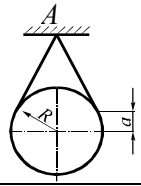
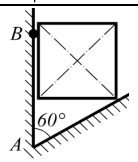
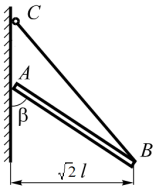
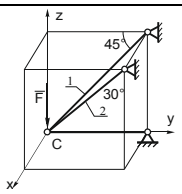
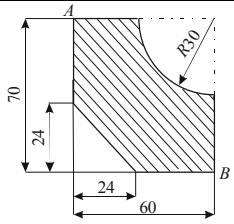
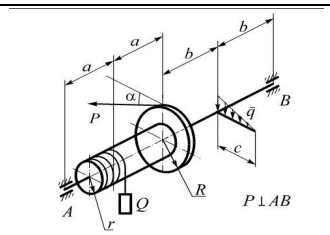
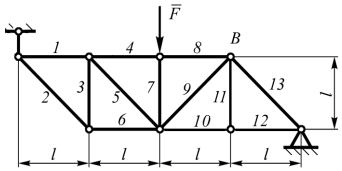
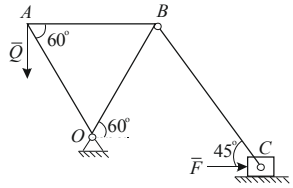
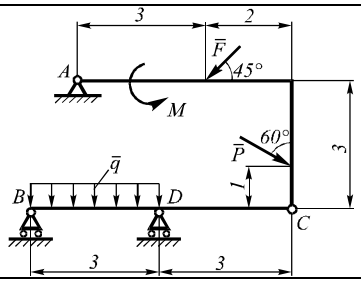
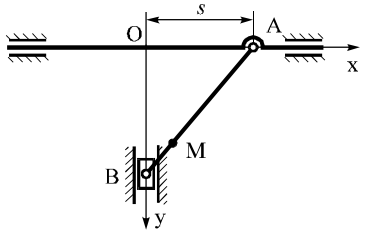
Brain-ring 2015

Statics

1	Find out the module of the three forces resultant R: $\overline{F_1} = 3\bar{i} - 2\bar{j}$ N; $\overline{F_2} = 6\bar{j}$ N; $\overline{F_3} = 5\bar{i} + 8\bar{k}$ N.	
2		A cylinder of G = 90 кН and radius R = 0,55 m is covered by rope loop, attached to a fixed point in the wall. Find the value of the dimension a, determining the position of the vanishing point of the rope from the cylinder, if the tension forces of loop branches are $T_1 = T_2$ = 75 kN.
3		A cube of 200 N weight is held in equilibrium by two smooth surfaces. Determine the distance AB from the angle A vertex to the point of application of the the vertical plane reaction, if the cube edge length is $6\sqrt{3}$ cm.
4		The top end of the homogeneous rod AB of mass m is based on a rough vertical wall. A cable BC is connected with lower end of rod AB (at point B). The rod makes an angle β with the vertical. Determine the minimal value for the angle β for the case of rod equilibrium if AC = 1,5l, CB = 4l, friction coefficient f = 0,2.
5		Determine the value of the resultant reaction of rods 1 and 2 acting on the node C, if F = 40 H.
6		Determine the distance from the center of gravity of the plane figure to the diagonal AB (for reference: the center of gravity of the circular sector is at a distance $\frac{2R\sin\alpha}{3\alpha}$ from the center of the arc with a central angle 2α).
7		Find out the value of angle α for the equilibrium of the shown construction if Q = 0,6P, $q = \frac{Q}{3R}$, a = 2R= 6r, b = 3R, c = 4,5r.
8		The shown construction is in the equilibrium under the force F loading. Specify the numbers of rods that can be replaced by the cable.
9		In the shown mechanism OA = OB = l, BC = 2l. Two forces Q and F are applied to the mechanism. Determine the relation $\frac{Q}{F}$ for the case of equilibrium of the system.
10		Determine the reaction of the hinge C, if F = 10 kN; P = 5 kN; q = 4 kN/m; M = 20 kN m.

Kinematics

11



Find out the velocity of point M for time $t = 0$ if this point is located on the rod AB. It is known that s=3sin2t m, AB = 5 m, BM = 1 m.

12

Determine the $\rho(t)$ dependence of the trajectory curvature radius on time, if the coordinates of the point are adjusted according to the following laws: $x(t) = 3\cos\dfrac{\pi t}{2} - 7$ m; $y(t) = 5 + 4\sin^2(0.25\pi t)$ m.

13

Determine the duration of the photographic shutter, if during the ball falling along the vertical centimeter scale without initial velocity it was obtained strip on the negative lying from 25 to 28 cm scale interval?

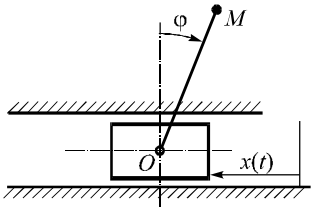
14

Rim points arc coordinate for the disk of 0.3m radius varies by law $s(t) = 0{,}6t^2$ m. Determine the angle between the velocity vector and acceleration vector of disk rim point at 0.5 seconds after the beginning of movement.

15

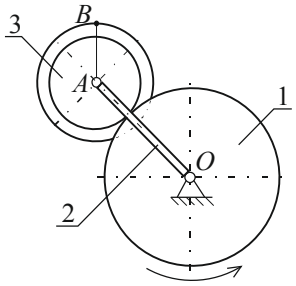
The shaft started to rotate with constant acceleration from the rest and made 3600 revolutions per 0.2 hours. Determine the angular acceleration of the shaft.

16



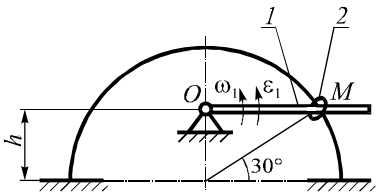
Find the value of the slide O velocity at time t = 1 sec, if it is known that OM = 4 m, x_0 = 0 m, the absolute velocity of a point M is twice more than the velocity of the slide O, $\varphi = \pi\sqrt{2}\sin\dfrac{\pi t}{4}$ рад

17



Determine velocity of point B (AB is vertical for the shown position) located on the rim of wheel 3, if the angular velocity of the wheel 1 $\omega_1 = \omega$, $OA = 4r$, AB = $2r$, $\omega_2 = 2\omega_1$. Rod 2 makes an angle of 30° with horizontal line.

18

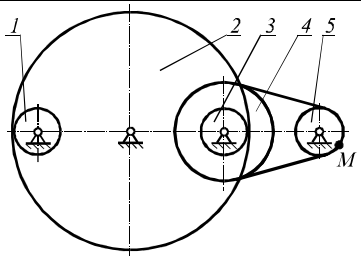


Determine the absolute velocity of point M for the shown position of the mechanism, if ω_1 = 2 rad/sec, h = 10 cm.

19

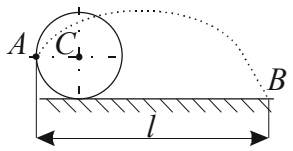
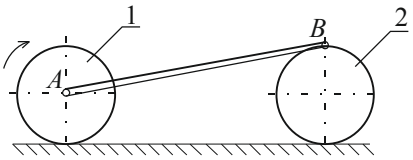
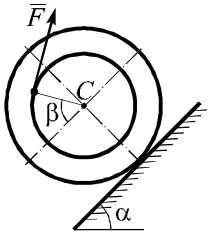
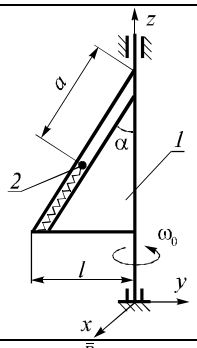
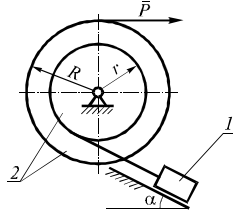
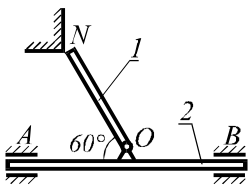
A point moves along a circle in the plane of the radius R = 10 cm according to the equation $s(t) = 12\pi t - 2\pi t^2$ cm. Determine the total acceleration of the point for the moment of time when the arc coordinate is equal to circle half.

20



Find the value of point M acceleration at t = 0,5 sec, if the point is based on the rim of wheel 5, the law of wheel 1 rotating $\varphi_1 = 2\ln\dfrac{1}{t-1}$ rad , and $r_1 = r_3 = r_5 = 0{,}2r_2 = 0{,}5r_4 = 0{,}8$ m.

Dynamics

21	A hammer of mass m = 0,6 kg had velocity v = 4 m/sec at hitting the nail head. The nail is under the resistance force F at its movement: $F = a + bx$, where x – nail displacement, a = 10 N, b = 2 N/m. Determine how many hits should be applied to move the nail at a distance L = 0,2 m.	
22		Determine the distance l of point M, separated from the bicycle wheel of radius R at position A. The movement of the point is in the vertical plane. Wheel center of mass velocity was equal to 5 m/s at the initial position. The wheel rolled without slipping.
23		A ball moves in a smooth curved tube and at point A it has velocity v_A = 0,5 m/sec. Determine the ball velocity at point C, if on the curved interval of the tube the ball is under the variable driving force $F = 2mg\sqrt{s}$, R = 0,2 m.
24	A skier of mass 75 kg acquires an initial velocity of 1 m/s due to a push and slides down the slope, making an angle of 30 ° with the horizon. Resistance force due to the motion of the skier is proportional to his velocity. Determine the velocity of the skier 5 seconds after the beginning of the movement, if the value of the resistance force for the velocity of 0.5 m/sec is equal to 10 N.	
25		Two homogeneous cylinders are connected by homogeneous rod AB of $2m$ mass. Each of the cylinders have radius r and mass $4m$ and can roll along the horizontal surface without slipping. Determine the kinetic energy of the system for the shown position if the angular velocity of the cylinder 1 is known and it is equal to ω.
26		A wheel of mass m rolls on a rough surface under the action of gravity and active force $F = 4mg$. Wheel radii are equal to R and r accordingly and R = 1,5r. The gyration radius of the wheel is i_C =1.2r. Rolling resistance coefficient is δ, coefficient of static friction is f. Determine the acceleration of the wheel center of mass, if α = β = 60°.
27		Homogeneous thin plate 1 of mass $m_1 = m$ rotates about a fixed vertical axis z with angular velocity ω_0. Ball 2 of mass m_2 = 0,5m is located in the groove on the plate and kept at a distance a. The ball starts to move along the gutters and compresses the spring by an amount λ. Determine the angular velocity of the plate at this time, if the distance l is known.
28		The mechanical system consists of two bodies with masses m_1 = 2m and m_2 = 3m. Wheel 2 is loaded by driving force P=6mg, friction coefficient between contacting surfaces is equal to f. Determine the acceleration of body 1, if R = 2,5r; $i_{2x} = r\sqrt{2}$.
29		A homogeneous rod 1 of mass m located in a vertical plane and it is pivotally connected with the rod 2 of mass 3m. The rod 2 can move along the horizontal line AB. The rod 1 falls down from the protrusion N on the horizontal rod 2, rod 2 under this movements is shifted by distance s. Determine the length of the rod 1, neglecting friction.
30	The dynamic equation of material point motion is $\ddot{x} + b\dot{x} + 100x = 0$. Determine the resistance coefficient b values of elastic medium for the case of movement with no oscillations.	