30.**

5



$$\omega_e = 0.84 \text{ рад/с,}$$

$$BM = \frac{3\pi}{4}(t^2 + 4)t,$$

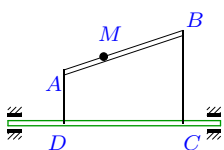
$$R = 39,$$

$$AB = 20,$$

$$t = 3 \text{ с.}$$

**Задача 11.31.**

5



$$\varphi_e = 0.24t^2,$$

$$AM = \frac{2}{3}(t^2 + 2)t,$$

$$AD = 2,$$

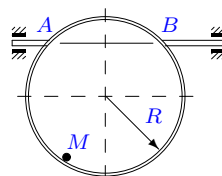
$$BC = 5,$$

$$DC = 3,$$

$$t = 1 \text{ с.}$$

**Задача 11.32.**

5



$$\omega_e = 0.86 \text{ рад/с,}$$

$$AM = \frac{\pi}{4}(t^2 + 4t),$$

$$R = 12,$$

$$AB = 12,$$

$$t = 2 \text{ с.}$$

**Сложное движение точки, пространственная траектория**

№	$R_e$	$v_r$	$v_e$	$v$	$\omega_e$	$\varepsilon_e$
1	55.500	4.189	-2.220	4.741	0.040	0.000
2	1.500	5.236	5.235	7.404	3.490	0.000
3	36.062	4.712	4.688	6.647	0.130	0.000
4	28.638	6.000	5.155	7.910	0.180	0.060
5	15.938	4.712	4.781	6.713	0.300	0.000
6	39.500	32.463	32.390	45.858	0.820	0.000
7	14.500	31.416	-15.660	35.103	1.080	0.000
8	26.847	4.000	3.222	5.136	0.120	0.040
9	8.833	3.333	-3.180	4.607	0.360	0.180
10	2.652	3.750	3.765	5.314	1.420	1.420
11	1.000	48.695	-24.350	54.444	24.350	0.000
12	2.530	1.000	-0.506	1.121	0.200	0.200
13	105.655	12.566	6.339	14.075	0.060	0.000
14	20.579	4.000	-2.470	4.701	0.120	0.040
15	20.667	18.000	18.600	25.884	0.900	0.300
16	8.167	12.500	12.413	17.616	1.520	0.760
17	7.908	9.425	9.411	13.319	1.190	0.000
18	9.222	9.425	9.406	13.316	1.020	0.000
19	8.099	10.000	-4.860	11.118	0.600	0.300
20	44.456	4.000	-2.667	4.808	0.060	0.020
21	88.335	4.189	-1.767	4.546	0.020	0.000
22	44.167	4.189	-2.208	4.735	0.050	0.000
23	8.908	9.425	-4.721	10.541	0.530	0.000
24	32.880	13.500	-5.918	14.740	0.180	0.060
25	5.500	6.283	-3.135	7.022	0.570	0.000
26	15.500	28.274	-14.105	31.597	0.910	0.000
27	1.500	7.854	-3.930	8.782	2.620	0.000
28	12.124	15.708	15.762	22.252	1.300	0.000
29	100.757	9.425	-5.038	10.687	0.050	0.000
30	86.577	73.042	72.725	103.073	0.840	0.000
31	3.414	3.333	-1.639	3.714	0.480	0.480
32	7.286	6.283	-6.266	8.874	0.860	0.000

№	$a_r^n$	$a_r^T$	$a_e^n$	$a_e^T$	$a_c$	$a_x$	$a_y$	$a$
1	0.319	2.094	0.089	0.000	0.290	1.885	-0.290	2.057
2	9.139	6.283	18.270	0.000	31.651	-8.259	31.651	33.057
3	0.435	4.712	0.609	0.000	0.866	-4.250	-0.866	5.287
4	0.000	1.000	0.928	1.718	1.527	-1.635	0.191	1.792
5	0.435	4.712	1.434	0.000	1.999	2.206	1.999	4.244
6	27.022	18.850	26.560	0.000	46.107	3.275	46.107	48.290
7	36.554	5.236	16.913	0.000	58.767	5.899	-58.767	65.815
8	0.000	0.667	0.387	1.074	0.831	-0.964	0.242	1.048
9	0.000	1.667	-1.145	-1.590	2.400	-0.522	-3.990	4.024
10	0.000	4.500	5.347	3.765	7.531	-8.529	-3.765	9.851
11	60.799	28.274	592.923	0.000	0.000	-532.123	0.000	532.874
12	0.000	0.500	0.101	-0.506	0.283	0.252	-0.789	0.901
13	2.589	4.189	-0.380	0.000	0.754	0.528	0.754	5.007
14	0.000	1.333	0.296	-0.823	0.293	-0.704	-0.530	1.545
15	0.000	12.000	16.740	6.200	16.200	-22.740	-10.000	26.928
16	0.000	10.000	18.868	6.207	19.000	-23.868	-12.793	28.432
17	3.290	1.571	11.199	0.000	15.861	-7.762	15.861	17.700
18	8.075	9.425	9.594	0.000	13.595	2.780	13.595	13.909
19	0.000	10.000	2.916	-2.430	5.367	1.556	-7.796	11.967
20	0.000	1.333	0.160	-0.889	0.416	-1.315	-0.473	1.548
21	0.344	4.189	0.035	0.000	0.084	1.761	-0.084	4.189
22	0.344	4.189	0.110	0.000	0.209	-2.503	0.209	4.272
23	3.290	1.571	2.502	0.000	7.064	-1.287	7.064	7.961
24	0.000	9.000	1.065	-1.973	3.437	-7.429	1.464	9.891
25	3.589	6.283	1.787	0.000	6.203	1.860	-6.203	9.000
26	25.788	18.850	12.836	0.000	44.565	16.383	-44.565	49.204
27	20.562	15.708	10.297	0.000	35.641	-34.181	35.641	50.375
28	17.624	12.566	20.490	0.000	20.420	-29.470	20.420	40.907
29	1.615	4.712	0.252	0.000	0.244	-0.592	-0.244	5.011
30	136.798	42.412	61.089	0.000	86.770	-127.830	86.770	199.819
31	0.000	4.000	0.787	-1.639	2.263	2.042	-3.902	5.234
32	3.290	1.571	-5.389	0.000	10.439	3.020	-10.439	11.215