(a) the vector of the angular velocity of the cone and the angle it forms with the vertical;

(b) the vector of the angular acceleration of the cone.

1.58. A solid body rotates with a constant angular velocity $\omega_0 = 0.50$ rad/s about a horizontal axis AB. At the moment $t = 0$ the axis AB starts turning about the vertical with a constant angular acceleration $\beta_0 = 0.10$ rad/s^2. Find the angular velocity and angular acceleration of the body after $t = 3.5$ s.

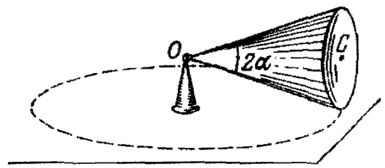

Fig. 1.8.

1.2. THE FUNDAMENTAL EQUATION OF DYNAMICS

• The fundamental equation of dynamics of a mass point (Newton's second law):

$$m\frac{d\mathbf{v}}{dt} = \mathbf{F}. \quad (1.2a)$$

• The same equation expressed in projections on the tangent and the normal of the point's trajectory:

$$m\frac{dv_\tau}{dt} = F_\tau, \quad m\frac{v^2}{R} = F_n. \quad (1.2b)$$

• The equation of dynamics of a point in the non-inertial reference frame K' which rotates with a constant angular velocity $\boldsymbol{\omega}$ about an axis translating with an acceleration $\mathbf{w}_0$:

$$m\mathbf{w}' = \mathbf{F} - m\mathbf{w}_0 + m\omega^2\mathbf{R} + 2m[\mathbf{v}'\boldsymbol{\omega}], \quad (1.2c)$$

where $\mathbf{R}$ is the radius vector of the point relative to the axis of rotation of the K' frame.

1.59. An aerostat of mass m starts coming down with a constant acceleration w. Determine the ballast mass to be dumped for the aerostat to reach the upward acceleration of the same magnitude. The air drag is to be neglected.

1.60. In the arrangement of Fig. 1.9 the masses m_0, m_1, and m_2 of bodies are equal, the masses of the pulley and the threads are negligible, and there is no friction in the pulley. Find the acceleration w with which the body m_0 comes down, and the tension of the thread binding together the bodies m_1 and m_2, if the coefficient of friction between these bodies and the horizontal surface is equal to k. Consider possible cases.

1.61. Two touching bars *1* and *2* are placed on an inclined plane forming an angle α with the horizontal (Fig. 1.10). The masses of the bars are equal to m_1 and m_2, and the coefficients of friction between the inclined plane and these bars are equal to k_1 and k_2 respectively, with $k_1 > k_2$. Find:

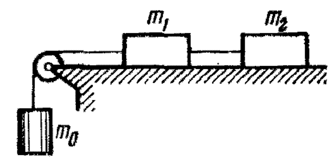

Fig. 1.9.

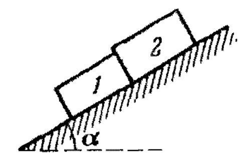

Fig. 1.10.

(a) the force of interaction of the bars in the process of motion;

(b) the minimum value of the angle α at which the bars start sliding down.

1.62. A small body was launched up an inclined plane set at an angle $\alpha = 15°$ against the horizontal. Find the coefficient of friction, if the time of the ascent of the body is $\eta = 2.0$ times less than the time of its descent.

1.63. The following parameters of the arrangement of Fig. 1.11 are available: the angle α which the inclined plane forms with the horizontal, and the coefficient of friction k between the body m_1 and the inclined plane. The masses of the pulley and the threads, as well as the friction in the pulley, are negligible. Assuming both bodies to be motionless at the initial moment, find the mass ratio m_2/m_1 at which the body m_2

(a) starts coming down;

(b) starts going up;

(c) is at rest.

1.64. The inclined plane of Fig. 1.11 forms an angle $\alpha = 30°$ with the horizontal. The mass ratio $m_2/m_1 = \eta = 2/3$. The coefficient of friction between the body m_1 and the inclined plane is equal to $k = 0.10$. The masses of the pulley and the threads are negligible. Find the magnitude and the direction of acceleration of the body m_2 when the formerly stationary system of masses starts moving.

1.65. A plank of mass m_1 with a bar of mass m_2 placed on it lies on a smooth horizontal plane. A horizontal force growing with time t as $F = at$ (a is constant) is applied to the bar. Find how the accelerations of the plank w_1 and of the bar w_2 depend on t, if the coefficient of friction between the plank and the bar is equal to k. Draw the approximate plots of these dependences.

1.66. A small body A starts sliding down from the top of a wedge (Fig. 1.12) whose base is equal to $l = 2.10$ m. The coefficient of friction between the body and the wedge surface is $k = 0.140$. At