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 $\rho$, 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 \( \vec{V} = u \hat{i} + v \hat{j} \).

\[
\begin{align*}
    u &= 1 \\
    v &= 3xt
\end{align*}
\]

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 \( t = 1 \).