• • 1.16. Two particles, 1 and 2, move with constant velocities v_1 and v_2 along two mutually perpendicular straight lines toward the intersection point O. At the moment $t = 0$ the particles were located at the distances l_1 and l_2 from the point O. How soon will the distance between the particles become the smallest? What is it equal to?

• • 1.17. From point A located on a highway (Fig. 1.2) one has to get by car as soon as possible to point B located in the field at a distance l from the highway. It is known that the car moves in the field η times slower than on the highway. At what distance from point D one must turn off the highway?

• 1.18. A point travels along the x axis with a velocity whose projection v_x is presented as a function of time by the plot in Fig. 1.3.

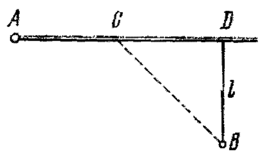

Fig. 1.2.

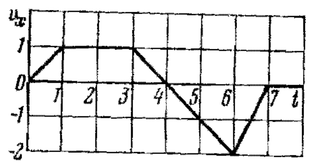

Fig. 1.3.

Assuming the coordinate of the point $x = 0$ at the moment $t = 0$, draw the approximate time dependence plots for the acceleration w_x, the x coordinate, and the distance covered s.

• 1.19. A point traversed half a circle of radius $R = 160$ cm during time interval $\tau = 10.0$ s. Calculate the following quantities averaged over that time:

(a) the mean velocity $\langle v \rangle$;

(b) the modulus of the mean velocity vector $|\langle \mathbf{v} \rangle|$;

(c) the modulus of the mean vector of the total acceleration $|\langle \mathbf{w} \rangle|$ if the point moved with constant tangent acceleration.

• 1.20. A radius vector of a particle varies with time t as $\mathbf{r} = \mathbf{a}t(1 - \alpha t)$, where $\mathbf{a}$ is a constant vector and α is a positive factor. Find:

(a) the velocity $\mathbf{v}$ and the acceleration $\mathbf{w}$ of the particle as functions of time;

(b) the time interval Δt taken by the particle to return to the initial points, and the distance s covered during that time.

• 1.21. At the moment $t = 0$ a particle leaves the origin and moves in the positive direction of the x axis. Its velocity varies with time as $\mathbf{v} = \mathbf{v}_0(1 - t/\tau)$, where $\mathbf{v}_0$ is the initial velocity vector whose modulus equals $v_0 = 10.0$ cm/s; $\tau = 5.0$ s. Find:

(a) the x coordinate of the particle at the moments of time 6.0, 10, and 20 s;

(b) the moments of time when the particle is at the distance 10.0 cm from the origin;

(c) the distance s covered by the particle during the first 4.0 and 8.0 s; draw the approximate plot $s(t)$.

• • 1.22. The velocity of a particle moving in the positive direction of the x axis varies as $v = \alpha\sqrt{x}$, where α is a positive constant. Assuming that at the moment $t = 0$ the particle was located at the point $x = 0$, find:

(a) the time dependence of the velocity and the acceleration of the particle;

(b) the mean velocity of the particle averaged over the time that the particle takes to cover the first s metres of the path.

• • 1.23. A point moves rectilinearly with deceleration whose modulus depends on the velocity v of the particle as $w = a\sqrt{v}$, where a is a positive constant. At the initial moment the velocity of the point is equal to v_0. What distance will it traverse before it stops? What time will it take to cover that distance?

• • 1.24. A radius vector of a point A relative to the origin varies with time t as $\mathbf{r} = at\mathbf{i} - bt^2\mathbf{j}$, where a and b are positive constants, and $\mathbf{i}$ and $\mathbf{j}$ are the unit vectors of the x and y axes. Find:

(a) the equation of the point's trajectory $y(x)$; plot this function;

(b) the time dependence of the velocity $\mathbf{v}$ and acceleration $\mathbf{w}$ vectors, as well as of the moduli of these quantities;

(c) the time dependence of the angle α between the vectors $\mathbf{w}$ and $\mathbf{v}$;

(d) the mean velocity vector averaged over the first t seconds of motion, and the modulus of this vector.

• • 1.25. A point moves in the plane xy according to the law $x = at$, $y = at(1 - \alpha t)$, where a and α are positive constants, and t is time. Find:

(a) the equation of the point's trajectory $y(x)$; plot this function;

(b) the velocity v and the acceleration w of the point as functions of time;

(c) the moment t_0 at which the velocity vector forms an angle $\pi/4$ with the acceleration vector.

• 1.26. A point moves in the plane xy according to the law $x = a \sin \omega t$, $y = a(1 - \cos \omega t)$, where a and ω are positive constants. Find:

(a) the distance s traversed by the point during the time τ;

(b) the angle between the point's velocity and acceleration vectors.

• • 1.27. A particle moves in the plane xy with constant acceleration $\mathbf{w}$ directed along the negative y axis. The equation of motion of the particle has the form $y = ax - bx^2$, where a and b are positive constants. Find the velocity of the particle at the origin of coordinates.

• 1.28. A small body is thrown at an angle to the horizontal with the initial velocity $\mathbf{v}_0$. Neglecting the air drag, find:

(a) the displacement of the body as a function of time $\mathbf{r}(t)$;

(b) the mean velocity vector $\langle \mathbf{v} \rangle$ averaged over the first t seconds and over the total time of motion.

• • 1.29. A body is thrown from the surface of the Earth at an angle α