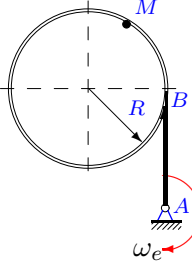


## Сложное движение точки, плоская траектория

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.)

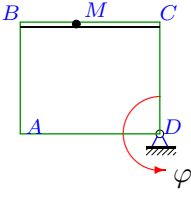
**Задача 10.1.** 4



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

$\omega_e = 2.06$  рад/с,  
 $R = 27$  см,  
 $AB = 32$  см,  
 $t_1 = 3$  с.

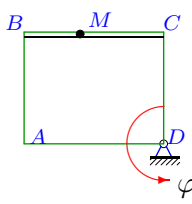
**Задача 10.2.** 4



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

$\varphi_e = 0.12t^2$ ,  
 $AB = 6$  см,  
 $BC = 12$  см,  
 $t_1 = 2$  с.

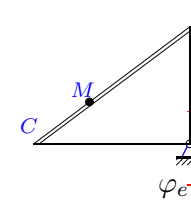
**Задача 10.3.** 4



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

$\varphi_e = 0.18t^2$ ,  
 $AB = 6$  см,  
 $BC = 12$  см,  
 $t_1 = 2$  с.

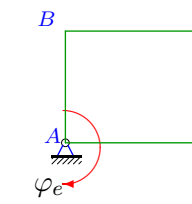
**Задача 10.4.** 4



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

$\varphi_e = 0.02t^2$ ,  
 $AB = 28$  см,  
 $AC = 49$  см,  
 $t_1 = 2$  с.

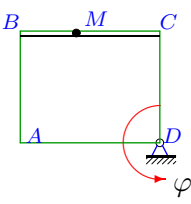
**Задача 10.5.** 4



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

$\varphi_e = 0.1t^2$ ,  
 $AB = 3$  см,  
 $BC = 5$  см,  
 $t_1 = 1$  с.

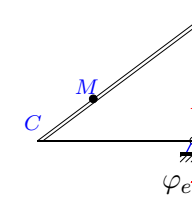
**Задача 10.6.** 4



$\sigma(t) = BM = \frac{1}{2}(t^2 + 50)$  см.

$\varphi_e = 0.01t^2$ ,  
 $AB = 26$  см,  
 $BC = 51$  см,  
 $t_1 = 1$  с.

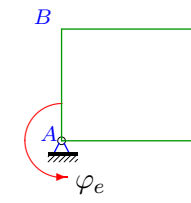
**Задача 10.7.** 4



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

$\varphi_e = 0.02t^2$ ,  
 $AB = 28$  см,  
 $AC = 49$  см,  
 $t_1 = 2$  с.

**Задача 10.8.** 4

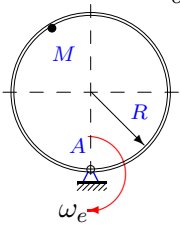


$\sigma(t) = DM = \frac{1}{2}(t^2 + 2)t$  см.

$\varphi_e = 0.24t^2$ ,  
 $AB = 3$  см,  
 $BC = 5$  см,  
 $t_1 = 1$  с.

**Задача 10.9.**

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



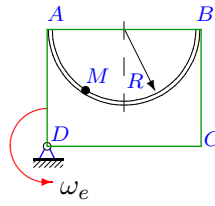
$$\omega_e = 2.65 \text{ рад/с,}$$

$$R = 39 \text{ см,}$$

$$t_1 = 3 \text{ с.}$$

**Задача 10.10.**

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



$$\omega_e = 1.31 \text{ рад/с,}$$

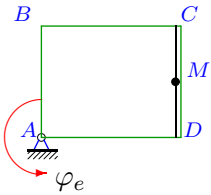
$$R = 3 \text{ см,}$$

$$AD = 5 \text{ см,}$$

$$t_1 = 1 \text{ с.}$$

**Задача 10.11.**

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



$$\varphi_e = 0.13t^2,$$

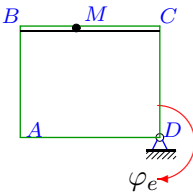
$$AB = 3 \text{ см,}$$

$$BC = 5 \text{ см,}$$

$$t_1 = 1 \text{ с.}$$

**Задача 10.12.**

$$\sigma(t) = BM = \frac{3}{4}(t^2 + 50) \text{ см.}$$



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

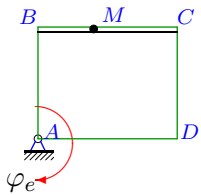
$$AB = 26 \text{ см,}$$

$$BC = 51 \text{ см,}$$

$$t_1 = 1 \text{ с.}$$

**Задача 10.13.**

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



$$\varphi_e = 0.11t^2,$$

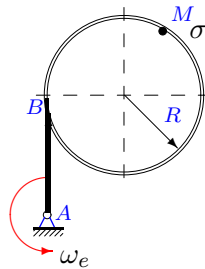
$$AB = 20 \text{ см,}$$

$$BC = 39 \text{ см,}$$

$$t_1 = 3 \text{ с.}$$

**Задача 10.14.**

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



$$\omega_e = 1.75 \text{ рад/с,}$$

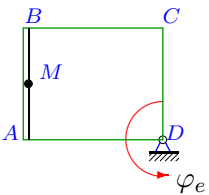
$$R = 12 \text{ см,}$$

$$AB = 17 \text{ см,}$$

$$t_1 = 2 \text{ с.}$$

**Задача 10.15.**

$$\sigma(t) = AM = \frac{1}{3}(t^2 + 52) \text{ см.}$$



$$\varphi_e = 0.01t^2,$$

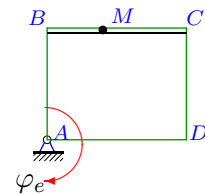
$$AB = 61 \text{ см,}$$

$$BC = 63 \text{ см,}$$

$$t_1 = 3 \text{ с.}$$

**Задача 10.16.**

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



$$\varphi_e = 0.19t^2,$$

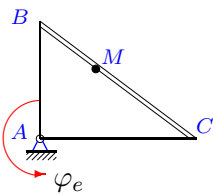
$$AB = 7 \text{ см,}$$

$$BC = 14 \text{ см,}$$

$$t_1 = 2 \text{ с.}$$

**Задача 10.17.**

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



$$\varphi_e = 0.15t^2,$$

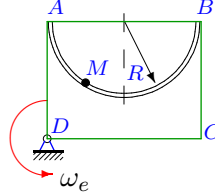
$$AB = 20 \text{ см,}$$

$$AC = 35 \text{ см,}$$

$$t_1 = 3 \text{ с.}$$

**Задача 10.18.**

$$\sigma(t) = AM = \frac{5\pi}{6}(t^3 + 4) \text{ см.}$$



$$\omega_e = 1.17 \text{ рад/с,}$$

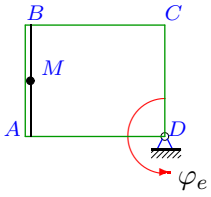
$$R = 31 \text{ см,}$$

$$AD = 33 \text{ см,}$$

$$t_1 = 3 \text{ с.}$$

**Задача 10.19.**

4

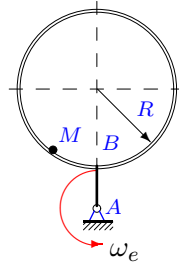


$$\sigma(t) = AM = \frac{3}{4}(t^2 + 51) \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.01t^2, \\ AB &= 55 \text{ см,} \\ BC &= 57 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.20.**

4

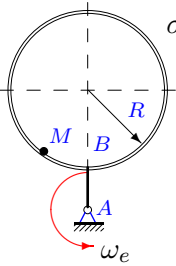


$$\sigma(t) = BM = \frac{\pi}{3}(t^2 + 51) \text{ см.}$$

$$\begin{aligned} \omega_e &= 0.07 \text{ рад/с,} \\ R &= 55 \text{ см,} \\ AB &= 2 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.21.**

4

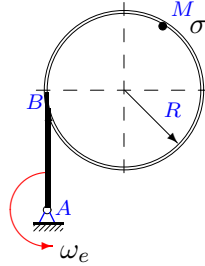


$$\sigma(t) = BM = \frac{5\pi}{3}(t^2 + 4)t \text{ см.}$$

$$\begin{aligned} \omega_e &= 4.05 \text{ рад/с,} \\ R &= 39 \text{ см,} \\ AB &= 2 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Задача 10.22.**

4

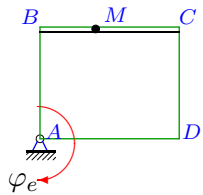


$$\sigma(t) = BM = \frac{2\pi}{3}(t^2 + 4t) \text{ см.}$$

$$\begin{aligned} \omega_e &= 0.51 \text{ рад/с,} \\ R &= 12 \text{ см,} \\ AB &= 17 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.23.**

4

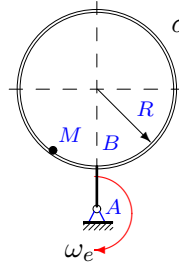


$$\sigma(t) = BM = \frac{2}{3}(t^2 + 2t) \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.47t^2, \\ AB &= 2 \text{ см,} \\ BC &= 3 \text{ см,} \\ t_1 &= 1 \text{ с.} \end{aligned}$$

**Задача 10.24.**

4

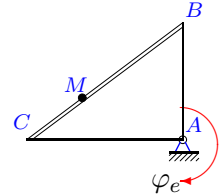


$$\sigma(t) = BM = \frac{4\pi}{3}(t^2 + 51) \text{ см.}$$

$$\begin{aligned} \omega_e &= 0.17 \text{ рад/с,} \\ R &= 55 \text{ см,} \\ AB &= 2 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.25.**

4

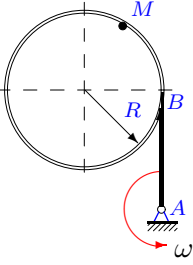


$$\sigma(t) = BM = \frac{1}{3}(t^2 + 52) \text{ см.}$$

$$\begin{aligned} \varphi_e &= 0.01t^2, \\ AB &= 30 \text{ см,} \\ AC &= 54 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Задача 10.26.**

4

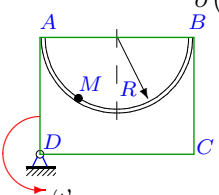


$$\sigma(t) = BM = \frac{\pi}{3}(t^2 + 4t) \text{ см.}$$

$$\begin{aligned} \omega_e &= 0.3 \text{ рад/с,} \\ R &= 12 \text{ см,} \\ AB &= 17 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.27.**

4

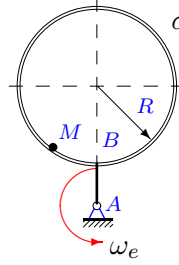


$$\sigma(t) = AM = \frac{\pi}{6}(t^2 + 51) \text{ см.}$$

$$\begin{aligned} \omega_e &= 0.07 \text{ рад/с,} \\ R &= 55 \text{ см,} \\ AD &= 57 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.28.**

4



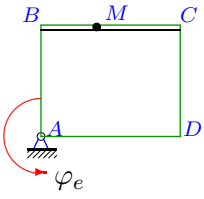
$$\sigma(t) = BM = \frac{3\pi}{2}(t^2 + 52) \text{ см.}$$

$$\begin{aligned} \omega_e &= 0.32 \text{ рад/с,} \\ R &= 61 \text{ см,} \\ AB &= 2 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Задача 10.29.**

4

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

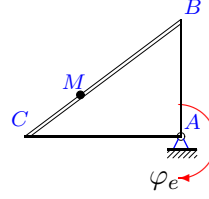


$$\begin{aligned} \varphi_e &= 0.06t^2, \\ AB &= 14 \text{ см,} \\ BC &= 27 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Задача 10.30.**

4

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

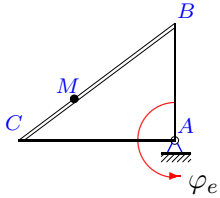


$$\begin{aligned} \varphi_e &= 0.3t^2, \\ AB &= 7 \text{ см,} \\ AC &= 13 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.31.**

4

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

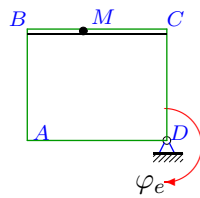


$$\begin{aligned} \varphi_e &= 0.14t^2, \\ AB &= 6 \text{ см,} \\ AC &= 11 \text{ см,} \\ t_1 &= 2 \text{ с.} \end{aligned}$$

**Задача 10.32.**

4

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

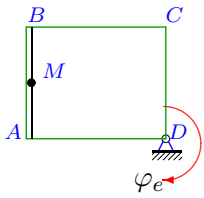


$$\begin{aligned} \varphi_e &= 0.03t^2, \\ AB &= 30 \text{ см,} \\ BC &= 61 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Задача 10.33.**

4

$$\sigma(t) = AM = \frac{1}{4}(t^2 + 52) \text{ см.}$$

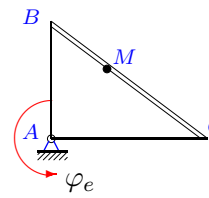


$$\begin{aligned} \varphi_e &= 0t^2, \\ AB &= 61 \text{ см,} \\ BC &= 63 \text{ см,} \\ t_1 &= 3 \text{ с.} \end{aligned}$$

**Задача 10.34.**

4

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



$$\begin{aligned} \varphi_e &= 0.66t^2, \\ AB &= 2 \text{ см,} \\ AC &= 4 \text{ см,} \\ t_1 &= 1 \text{ с.} \end{aligned}$$

**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	27.459	56.549	56.566	86.962	118.810	116.525	232.981	183.870
2	8.485	4.000	4.073	3.090	1.000	2.823	3.840	1.387
3	7.211	5.333	5.192	3.053	1.333	4.551	7.680	3.369
4	33.312	2.667	2.665	1.960	1.333	1.349	0.427	1.201
5	5.056	1.000	1.011	0.150	0.500	1.031	0.400	0.635
6	36.418	1.000	0.728	0.700	1.000	0.728	0.040	0.686
7	33.312	2.667	2.665	1.960	1.333	1.349	0.427	1.201
8	5.220	2.500	2.506	4.953	3.000	2.779	2.400	6.618
9	55.154	146.084	146.159	269.997	553.729	387.321	774.246	1635.146
10	3.606	4.712	4.723	4.452	11.984	6.187	12.346	16.868
11	5.099	1.333	1.326	2.646	0.667	1.370	0.693	2.297
12	28.958	1.500	1.737	3.154	1.500	1.741	0.180	3.145
13	35.434	23.250	23.386	41.247	13.500	17.292	30.690	46.126
14	19.175	33.510	33.555	43.180	93.953	58.722	117.286	67.631
15	66.200	2.000	3.972	2.158	0.667	1.345	0.240	0.788
16	9.899	7.500	7.524	13.880	6.000	6.844	11.400	18.683
17	23.665	20.667	21.298	15.322	12.000	20.441	37.200	28.644
18	60.436	70.686	70.710	129.751	167.925	82.731	165.405	383.409
19	70.360	3.000	2.814	1.800	1.500	1.412	0.240	1.017
20	56.027	4.189	3.922	4.170	2.119	0.275	0.586	1.858
21	40.037	162.316	162.152	168.275	682.090	656.715	1314.757	755.377
22	32.777	16.755	16.716	0.967	23.767	8.525	17.090	15.270
23	2.828	2.667	2.659	4.920	1.333	3.649	5.013	8.780
24	97.000	16.755	16.490	32.068	9.810	2.803	5.697	16.454
25	26.851	2.000	1.611	0.549	0.667	0.546	0.240	0.288
26	28.042	8.378	8.413	15.656	6.212	2.524	5.027	12.746
27	30.406	2.094	2.128	1.649	1.050	0.149	0.293	1.185
28	87.693	28.274	28.062	21.979	16.143	8.980	18.096	15.926
29	26.500	10.000	9.540	9.498	1.667	4.681	7.200	8.600
30	9.463	11.250	11.356	9.440	9.000	14.763	27.000	22.993
31	5.269	3.000	2.951	5.950	3.000	2.215	3.360	6.719
32	31.676	5.000	5.702	10.560	1.667	2.160	1.800	4.369
33	64.819	1.500	0.000	1.500	0.500	0.000	0.000	0.500
34	1.889	2.500	2.493	0.811	3.000	4.128	6.600	4.303

№	$a_r^n$	$a_r^\tau$	$a_e^n$	$a_e^\tau$	$a_x$	$a_y$
1	118.435	9.425	116.525	0.000	124.002	-135.763
2	0.000	1.000	1.955	2.036	0.942	1.018
3	0.000	1.333	3.738	2.596	1.247	3.130
4	0.000	1.333	0.213	-1.332	-0.773	0.920
5	0.000	0.500	0.202	-1.011	0.350	-0.530
6	0.000	1.000	0.015	0.728	0.490	-0.480
7	0.000	1.333	0.213	-1.332	-0.773	0.920
8	0.000	3.000	1.203	2.506	-4.272	5.054
9	547.194	84.823	387.321	0.000	-1595.317	-358.701
10	7.402	9.425	6.187	0.000	4.276	16.316
11	0.000	0.667	0.345	1.326	-1.291	1.899
12	0.000	1.500	0.104	-1.737	3.106	0.491
13	0.000	13.500	15.435	-7.795	5.159	-45.837
14	93.578	8.378	58.722	0.000	-50.526	-44.956
15	0.000	0.667	0.238	1.324	-0.420	-0.667
16	0.000	6.000	5.718	-3.762	4.617	-18.103
17	0.000	12.000	19.168	7.099	8.460	27.366
18	161.177	47.124	82.731	0.000	-338.453	180.146
19	0.000	1.500	0.113	1.407	-0.974	0.294
20	0.319	2.094	0.275	0.000	-1.045	1.536
21	675.548	94.248	656.715	0.000	-47.547	-753.879
22	23.395	4.189	8.525	0.000	-4.206	-14.679
23	0.000	1.333	2.499	-2.659	1.446	-8.661
24	5.104	8.378	2.803	0.000	-6.542	-15.098
25	0.000	0.667	0.097	-0.537	-0.233	0.169
26	5.849	2.094	2.524	0.000	-6.711	-10.836
27	0.080	1.047	0.149	0.000	0.810	-0.865
28	13.106	9.425	8.980	0.000	-1.256	-15.876
29	0.000	1.667	3.434	3.180	-2.929	8.086
30	0.000	9.000	13.627	-5.678	-6.199	22.141
31	0.000	3.000	1.652	1.475	-1.579	-6.531
32	0.000	1.667	1.026	-1.901	3.796	-2.162
33	0.000	0.500	0.000	0.000	0.000	0.500
34	0.000	3.000	3.291	2.493	1.543	4.017