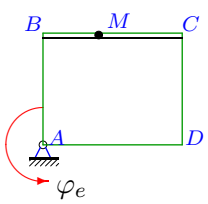


## Сложное движение точки, плоская траектория

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

Кирсанов М.Н. **Решбник. Теоретическая механика**/Под ред. А. И. Кириллова. — М.: ФИЗМАТЛИТ, 2002. — 384 с. (с.195.)

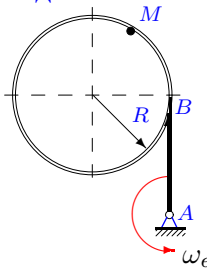
**Задача 10.1.** 7



$\sigma(t) = BM = \frac{3}{4}(t^2 + 51)$  см.

$\varphi_e = 0.02t^2$ ,  
 $AB = 28$  см,  
 $BC = 55$  см,  
 $t_1 = 2$  с.

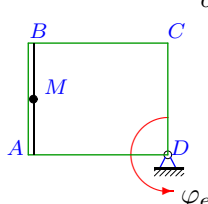
**Задача 10.2.** 7



$\sigma(t) = BM = \frac{\pi}{4}(t^2 + 52)$  см.

$\omega_e = 0.04$  рад/с,  
 $R = 61$  см,  
 $AB = 66$  см,  
 $t_1 = 3$  с.

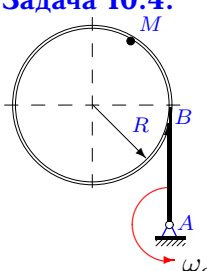
**Задача 10.3.** 7



$\sigma(t) = AM = \frac{5}{6}(t^2 + 51)$  см.

$\varphi_e = 0.01t^2$ ,  
 $AB = 55$  см,  
 $BC = 57$  см,  
 $t_1 = 2$  с.

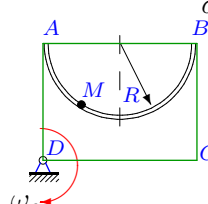
**Задача 10.4.** 7



$\sigma(t) = BM = \frac{\pi}{3}(t^2 + 2)t$  см.

$\omega_e = 0.49$  рад/с,  
 $R = 3$  см,  
 $AB = 8$  см,  
 $t_1 = 1$  с.

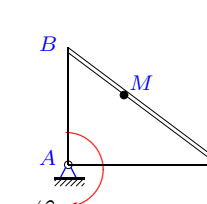
**Задача 10.5.** 7



$\sigma(t) = AM = \frac{\pi}{2}(t^2 + 4)t$  см.

$\omega_e = 1.25$  рад/с,  
 $R = 39$  см,  
 $AD = 41$  см,  
 $t_1 = 3$  с.

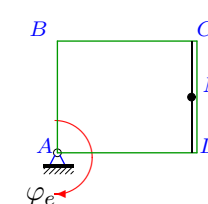
**Задача 10.6.** 7



$\sigma(t) = BM = \frac{1}{2}(t^2 + 52)$  см.

$\varphi_e = 0.02t^2$ ,  
 $AB = 30$  см,  
 $AC = 54$  см,  
 $t_1 = 3$  с.

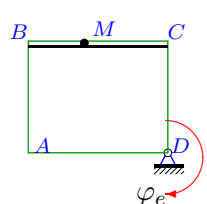
**Задача 10.7.** 7



$\sigma(t) = DM = \frac{1}{4}(t^3 + 4)$  см.

$\varphi_e = 0.03t^2$ ,  
 $AB = 31$  см,  
 $BC = 33$  см,  
 $t_1 = 3$  с.

**Задача 10.8.** 7



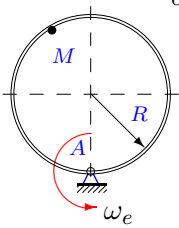
$\sigma(t) = BM = \frac{1}{2}(t^3 + 3)$  см.

$\varphi_e = 0.18t^2$ ,  
 $AB = 6$  см,  
 $BC = 11$  см,  
 $t_1 = 2$  с.

**Задача 10.9.**

7

$$\sigma(t) = AM = \frac{5\pi}{3}(t^2 + 3)t \text{ см.}$$



$$\omega_e = 5.61 \text{ рад/с,}$$

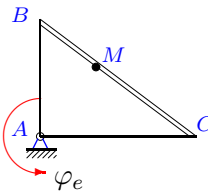
$$R = 14 \text{ см,}$$

$$t_1 = 2 \text{ с.}$$

**Задача 10.10.**

7

$$\sigma(t) = BM = \frac{1}{6}(t^2 + 3)t \text{ см.}$$



$$\varphi_e = 0.1t^2,$$

$$AB = 7 \text{ см,}$$

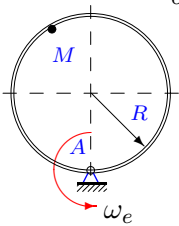
$$AC = 13 \text{ см,}$$

$$t_1 = 2 \text{ с.}$$

**Задача 10.11.**

7

$$\sigma(t) = AM = \frac{3\pi}{2}(t^2 + 2t) \text{ см.}$$



$$\omega_e = 4.44 \text{ рад/с,}$$

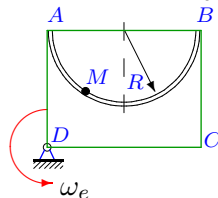
$$R = 3 \text{ см,}$$

$$t_1 = 1 \text{ с.}$$

**Задача 10.12.**

7

$$\sigma(t) = AM = \frac{\pi}{2}(t^2 + 50) \text{ см.}$$



$$\omega_e = 0.06 \text{ рад/с,}$$

$$R = 51 \text{ см,}$$

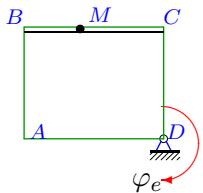
$$AD = 53 \text{ см,}$$

$$t_1 = 1 \text{ с.}$$

**Задача 10.13.**

7

$$\sigma(t) = BM = \frac{1}{4}(t^3 + 4) \text{ см.}$$



$$\varphi_e = 0.04t^2,$$

$$AB = 16 \text{ см,}$$

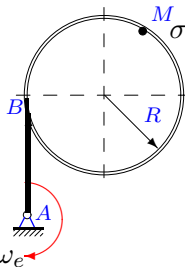
$$BC = 31 \text{ см,}$$

$$t_1 = 3 \text{ с.}$$

**Задача 10.14.**

7

$$\sigma(t) = BM = \frac{2\pi}{3}(t^2 + 3)t \text{ см.}$$



$$\omega_e = 0.84 \text{ рад/с,}$$

$$R = 14 \text{ см,}$$

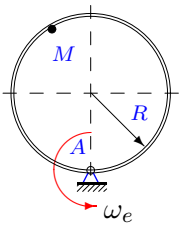
$$AB = 19 \text{ см,}$$

$$t_1 = 2 \text{ с.}$$

**Задача 10.15.**

7

$$\sigma(t) = AM = \frac{4\pi}{3}(t^3 + 3) \text{ см.}$$



$$\omega_e = 2.64 \text{ рад/с,}$$

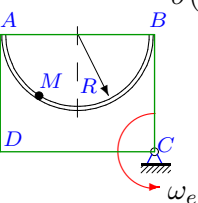
$$R = 11 \text{ см,}$$

$$t_1 = 2 \text{ с.}$$

**Задача 10.16.**

7

$$\sigma(t) = AM = \frac{3\pi}{4}(t^2 + 4t) \text{ см.}$$



$$\omega_e = 2.88 \text{ рад/с,}$$

$$R = 12 \text{ см,}$$

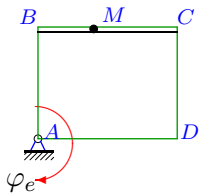
$$AD = 14 \text{ см,}$$

$$t_1 = 2 \text{ с.}$$

**Задача 10.17.**

7

$$\sigma(t) = BM = \frac{3}{4}(t^2 + 2t) \text{ см.}$$



$$\varphi_e = 0.5t^2,$$

$$AB = 2 \text{ см,}$$

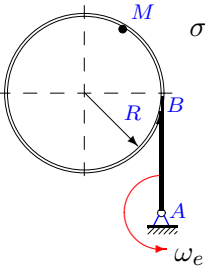
$$BC = 3 \text{ см,}$$

$$t_1 = 1 \text{ с.}$$

**Задача 10.18.**

7

$$\sigma(t) = BM = \frac{5\pi}{3}(t^2 + 3)t \text{ см.}$$



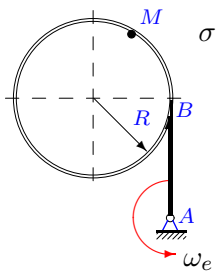
$$\omega_e = 8 \text{ рад/с,}$$

$$R = 14 \text{ см,}$$

$$AB = 19 \text{ см,}$$

$$t_1 = 2 \text{ с.}$$

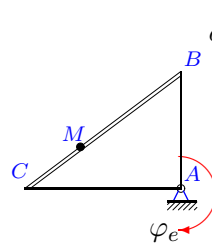
**Задача 10.19.**



$$\sigma(t) = BM = \frac{4\pi}{3}(t^2 + 4t) \text{ см.}$$

$$\begin{aligned} \omega_e &= 1.75 \text{ рад/с,} \\ R &= 12 \text{ см,} \\ AB &= 17 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

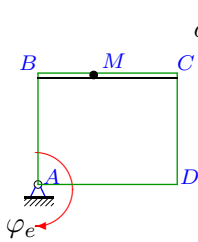
**Задача 10.20.**



$$\sigma(t) = BM = \frac{5}{6}(t^3 + 2) \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.52t^2, \\ AB &= 2 \text{ см,} \\ AC &= 4 \text{ см,} \\ t_1 &= 1 \text{ с.} \end{aligned}$$

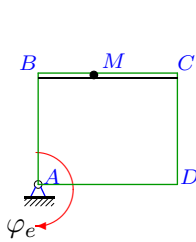
**Задача 10.21.**



$$\sigma(t) = BM = \frac{2}{3}(t^2 + 50) \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.02t^2, \\ AB &= 26 \text{ см,} \\ BC &= 51 \text{ см,} \\ t_1 &= 1 \text{ с.} \end{aligned}$$

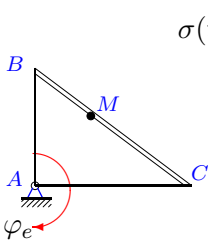
**Задача 10.22.**



$$\sigma(t) = BM = \frac{2}{3}(t^2 + 6t) \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.06t^2, \\ AB &= 14 \text{ см,} \\ BC &= 27 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

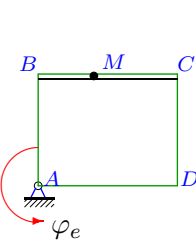
**Задача 10.23.**



$$\sigma(t) = BM = \frac{5}{6}(t^2 + 52) \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.02t^2, \\ AB &= 30 \text{ см,} \\ AC &= 54 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

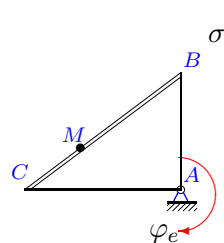
**Задача 10.24.**



$$\sigma(t) = BM = \frac{5}{6}(t^2 + 4t) \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.14t^2, \\ AB &= 6 \text{ см,} \\ BC &= 12 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

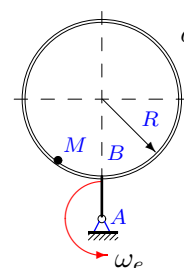
**Задача 10.25.**



$$\sigma(t) = BM = \frac{1}{3}(t^3 + 4) \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.11t^2, \\ AB &= 16 \text{ см,} \\ AC &= 28 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

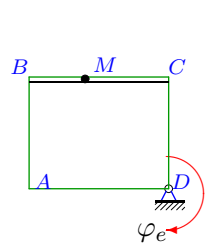
**Задача 10.26.**



$$\sigma(t) = BM = \frac{3\pi}{2}(t^2 + 3)t \text{ см.}$$

$$\begin{aligned} \omega_e &= 3.32 \text{ рад/с,} \\ R &= 14 \text{ см,} \\ AB &= 2 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

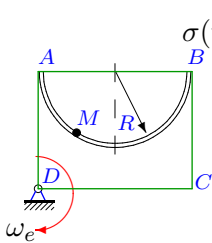
**Задача 10.27.**



$$\sigma(t) = BM = \frac{1}{4}(t^2 + 4)t \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.04t^2, \\ AB &= 20 \text{ см,} \\ BC &= 39 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Задача 10.28.**

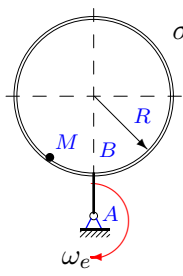


$$\sigma(t) = AM = \frac{2\pi}{3}(t^2 + 6t) \text{ см.}$$

$$\begin{aligned} \omega_e &= 0.61 \text{ рад/с,} \\ R &= 27 \text{ см,} \\ AD &= 29 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Задача 10.29.**

7

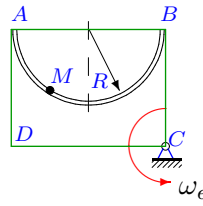


$$\sigma(t) = BM = \frac{5\pi}{3}(t^2 + 4t) \text{ см.}$$

$$\begin{aligned} \omega_e &= 3.19 \text{ рад/с,} \\ R &= 12 \text{ см,} \\ AB &= 2 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.30.**

7

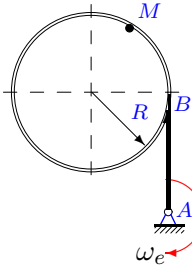


$$\sigma(t) = AM = \frac{\pi}{2}(t^3 + 4) \text{ см.}$$

$$\begin{aligned} \omega_e &= 1.37 \text{ рад/с,} \\ R &= 31 \text{ см,} \\ AD &= 33 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Задача 10.31.**

7

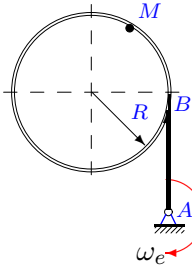


$$\sigma(t) = BM = \frac{2\pi}{3}(t^2 + 3)t \text{ см.}$$

$$\begin{aligned} \omega_e &= 0.84 \text{ рад/с,} \\ R &= 14 \text{ см,} \\ AB &= 19 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.32.**

7

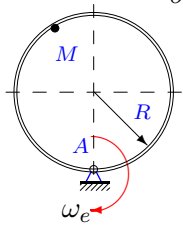


$$\sigma(t) = BM = \frac{3\pi}{2}(t^2 + 4t) \text{ см.}$$

$$\begin{aligned} \omega_e &= 2.9 \text{ рад/с,} \\ R &= 12 \text{ см,} \\ AB &= 17 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.33.**

7

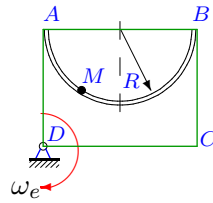


$$\sigma(t) = AM = \frac{3\pi}{2}(t^2 + 50) \text{ см.}$$

$$\begin{aligned} \omega_e &= 0.13 \text{ рад/с,} \\ R &= 51 \text{ см,} \\ t_1 &= 1 \text{ с.} \end{aligned}$$

**Задача 10.34.**

7



$$\sigma(t) = AM = \frac{\pi}{3}(t^3 + 4) \text{ см.}$$

$$\begin{aligned} \omega_e &= 1.7 \text{ рад/с,} \\ R &= 31 \text{ см,} \\ AD &= 33 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Сложное движение точки, плоская траектория**

№	$R_e$	$v_r$	$v_e$	$v$	$a_r$	$a_e$	$a_c$	$a$
	Радиус, см	Скорости, см/с			Ускорения, см/с <sup>2</sup>			
1	49.855	3.000	3.988	3.386	1.500	2.020	0.480	1.954
2	110.586	4.712	4.423	8.130	1.612	0.177	0.377	1.658
3	73.142	3.333	2.926	2.114	1.667	1.468	0.267	1.182
4	10.704	5.236	5.245	9.908	11.090	2.570	5.131	16.957
5	39.051	48.695	48.814	70.693	67.052	61.018	121.737	71.909
6	30.684	3.000	3.682	6.437	1.000	1.304	0.720	2.514
7	33.898	6.750	6.102	1.613	4.500	2.311	2.430	2.912
8	8.139	6.000	5.860	11.054	6.000	5.137	8.640	14.721
9	14.000	78.540	78.540	78.540	445.065	440.609	881.217	496.019
10	6.242	2.500	2.497	0.396	2.000	1.599	2.000	1.234
11	4.243	18.850	18.837	14.422	118.810	83.638	167.384	69.319
12	51.039	3.142	3.062	4.300	3.148	0.184	0.377	3.011
13	28.223	6.750	6.774	11.970	4.500	2.782	3.240	7.482
14	37.546	31.416	31.539	62.916	74.843	26.493	52.779	151.503
15	19.053	50.265	50.299	26.028	235.128	132.789	265.402	141.054
16	6.540	18.850	18.834	4.099	29.981	54.241	108.573	85.513
17	3.010	3.000	3.010	5.483	1.500	4.257	6.000	10.326
18	9.812	78.540	78.496	21.195	445.065	627.965	1256.637	1116.276
19	19.175	33.510	33.555	51.316	93.953	58.722	117.286	230.618
20	2.404	2.500	2.500	1.788	5.000	3.607	5.200	5.131
21	42.802	1.333	1.712	2.735	1.333	1.713	0.107	2.766
22	22.804	8.000	8.209	14.561	1.333	4.028	5.760	9.758
23	44.753	5.000	5.370	9.236	1.667	1.903	1.200	3.739
24	11.662	6.667	6.531	6.503	1.667	4.903	7.467	8.957
25	14.097	9.000	9.304	1.590	6.000	6.879	11.880	6.634
26	21.260	70.686	70.584	58.375	361.344	234.339	469.354	236.637
27	35.434	7.750	8.504	14.380	4.500	3.493	3.720	8.186
28	40.888	25.133	24.941	27.964	23.767	15.214	30.662	10.027
29	13.115	41.888	41.836	69.578	146.591	133.458	267.245	483.249
30	31.064	42.412	42.558	58.117	64.546	58.305	116.208	191.148
31	37.546	31.416	31.539	2.205	74.843	26.493	52.779	49.909
32	13.000	37.699	37.700	62.736	118.810	109.330	218.655	180.046
33	72.125	9.425	9.376	17.370	9.584	1.219	2.450	11.461
34	16.677	28.274	28.350	53.484	31.943	48.196	96.133	108.706

$N_0$	$a_r^n$	$a_r^\tau$	$a_e^n$	$a_e^\tau$	$a_x$	$a_y$
1	0.000	1.500	0.319	1.994	0.116	1.951
2	0.364	1.571	0.177	0.000	-1.606	0.412
3	0.000	1.667	0.117	1.463	-1.092	0.453
4	9.139	6.283	2.570	0.000	-12.216	-11.761
5	60.799	28.274	61.018	0.000	-32.663	-64.062
6	0.000	1.000	0.442	-1.227	0.748	-2.400
7	0.000	4.500	1.098	-2.034	1.826	2.269
8	0.000	6.000	4.219	-2.930	11.011	-9.770
9	440.607	62.832	440.609	0.000	-31.416	-495.023
10	0.000	2.000	0.999	1.248	1.202	0.281
11	118.435	9.425	83.638	0.000	-10.192	-68.566
12	0.194	3.142	0.184	0.000	2.958	0.563
13	0.000	4.500	1.626	-2.258	7.119	-2.302
14	70.497	25.133	26.493	0.000	-54.690	-141.288
15	229.693	50.265	132.789	0.000	-10.337	-140.675
16	29.609	4.712	54.241	0.000	-65.225	55.300
17	0.000	1.500	3.010	-3.010	1.250	-10.250
18	440.607	62.832	627.965	0.000	-346.208	1061.231
19	93.578	8.378	58.722	0.000	167.812	158.189
20	0.000	5.000	2.600	-2.500	-3.462	3.787
21	0.000	1.333	0.068	-1.712	2.319	-1.508
22	0.000	1.333	2.955	-2.736	0.681	-9.734
23	0.000	1.667	0.644	-1.790	0.447	-3.712
24	0.000	1.667	3.657	3.265	-3.149	8.385
25	0.000	6.000	6.141	-3.101	-4.803	4.575
26	356.892	56.549	234.339	0.000	-41.852	-232.907
27	0.000	4.500	2.041	-2.835	7.785	-2.532
28	23.395	4.189	15.214	0.000	-7.809	-6.289
29	146.216	10.472	133.458	0.000	-469.057	116.253
30	58.024	28.274	58.305	0.000	86.458	170.477
31	70.497	25.133	26.493	0.000	1.911	-49.872
32	118.435	9.425	109.330	0.000	110.345	-142.270
33	1.742	9.425	1.219	0.000	-5.054	-10.287
34	25.788	18.850	48.196	0.000	-63.643	-88.128