FROM THE EXPERIENCE OF MAKING MULTIPLE OPTION PROBLEMS ON THE DEPARTMENT OF STATICS OF THEORETICAL MECHANICS

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Abstract: The number of higher educational institutions in our country has increased dramatically recently, and modern ones have been added to the existing specializations, and the number of students admitted has also increased accordingly. The issue of educational and methodological provision of subjects taught for a large number of these students has arisen. The article talks about the experience of creating multiple-choice problems for students from the statics department of theoretical mechanics.

Key words: theoretical mechanics, statics, hammer, broken hammer, force, force system, evenly distributed force, couple force, coordinate axes, equilibrium equations, base reaction forces, force moment, force projection.

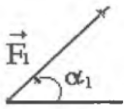
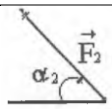
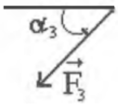
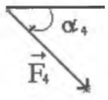
The science of theoretical mechanics, which is one of the technical sciences, is studied as one of the main technical sciences in many higher educational institutions. Many sets of problems and assignments in these three subjects were created by leading scientists or a team of scientists in the field and have successfully passed many years of practical tests. To date, the large increase in the number of students in higher educational institutions, the availability of solutions to problems and assignments on the Internet, the fact that many problems and assignments are colorless, the appearance of modern machines and mechanisms have brought new multi-variable options to scientists. is putting the issue of creating tasks.

A multiple-choice assignment was prepared for students in the department of statics of theoretical mechanics. In the assignment, the students were given 10 forms and 10 conditional questions, which were compiled independently by the authors. It contains the text of the assignment, a diagram, and an example of the assignment. These three multiple-choice tasks on the system of arbitrary forces in a plane are convenient for a large number of students to work on independently or for HGI. Below is this assignment in full.

C6 Assignment. A system of forces located arbitrarily in a plane

A broken beam AB located in a plane is subjected to 4 $\vec{F}_1, \vec{F}_2, \vec{F}_3, \vec{F}_4$ (the magnitudes and directions of these forces are given in figures C6.0-C6.9), a pair of forces equal to M, intensity q, uniformly distributed force acting on the part SD. Find the base reaction forces of the beam. The necessary quantities for calculations are given in table C6.

Table C6

Forces => *Variants*	 *F_1* *kN*	 *F_2* *kN*	 *F_3* *kN*	 *F_4* *kN*	*a* *m*	*q* *kN/m*	*M* *kNm*
0	45	30	25	0	1	2	10
1	30	60	15	90	1,5	3	12
2	25	45	90	60	2	4	14
3	60	90	30	15	3	5	16
4	90	30	25	45	1	6	18
5	0	45	60	75	2	4	20
6	15	60	0	30	1,5	5	8
7	30	25	90	60	0,5	2,5	6
8	45	30	15	0	4	3,5	4
9	60	90	45	25	3	1,5	2

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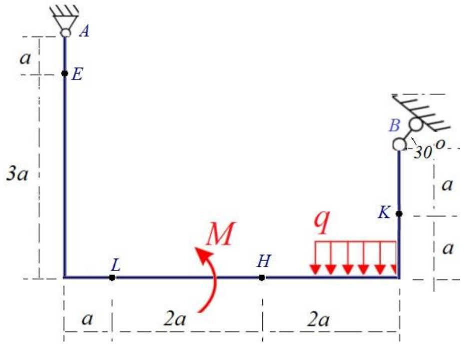
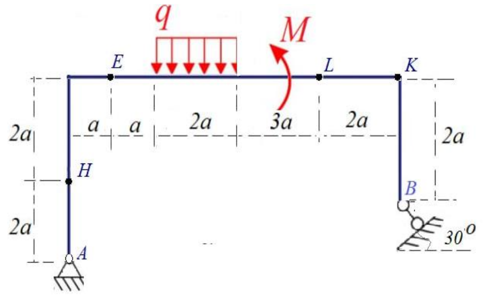
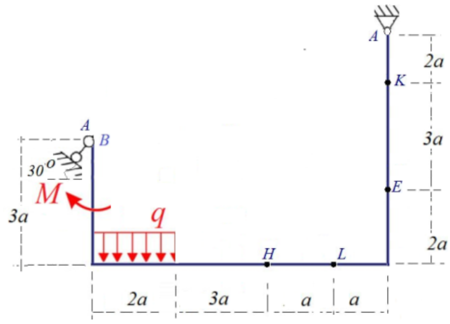


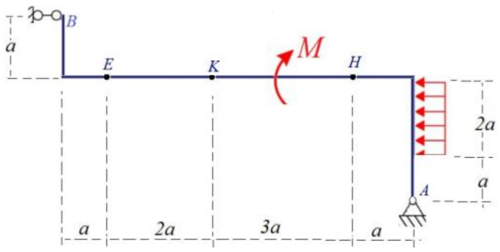
C6.0- figure



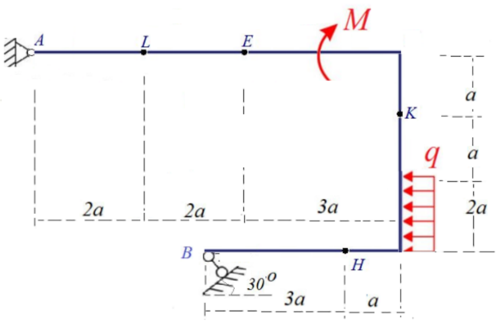
C6.1 - figure



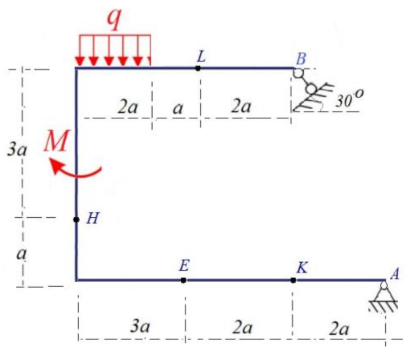
C6.2 - figure



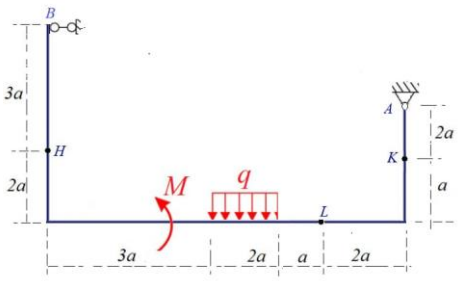
C6.3 - figure



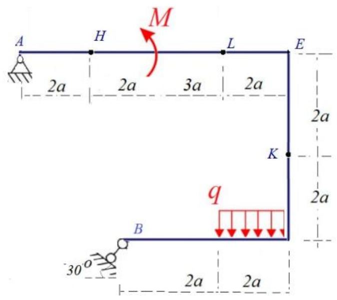
C6.4 - figure



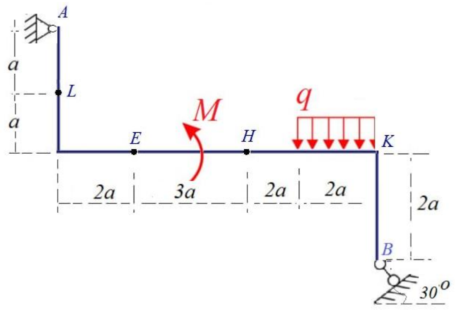
C6.5 - figure



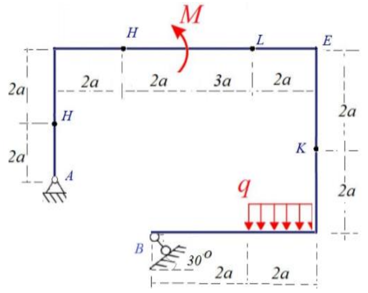
C6.6 - figure



C6.7 - figure



C6.8 - figure



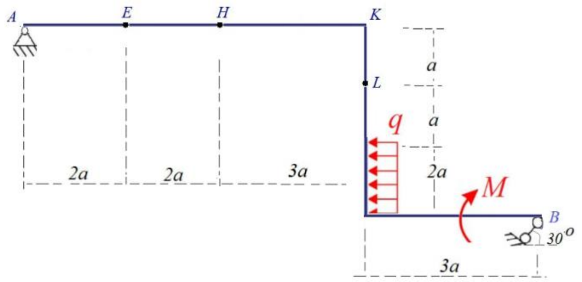
C6.9- figure

An example of a task C6

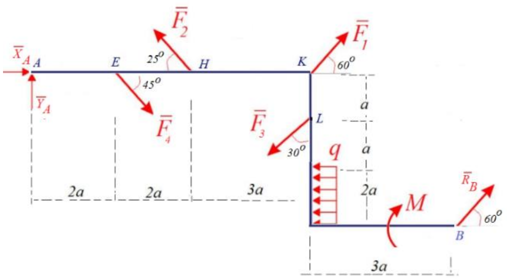
Given: A square block AB is in equilibrium under the action of a given system of forces (Fig. C6.10). $a = 2m; q = \frac{3kN}{m}$, $M = 12kN \cdot m$, at the point of K $F_1 = 6kN, \alpha_1 = 60^{\circ}$ at the point of H $F_2 = 8kN, \alpha_2 = 25^{\circ}$, at the point of L $F_3 = 10kN, \alpha_3 = 30^{\circ}$, at the point of E $F_4 = 12kN, \alpha_4 = 45^{\circ}$.

Find the support reaction forces on the beam: $X_A, Y_A, R_B = ?$

Yechish:



C6.10- figure



C6.11- figure

1. In the figure, we describe the $\vec{F}_1, \vec{F}_2, \vec{F}_3, \vec{F}_4$ forces at the points placed under the given angles. We replace the uniformly distributed force with the accumulated force (Figure C6.11).

$$Q = q \cdot 2a = \frac{3kN}{m} \cdot 2 \cdot 2m = 12\ kN$$

2. We transfer the coordinate axes.

3. We describe the $\vec{X}_A$, $\vec{R}_B$, $\vec{Y}_A$ base reaction forces of the beam given in the following figure (Figure C6.11).

4. We construct 3 equations of equilibrium for a system of forces located arbitrarily on the resulting plane:

$$\sum F_{k_x} = 0; X_A + F_4 \cos 45^\circ - F_2 \cos 25^\circ + F_1 \cos 60^\circ - F_3 \cos 30^\circ - Q + R_B \cos 60^\circ = 0 \quad (1)$$

$$\sum F_{k_y} = 0;\ Y_A - F_4 \sin 45^\circ + F_2 \sin 25^\circ + F_1 \sin 60^\circ - F_3 \sin 30^\circ - Q + R_B \sin 60^\circ = 0 \quad (2)$$

$$\sum m_A(\overline{F}_k) = 0;\ -2aF_4 \sin 45^\circ + 4aF_2 \sin 25^\circ + 7aF_1 \sin 60^\circ - aF_3(\cos 30^\circ - 7 \sin 30^\circ) - 3aQ - M + aR_B(4 \cos 60^\circ + 10 \sin 60^\circ) = 0 \quad (3)$$

5. From the constructed equations, we can find the unknown reaction forces of the beam.

from the equatation (3) we can find the amount of reaction force R_B $R_B =$

$$\frac{2aF_4 \sin 45^\circ - 4aF_2 \sin 25^\circ - 7aF_1 \sin 60^\circ + aF_3(\cos 30^\circ + 7a \sin 30^\circ) + 3aQ + M}{a(4 \cos 60^\circ + 10 \sin 60^\circ)} =$$

$$\frac{2 \cdot 2 \cdot 12 \cdot 0{,}7(-4 \cdot 2 \cdot 8 \cdot 0{,}42 - 7 \cdot 2 \cdot 6 \cdot 0{,}86 + 2 \cdot 10(0{,}86 + 7 \cdot 2 \cdot 0{,}5) + 3 \cdot 2{,}12 +}{2(4 \cdot 0{,}5 + 10 \cdot 0{,}86)}$$

$$=$$

$$= \frac{34{,}08 - 26{,}88 - 72{,}24 + 157{,}2 + 72 + 12}{21{,}2} = \frac{176{,}16}{21{,}2} = 8{,}3\ kN;$$

$$R_B = 8{,}3\ kN$$

from the equation (1)

$$X_A = -F_4 \cos 45^\circ + F_2 \cos 25^\circ - F_1 \cos 60^\circ + F_3 \cos 30^\circ + Q - R_B \cos 60^\circ =$$

$$= -12 \cdot 0{,}71 + 8 \cdot 0{,}9 - 6 \cdot 0{,}5 + 10 \cdot 0{,}86 + 12 - 8{,}3 \cdot 0{,}5 =$$

$$= -8{,}52 + 7{,}2 - 3 + 8{,}6 + 12 - 4{,}15 = 12{,}13$$

$$X_A = 12{,}13\ kN$$

from the equation (2)

(2) $$Y_A = F_4 \sin 45^\circ - F_2 \sin 25^\circ - F_1 \sin 60^\circ + F_3 \sin 30^\circ - R_B \sin 60^\circ =$$

$$= -12 \cdot 0{,}71 - 8 \cdot 0{,}42 - 6 \cdot 0{,}86 + 10 \cdot 0{,}5 - 8{,}3 \cdot 0{,}86 =$$

$$= 8{,}52 - 3{,}36 - 5{,}16 + 5 - 7{,}14 = -2{,}14$$

$$Y_A = -2{,}14\ kN$$

The signs in front of the reaction forces $\vec{X}_A$ and $\vec{R}_B$ are the correct direction of the reaction forces, while the direction of the reaction force Y_A is in the opposite direction to that shown in the figure.

Answers: $X_A = 12{,}13\ kN, R_B = 8{,}3\ kN, Y_A = -2{,}14\ kN$

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