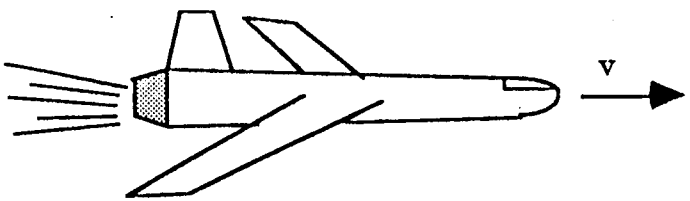
CMspring96A

A rocket plane travels through still air in level flight, so that its weight is exactly compensated by the lift from the wings. It expels matter (i.e. loses mass) at a constant rate γ, with the speed of the exhaust relative to the rocket plane being V. The rocket plane experiences a drag force $\vec{F}_D$ from the air, which is proportional to its velocity $\vec{v}$ in the rest frame of the air (and also the ground): $\vec{F}_D = -k\,\vec{v}$. At time $t = 0$ the rocket plane has mass m_0, and is released from a jumbo jet flying horizontally with speed v_0.



(a) Determine the differential equation governing the speed v(t) of the rocket plane.

(b) For the case where $k = 0$, determine v(t) in terms of the parameters given above.

(c) For the case where $k \neq 0$, determine v(t) in terms of the parameters given above.

(d) Verify that your solution to part (c) reduces to that of part (b) as $k \to 0$.

(e) For the case where $k \neq 0$, determine the general relationship among the parameters given above that permits the rocket plane to move at constant speed.