to the horizontal with the initial velocity v_0. Assuming the air drag to be negligible, find:

(a) the time of motion;

(b) the maximum height of ascent and the horizontal range; at what value of the angle α they will be equal to each other;

(c) the equation of trajectory $y(x)$, where y and x are displacements of the body along the vertical and the horizontal respectively;

(d) the curvature radii of trajectory at its initial point and at its peak.

• **1.30.** Using the conditions of the foregoing problem, draw the approximate time dependence of moduli of the normal w_n and tangent w_τ acceleration vectors, as well as of the projection of the total acceleration vector w_v on the velocity vector direction.

••• **1.31.** A ball starts falling with zero initial velocity on a smooth inclined plane forming an angle α with the horizontal. Having fallen the distance h, the ball rebounds elastically off the inclined plane. At what distance from the impact point will the ball rebound for the second time?

•• **1.32.** A cannon and a target are 5.10 km apart and located at the same level. How soon will the shell launched with the initial velocity 240 m/s reach the target in the absence of air drag?

••• **1.33.** A cannon fires successively two shells with velocity $v_0 = 250$ m/s; the first at the angle $\theta_1 = 60°$ and the second at the angle $\theta_2 = 45°$ to the horizontal, the azimuth being the same. Neglecting the air drag, find the time interval between firings leading to the collision of the shells.

• **1.34.** A balloon starts rising from the surface of the Earth. The ascension rate is constant and equal to v_0. Due to the wind the balloon gathers the horizontal velocity component $v_x = ay$, where a is a constant and y is the height of ascent. Find how the following quantities depend on the height of ascent:

(a) the horizontal drift of the balloon $x(y)$;

(b) the total, tangential, and normal accelerations of the balloon.

• **1.35.** A particle moves in the plane xy with velocity $\mathbf{v} = a\mathbf{i} + bx\mathbf{j}$, where $\mathbf{i}$ and $\mathbf{j}$ are the unit vectors of the x and y axes, and a and b are constants. At the initial moment of time the particle was located at the point $x = y = 0$. Find:

(a) the equation of the particle's trajectory $y(x)$;

(b) the curvature radius of trajectory as a function of x.

• **1.36.** A particle A moves in one direction along a given trajectory with a tangential acceleration $w_\tau = \mathbf{a}\boldsymbol{\tau}$, where $\mathbf{a}$ is a constant vector coinciding in direction with the x axis (Fig. 1.4), and $\boldsymbol{\tau}$ is a unit vector coinciding in direction with the velocity vector at a given point. Find how the velocity of the particle depends on x provided that its velocity is negligible at the point $x = 0$.

• **1.37.** A point moves along a circle with a velocity $v = at$, where $a = 0.50$ m/s^2. Find the total acceleration of the point at the moment when it covered the n-th ($n = 0.10$) fraction of the circle after the beginning of motion.

•• **1.38.** A point moves with deceleration along the circle of radius R so that at any moment of time its tangential and normal accelerations are equal in moduli. At the initial moment $t = 0$ the velocity of the point equals v_0. Find:

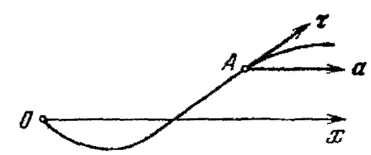

Fig. 1.4.

(a) the velocity of the point as a function of time and as a function of the distance covered s;

(b) the total acceleration of the point as a function of velocity and the distance covered.

• **1.39.** A point moves along an arc of a circle of radius R. Its velocity depends on the distance covered s as $v = a\sqrt{s}$, where a is a constant. Find the angle α between the vector of the total acceleration and the vector of velocity as a function of s.

•• **1.40.** A particle moves along an arc of a circle of radius R according to the law $l = a \sin \omega t$, where l is the displacement from the initial position measured along the arc, and a and ω are constants. Assuming $R = 1.00$ m, $a = 0.80$ m, and $\omega = 2.00$ rad/s, find:

(a) the magnitude of the total acceleration of the particle at the points $l = 0$ and $l = \pm a$;

(b) the minimum value of the total acceleration w_{min} and the corresponding displacement l_m.

• **1.41.** A point moves in the plane so that its tangential acceleration $w_\tau = a$, and its normal acceleration $w_n = bt^4$, where a and b are positive constants, and t is time. At the moment $t = 0$ the point was at rest. Find how the curvature radius R of the point's trajectory and the total acceleration w depend on the distance covered s.

• **1.42.** A particle moves along the plane trajectory $y(x)$ with velocity v whose modulus is constant. Find the acceleration of the particle at the point $x = 0$ and the curvature radius of the trajectory at that point if the trajectory has the form

(a) of a parabola $y = ax^2$;

(b) of an ellipse $(x/a)^2 + (y/b)^2 = 1$; a and b are constants here.

••• **1.43.** A particle A moves along a circle of radius $R = 50$ cm so that its radius vector $\mathbf{r}$ relative to the point O (Fig. 1.5) rotates with the constant angular velocity $\omega = 0.40$ rad/s. Find the modulus of the velocity of the particle, and the modulus and direction of its total acceleration.