1. (65 %) The exhaust from a jet engine in a ground test is deflected by a safety deflector. The deflector changes the jet direction up 45° from the horizontal, with no change in the jet speed V. The jet's friction force on the deflector is negligible. The gravity force is negligible. The jet has some constant density ρ, and constant cross-sectional area A. The surrounding atmosphere is still and at constant pressure. You are to determine the force $\vec{R}$ that the deflector feels. Explicitly perform the following parts of the problem:

a) On the figure below, draw a suitable Control Volume and x, y axes for this problem.

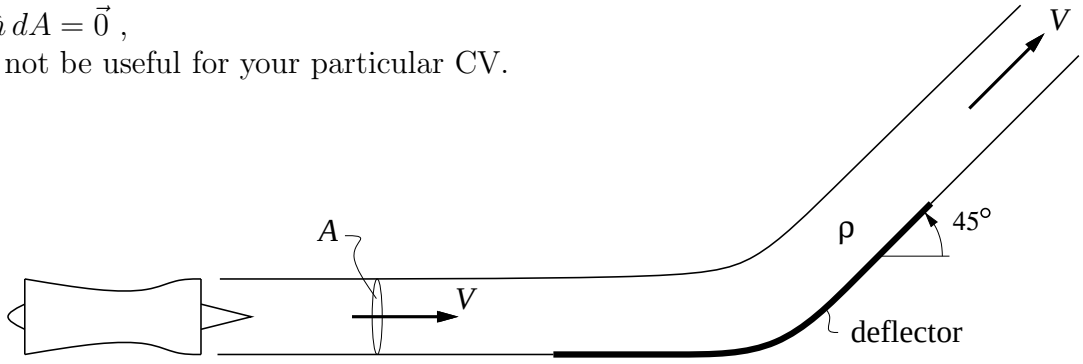
b) Determine the net mass flow $\oint \rho(\vec{V}\cdot\hat{n})\,dA$ across the CV boundaries.

c) Determine the net momentum flow $\oint \rho(\vec{V}\cdot\hat{n})\vec{V}\,dA$ across the CV boundaries. Your result must be given as a vector, or as two separate x and y component results.

d) Determine the net pressure integral $\oint p\,\hat{n}\,dA$ on the CV boundaries. This is also a vector.

e) Determine $\vec{R}$.

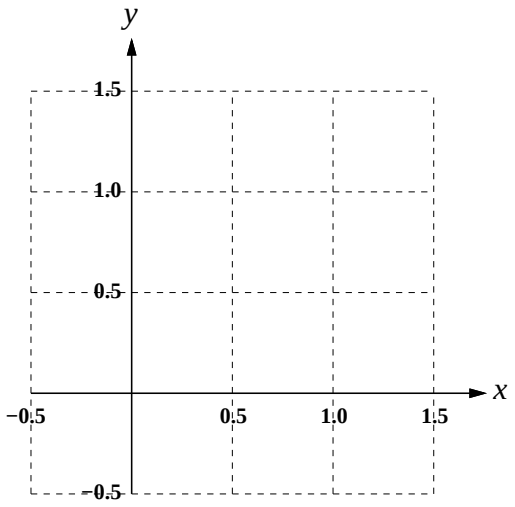
Hint: $\oint(\text{constant})\,\hat{n}\,dA = \vec{0}$,
which may or may not be useful for your particular CV.



2. (35 %) Consider the following velocity field $\vec{V} = u\hat{\imath} + v\hat{\jmath}$.

$$\begin{aligned} u &= 1 \\ v &= 3xt \end{aligned}$$

a) A particle A is released in the field at the origin $x, y = (0, 0)$, at time $t = 0$. Determine and sketch the particle's pathline.



b) Determine the x and y components of the fluid's acceleration at the point $x, y = (1, 1)$, at time $t = 1$.