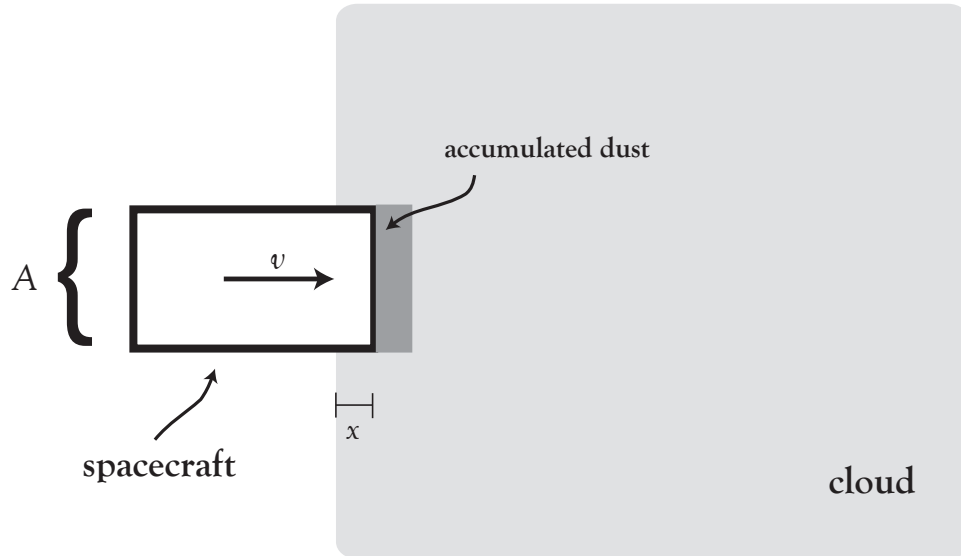


# QP39

## Problem (4 points) - Dust in Space

A spacecraft of mass  $m_0$  and cross sectional area  $A$  is moving at a constant velocity  $v_0$  when it encounters a stationary cloud of dust of density  $\rho$ . Assume the dust sticks to the surface of the spacecraft and that  $A$  is constant over time.



- (a) (1 point) Will the total mechanical energy be conserved as the spacecraft moves through the cloud? Will the momentum? Explain why.
- (b) (1 point) Find an expression for the time rate  $\frac{dm}{dt}$  at which the dust-covered spacecraft gains mass. Express your answer in terms of  $A$ ,  $\rho$ , and the velocity  $v$  of the spacecraft.
- (c) (2 points) Write down a first-order differential equation for  $v(x)$ . Solve it by integration.