COMPOSITION OF MULTIPLE OPTION PROBLEMS ON THEORETICAL MECHANICS

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Abstract: Over the next five years, the number of higher education institutions in our country has increased dramatically, and the number of admissions to them has also increased accordingly. The issue of educational and methodological support for students has arisen. This article deals with the experience of creating multiple-choice problems for students of theoretical mechanics.

Keywords: theoretical mechanics, kinematics, forward motion, velocity, acceleration, rotational motion, linear velocity, rotational acceleration, centripetal acceleration, transmission of motion, rail, gear wheel.

Today, great changes are being made in the field of education in our country. The number of students of higher educational institutions and the number of educational fields is constantly expanding and increasing. Non-state higher educational institutions are being added to the number of active state higher educational institutions. Our opinion is evidenced by the addition of 5 new state and non-state higher educational institutions to the existing 3 higher educational institutions in Namangan region alone. Therefore, the increase in the number of students, along with providing them with quality education, also puts the issue of improving the educational and methodological provision of subjects on the agenda. It is not a secret that it is necessary to improve the methodological provision of students, especially in the Latin alphabet. They need high-quality and color printed textbooks, study guides and problem sets that meet the requirements of the time.

A multiple-choice assignment was prepared for students from the Department of Theoretical Mechanics and Kinematics. In it, 10 forms and 10 conditional questions were presented to the students, which were compiled independently by the authors. It contains the text of the assignment, a diagram, and an example of the assignment. Below is this assignment in full.

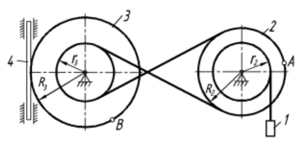
K9 Assignment. Determination of velocity and acceleration of rigid body points in forward and rotational motion

A mechanical system consists of four bodies that are in contact with each other or connected by an inextensible rope. According to the law $x_1=f(t)$, the 1st body in forward motion drives the 2nd gear wheel by means of a rope (in some variants, the 4th gear rack drives the 3rd gear wheel). The 2nd wheel is in turn meshed with the 3-speed wheel externally (or internally) and the drive is transmitted to the 3rd wheel. In turn, the 3rd gear wheel drives the 4th gear rack. Assignment forms are presented in forms K9.0-K9.9. The movement starts with the forward motion of load 1 according to the law $x_1=f(t)$ (in some variants, the 4th rack moving according to the law $S_4=f(t)$ drives the 3rd gear wheel). Find the linear velocities and accelerations of the indicated points and the angular velocities and angular accelerations of the indicated wheels for the given time $t=t_1$ and represent the quantities found in the figure. The necessary quantities for calculations are given in table K9.

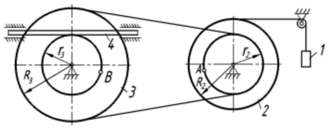
Table K9

№	$x_1=f(t)$ sm	$S_4=f(t)$ sm	t_1 sek	R_2 sm	r_2 sm	R_3 sm	r_3 sm
0	$10t^2$		1	20	10	24	12
1		$3t^2-1$	2	80	40	60	30
2	$9t^2+2$		1	90	45	70	35
3		$2t+5t^2$	2	24	12	28	14
4	$2t^3$		1	48	24	52	26
5		$6t^2-2t$	2	12	6	18	9

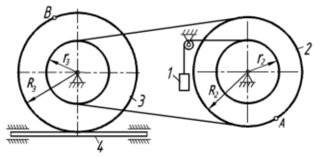
6	$1+2t+t^2$		1	32	16	36	18
7		$7t+4t^2$	2	42	21	38	19
8	$3t^3+1$		1	4	2	6	3
9		$5t^2$	2	8	4	10	5



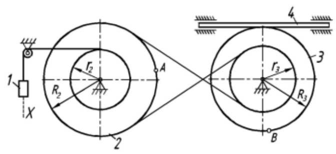
K9.0- figure



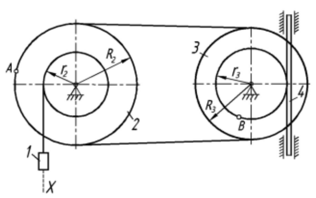
K9.1- figure



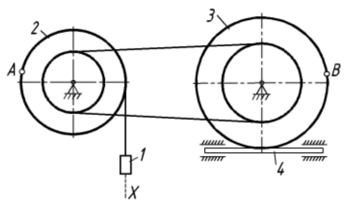
K9.2- figure



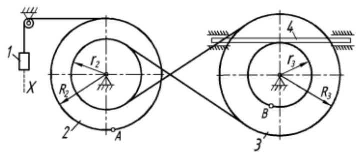
K9.3- figure



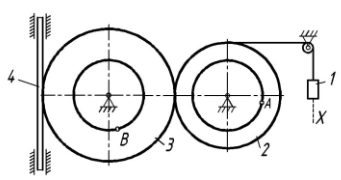
K9.4- figure



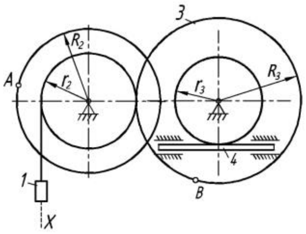
K9.5- figure



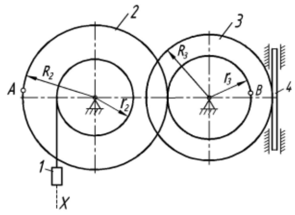
K9.6- figure



K9.7- figure



K9.8- figure

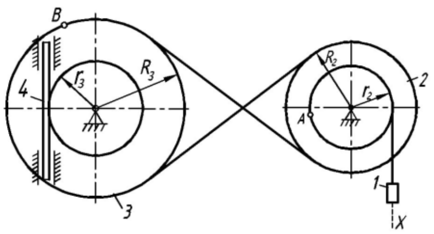


K9.9- figure

Example of K9 Assignment

Given:

$x_1=25t^2$ sm, $R_2=20$ sm, $r_2=16$ sm, $R_3=32$ sm, $r_3=22$ sm, $t_1=1$ sek.



K9.10- figure

Must find: $v_1, \omega_2, \omega_3, v_A, v_B, v_C, v_D, v_4, a_1, \varepsilon_2, \varepsilon_3, a_4, a_C, a_D$

Solution: Determination of velocities (Fig. k9.10 a).

1 load as the advance moves

$v_1 = \frac{dx_1}{dt} = 50t$, *for time $t_1=1$ sec*

$$v_1 = 50 \cdot 1 = 50 \ sm/s$$

v_1 speed is downward, based on its direction, we can determine the directions of angular velocities of the 2nd and 3rd gear wheels.

Because load 1 is attached to the inner flange of the second gear wheel by a rope

$v_1 = \omega_2 \cdot r_2$, here $\omega_2 = \frac{v_1}{r_2} = \frac{50t}{16} = 3{,}1\, t \quad 1/s,$

for time $t_1=1$ sec $\omega_2 = 3{,}1 \quad 1/s,$

Since the 2nd and 3rd gear wheels are connected from the outside by means of a belt, their speeds are equal at the point of contact

$$\omega_2 \cdot R_2 = \omega_3 \cdot R_3 \qquad \omega_3 = \frac{\omega_2 \cdot R_2}{R_3} = \frac{3{,}1t \cdot 20}{32} = 1{,}9\,t\,.$$

for time t_1*=1 sec* $\omega_3 = = 1{,}9 \cdot 1 = 1{,}9$ *1/s*

We find the sum of the velocities of the points.

$$v_A = v_1 = 50\ sm/s,\ v_B = \omega_3 \cdot R_3 = 1{,}9 \cdot 32 = 60{,}8\ sm/s$$

$$v_4 = \omega_3 \cdot r_3 = 1{,}9 \cdot 22 = 41{,}8\ \frac{sm}{s}$$

We describe all the found velocities in K9 a-form.

1. **1. Finding accelerations** (Figure K9 b). First, we will find the angular accelerations of the 2nd and 3rd gear wheels.

$$\varepsilon_2 = \frac{d\omega_2}{dt} = 3{,}1\ \frac{1}{c^2};\ \varepsilon_3 = \frac{d\omega_3}{dt} = 1{,}9\ \frac{1}{c^2};$$

1st load acceleration $a_1 = \frac{dv_1}{dt} = 50\ sm/s^2$

The acceleration of load 1 found is vertically downward. Using its direction, we can determine the direction of the angular acceleration of the 2nd and 3rd gear wheels. Note that the 2nd gear wheel rotates clockwise, and the 3rd gear wheel rotates counterclockwise.

We find the acceleration of point A lying on the inner flange of the 2nd gear wheel.

$$\vec{a_A} = \vec{a}_A^{\tau} + \vec{a}_A^{n}$$

$$a_A^{\tau} + \varepsilon_2 \cdot r_2 = 3{,}1 \cdot 16 = 49{,}6\ \ sm/s^2$$

$$a_a^n = \omega_2^2 \cdot r_2 = 9{,}6 \cdot 16 = 153{,}6\ \ sm/s^2$$

$$a_A = \sqrt{(a_A^{\tau})^2 + (a_A^n)^2} = \sqrt{2460{,}2 + 23593} = \sqrt{26053{,}2} = 161{,}4\ \ sm/s^2$$

We find the acceleration of point B lying on the outer flange of the 3-speed wheel.

$$\vec{a_B} = \vec{a}_B^{\tau} + \vec{a}_B^{n}$$

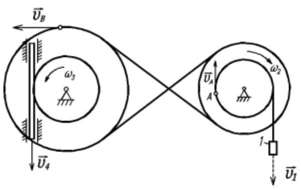
$$a_B^{\varepsilon} = \varepsilon_3 \cdot R_3 = 1{,}9 \cdot 32 = 60{,}8\ \ sm/s^2$$

$$a_B^n = \omega_3^2 \cdot R_3 = 3{,}6 \cdot 32 = 115{,}2\ \ sm/s^2$$

$$a_B = \sqrt{(a_B^{\tau})^2 + (a_B^{n})^2} = \sqrt{3696{,}6 + 13271} = \sqrt{16967{,}6} = 130{,}2\ \ sm/s^2$$

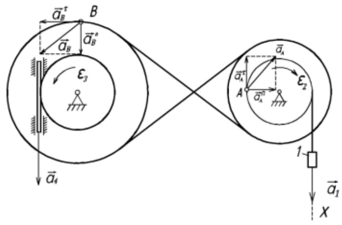
We find the acceleration of the 4th rail

$$a_4 = \varepsilon_3 \cdot r_3 = 1{,}9 \cdot 22 = 41{,}8 \quad sm/s^2$$



K9.10 a- figure

Velocity graph



K9.10 b- figure

Accelerations graph

We describe all the accelerations found in Fig. K9.10 b.

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