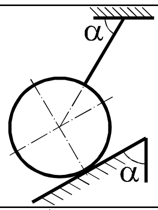
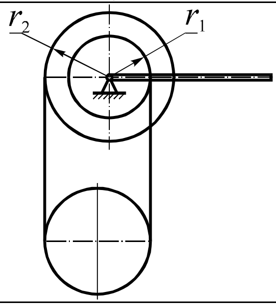
Statics

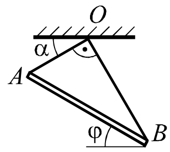
1. The load with the mass m is suspended to the end of the vertically hanging spring the weight of which can be ignored. Then one more load with the same mass is suspended to the middle of the stretched spring. Define the length of the spring with two loads. The coefficient of spring stiffness is c, and its length in the non-stretched condition is l_0.



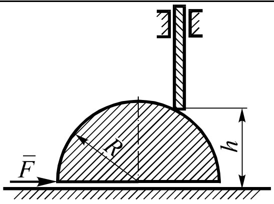
2. The cylinder with the weight $G = 10$ N is held in equilibrium by the inclined plane and cable. The angles $\alpha = 60°$. Define the tension of the cable.



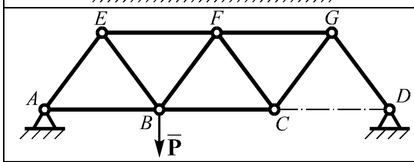
3. What force can be applied to the end of the differential winch handle to hold the load with the mass m=50 kg if the length of the handle l=98 cm, r_1=20 cm, r_2=10 cm?



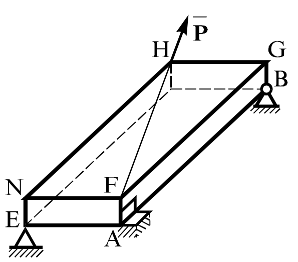
4. The homogeneous rod AB suspended on the cables OA and OB is in equilibrium. The cables are at right angle between each other. The cable OA is at the angle α to the horizontal. Define the angle of the rod inclination φ to the horizontal.



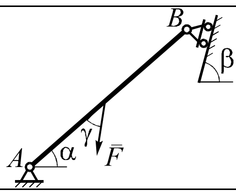
5. The semi-cylinder with the mass m_1 is on the horizontal plane. The rod AB with the mass m_2 placed in the vertical way is leaned against it. Ignoring the friction define the force F holding the system in equilibrium. The parameters are in the picture.



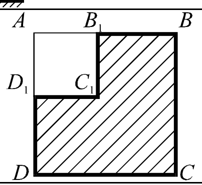
6. The external force P is applied to the truss. Define the constraint reaction in the point D if the lengths of all horizontal rods as well as the distance CD are 6 m (the rod CD is absent) and the length of each inclined rod is 5 m.



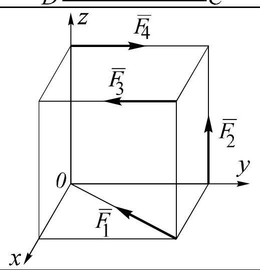
7. The homogeneous rectangular plate with the weight Q is connected to the foundation by the cylindrical hinge A and spherical hinge B. The plate is held in horizontal position by the point E set against the smooth surface of the plate lower side. The force P directed along the straight line FH is applied to the plate top side $FGHN$. Determine the point E constraint reaction if $AF = \dfrac{AB}{12} = \dfrac{AE}{5}$.



8. The active force $\overline{F}$ is applied to the middle of the weightless beam AB with the length l. The angles α, β, γ are known. Define the supporting force at the point B.



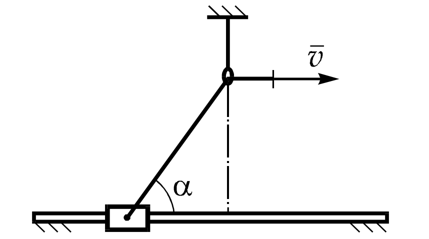
9. The square $AB_1C_1D_1$ is cut out from the homogeneous square area $ABCD$ with the side a so that the sides of both squares are parallel. What side x of the smaller square should be to make the coincidence of the centre of gravity for the cut-out part and the point C_1 possible?



10. Define the sum of moments about the centre O for the system of forces applied to the cube with the edge $a = 2$ m.

Given: $F_1 = 4\sqrt{2}$ N; $F_2 = 4$ N; $F_3 = 4$ N; $F_4 = 8$ N.

Kinematics



11. The rope put through the hoop is fastened to the slider which can be moving along the guideway. The rope is with the velocity v. Define the slider velocity at the moment when the rope makes the angle α with the horizontal.

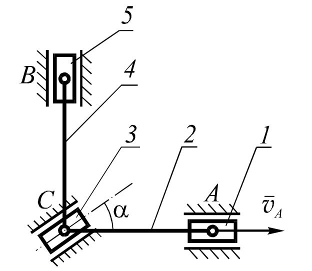
12. The point moves in the way that the covered distance s is proportional to the difference between the initial velocity v_0 and the velocity v at the present moment. The proportionality coefficient is k. Define the velocity-time dependence.

13. How long was the rectilinear motion of a skydiver with the constant acceleration if during the last second he flew the way three times shorter compared to the rest of the flight?

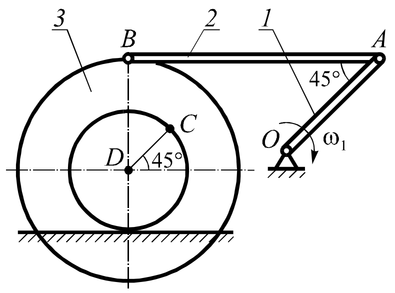
14. The disk with the diameter of 4 cm rotates so that its angular velocity varies according to $\omega = 2\pi t^2$ rad/s. Determine the tangential acceleration of the disc rim point at the moment when the disc has turned through the angle $\varphi = 18\pi$ rad.

15. The particle moves uniformly accelerated from the rest at the circle with the radius R. It makes the first full turn for t seconds. Define the acceleration of the particle at the end of this period of time.

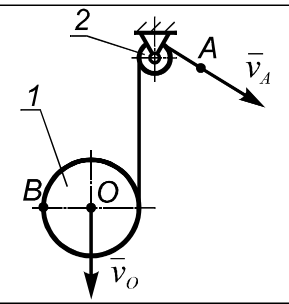
16. The shaft with the radius of 25 cm rotates uniformly accelerated from the rest. It has made the first two turnovers for 2 seconds. Define the normal acceleration rate for the shaft rim point at the end of the fifth second.



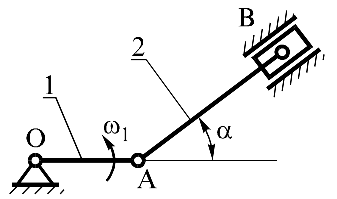
17. In the planar mechanism the guideways of the slides 1 and 5 are perpendicular to each other, and the guideway of the slide 3 forms an angle α with the guideway of the slide 1. In the depicted position the velocity of A is v_A. Find the angular velocity of the link 4 in the depicted position if $AC = BC = l$?



18. Find the distance between the instantaneous centers of velocity for the bodies 2 and 3 in the depicted position of the mechanism if OA = 12 cm; AB = 24 cm; BD = 10 cm; CD = 5 cm.



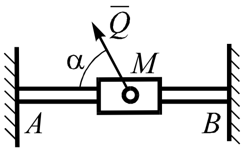
19. The cylinder 1 with the radius R is wound with the rope thrown through the block 2. The rope end A is being pulled with the velocity v_A while the center of the cylinder has the velocity v_O. Define the velocity of the point B on the horizontal diameter of the cylinder regarding that the rope part from the cylinder to the block is vertical.



20. In the planar mechanism the lengths of the links 1 and 2 are l_1 and l_2 respectively. The crankshaft OA rotates with the constant angular velocity ω_1. Determine the angular acceleration ε_2 of the connecting rod. The angle α is given.

Dynamics

21. The motor truck with the mass m = 4000 kg moving with the velocity v = 54 km/h on a rectilinear horizontal part of the road starts braking. Define the truck travel time till the full stop if the running braking force is $F = 8t$ kN.

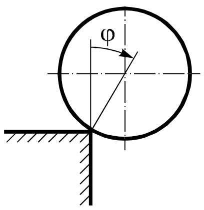


22. The slider with the mass of 15 kg moves along the horizontal rod AB under the force Q = 500 N directed at the angle $\alpha = 60°$ to the rod axis. Define the time during which the velocity of the slider will increase by 3 m/s if the coefficient of friction f = 0,1.

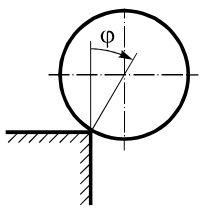
23. The tug is pulling a barge with the velocity of 18 km/h. The tug rope tension is 90 kN. What tug capacity is developed if it is known that for the motion with the same velocity without towing the barge the tug has to develop the capacity of 75 kilowatt?

24. A particle is moving along the rough horizontal plane. Having received the initial velocity $\overline{v}_1$ directed along the plane it passes the distance $s_1 = 2$ m, and the initial velocity $\overline{v}_2$ – the distance is $s_1 = 8$ m. Which distance will be passed by the particle on the same plane if its initial velocity $\overline{v} = \overline{v}_1 + \overline{v}_2$ and the velocities $\overline{v}_1$ and $\overline{v}_2$ are perpendicular.

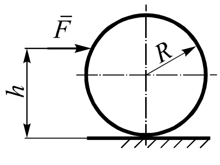
25. The homogeneous cylinder with the radius R starts rolling up without slipping on the inclined plane. Its centre has the initial velocity v_0. What distance will the roller centre pass till the full stop if the angle of the plane inclination is α, and the coefficient of rolling friction is δ?



26. The homogeneous cylinder with the radius r having been given a negligible initial speed is moving from the smooth horizontal plane. Define the centre velocity at the moment when the angle $\varphi = 30°$.



27. The homogeneous cylinder with the radius r having been given a negligible initial speed is rolling from the horizontal plane without slipping. Define the centre velocity at the moment when the angle $\varphi = 30°$.



28. At what distance h from the horizontal plane should the constant horizontal force F be applied to the homogeneous solid disc with the radius R to make the disc roll on the plane without slipping, and the coefficient of friction in the place of disk-plane contact is zero? Rolling friction is neglected.

29. The equation for the oscillatory motion of the particle is $0{,}1\ddot{x} + 1{,}2\dot{x} + 10x = 15\sin 10t$. Determine whether there is a resonance during the oscillations.

30. When a ball hits the smooth surface it loses one third of its kinetic energy. Regarding that the angle of incidence is 45° find the angle of reflection.