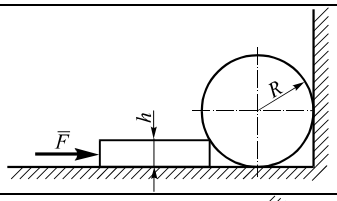
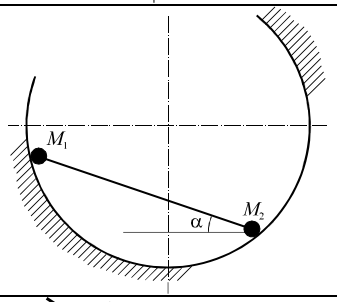
Statics

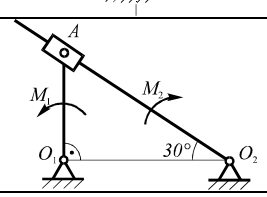
1. Forces $\overline{F}_1$, $\overline{F}_2$, $\overline{F}_3$ are applied to the body at the origin of coordinates. Points A_1(-4, 3, 12), A_2(2, -2, -1), A_3(0, 4, -3) are on the lines of action of forces $\overline{F}_1$, $\overline{F}_2$, $\overline{F}_3$ respectively. Define the resultant of these forces if F_1 = 13 N, F_2 = 6 N, F_3 =5 N.



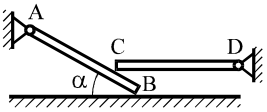
2. The smooth ball with radius R and weight P rests on the horizontal floor touching the vertical wall. Which force F should be applied to the bar with height h to raise the ball above the floor level?



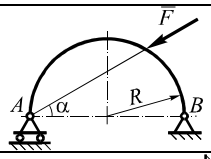
3. Two heavy points M_1 and M_2 linked together by a weightless hard rod are inside the smooth sphere. The rod length and sphere radius are equal. Define the angle α between the rod and horizon if point M_2 weight is twice as big as point M_1 weight.



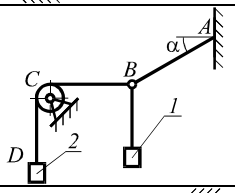
4. The crank-and-slot mechanism is in the horizontal plane. Driving torques M_1 and M_2 are applied to the crank and link. Define the mechanism M_1/ M_2 relations at balance for the depicted position. Ignore the friction.



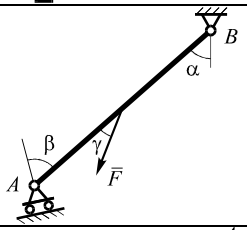
5. Two homogeneous rods with weight P and length $4l$ each are connected to the stationary hinges A and D. Horizontal rod CD lies on rod AB which by-turn lies on the horizontal plane. Define the pressure force of rod AB on the supporting plane if $BC = \ell$. Ignore the friction.



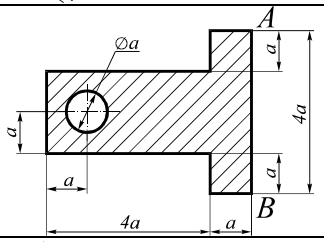
6. The arch with radius R = 2 m loaded with force F = 40 N is in equilibrium in the depicted position. Find the constraint at point B if α=30°.



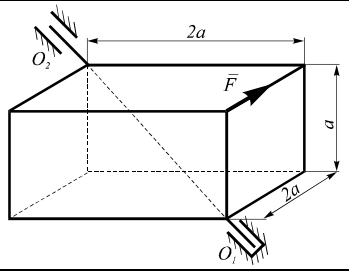
7. $ABCD$ thread carries two loads 1 and 2. Weight G_1 = 10 N; α = 30°. Define the load 2 weight and AB thread tension.



8. Active force $\overline{F}$ is applied to the center of the weightless beam AB with length l. Angles α, β, γ are known. Define the supporting force at point A.

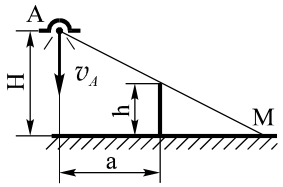


9. Find the distance from the centre of gravity to AB line for the depicted figure.



10. Find the moment of force $\overline{F}$ about axis O_1O_2. The dimensions are shown in the picture.

Kinematics



11. Light source *A* goes down the vertical line with velocity $v_A = const$. There is a rack with height *h* and it is *a* distant from the vertical. Define the velocity of shadow end *M* at the light source height *H*.

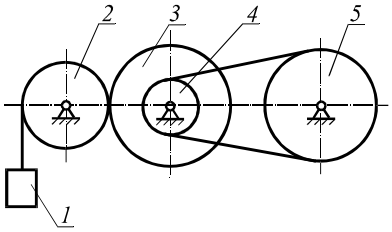
12. The point circumscribes the circle with radius *R* and initial velocity v_0. The point acceleration makes a constant angle α with the velocity. Find velocity as time function.

13. The ball is falling down from 100 m height without initial velocity. During what time does it run the last meter?

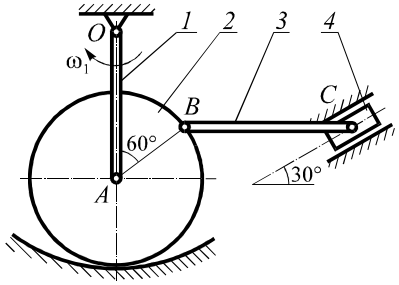
14. The point on the rim of the disc with 10 cm diameter has variable velocity $v = 10t^2$ cm/sec. What is the dependence of the velocity on the disc rotation angle?

15. The shaft rotating with angular velocity 10π rad/sec did 20 revolutions till the stopping. Define angular acceleration regarding it as constant.

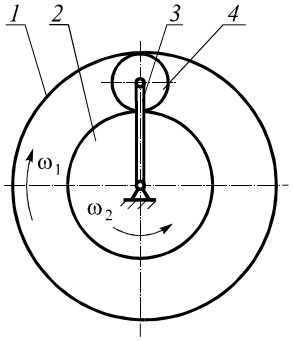
16. The ball is rolling up the inclined board. At 30 cm distance from the offset the ball was twice: in 1 sec and 2 sec after the start of motion. Define the ball acceleration regarding it as constant.



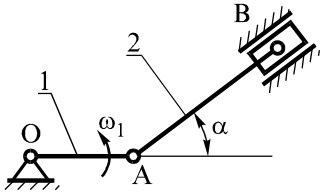
17. According to motion of body 1 equation $s_1 = 2 - 1{,}5t^2$ find angular acceleration of link 5. Consider the radii of all wheels as given.



18. Find the velocity of point C of the depicted mechanism if $\omega_1 = 4\dfrac{\text{rad}}{\text{sec}}$; $OA = 15$ cm.



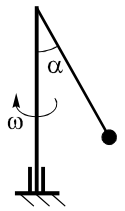
19. ***Given:*** $\omega_1; \omega_2; r_4 = r; r_2 = 3r$.
Define: ω_3.



20. In the planar mechanism the lengths of links 1 and 2 are l_1 and l_2 respectively. Crankshaft *OA* rotates with constant angular velocity ω_1. Define angular acceleration ε_2 of the connecting rod. Angle α is given.

Dynamics

21. What must the coefficient of friction for car tyres against the road when braking be if when the speed is 20 m/sec the car stops 6 seconds after the beginning of braking?

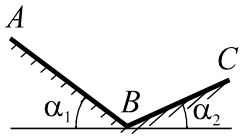


22. The ball with weight m is suspended to the inextensible thread with length l fastened to the shaft of the centrifugal machine rotating with angular velocity ω. What angle α does the thread make with the vertical?

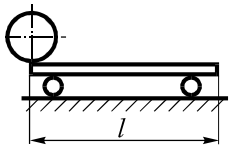
23. How many meters before the bus-stop must the bus with weight $m = 10$ ton moving with velocity $v_0 = 54$ km/h start braking if braking force $F = 11{,}25$ kN?

24. The hammer with weight $m = 0{,}8$ kg when hit the nail-head had velocity $v_0 = 3$ m/sec. Define the nail displacement if resistance force $F = 400$ N. How many knocks must be done to hammer in a nail with length $L = 5$ cm?

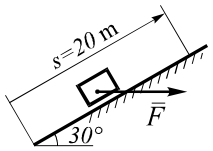
25. The diameter of car wheels is 50 cm. The brake-shoes provide the total constant moment of resistance 500 N·m. Define the work done by the moment of resistance when braking if the car braking distance is 30 m.



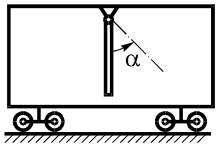
26. A particle is placed on the inclined plane AB with inclination angle α_1 to the horizon and goes down without initial velocity. Reaching position B and not changing speed level it moves up inclined plane BC with angle α_2 to the horizon. Supposing that the time of moving down is t_1, define the time of moving up t_2 for particle till its stopping. Ignore the friction.



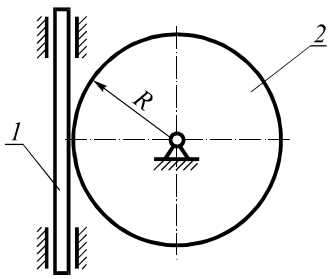
27. Workers roll the casting from the left end of the horizontal loading platform to the right one. The length of the platform is 12 m, weight is 14 tons and at initial time it is at rest. Which side and how much will the platform move if the mass of the workers with the casting is 3 tons? Ignore forces of resistance.



28. Define the work to be expended by the horizontal force F for 20 meters movement of the load with 5 kg weight along the inclined plane with 30º horizontal angle. Coefficient of sliding friction is 0,2.



29. The rod with length l is hanged inside the wagon. The wagon moving with constant velocity v stops immediately. What angle will the rod deviate from the vertical?



30. ***Given:*** $m_1 = m$; $m_2 = 3m$; R.
Define: ε_2.