Homework 3

Questions No.	1	2	3	4	Total
Score	20%	20%	30%	30%	100%

Q3.1 A flow field is defined by $\mu = (3x)\ ft/s$ and $v = (6y)\ ft/s$, where x and y are in feet. Determine the equation of the streamline passing through point (3ft, 1ft). Draw this streamline.

解: $\frac{dx}{u} = \frac{dy}{v}$

$\frac{dy}{dx} = \frac{6y}{3x} = \frac{2y}{x}$

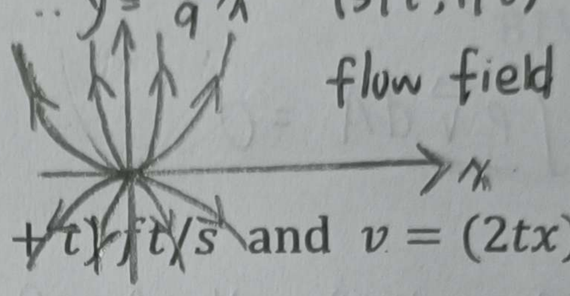
$\frac{1}{y}dy = \frac{2}{x}dx$

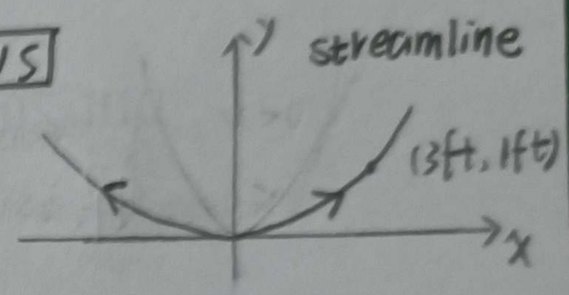
$\ln y = 2\ln x + C$

$y = Ax^2$

$x=3, y=1 \Rightarrow A = \frac{1}{9}$

$\therefore y = \frac{1}{9}x^2$ (3ft, 1ft) ANS





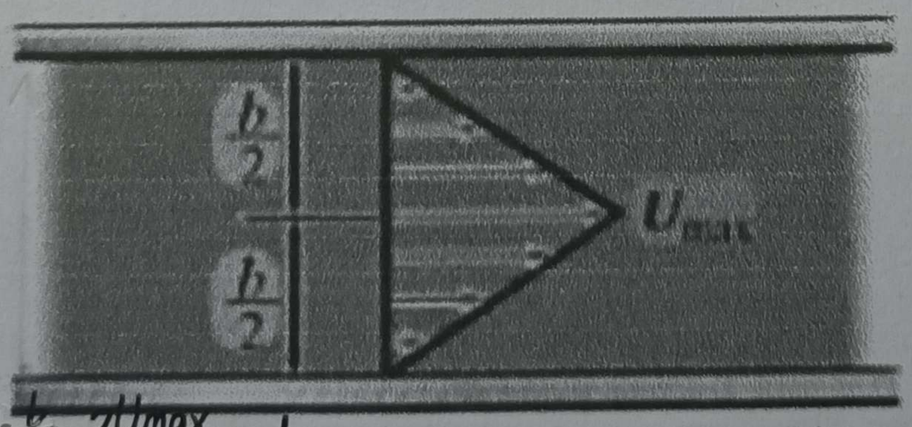
Q3.2 A fluid has velocity components of $\mu = (6y + t)\ ft/s$ and $v = (2tx)\ ft/s$ where x and y are in feet and t is in seconds. Determine the magnitude of acceleration of a particle passing through the point $(1ft, 2ft)$, when $t = 1s$.

解: $a_x = \frac{du}{dt} = 6\frac{dy}{dt} + 1 = 6(2tx) + 1 = 12tx + 1 = 13\ ft/s^2$

$a_y = \frac{dv}{dt} = 2(x + t\cdot\frac{dx}{dt}) = 2x + 2t\cdot(6y + t) = 2 + 2(13) = 28\ ft/s^2$

$a = \sqrt{a_x^2 + a_y^2} = 30.87\ ft/s^2$ ANS

Q3.3 A fluid flowing between two plates has a velocity profile that is assumed to be linear as shown. Determine the (average velocity) and volumetric discharge in terms of U_{max}. The plates have a (width of ω)



解: $V_{avg}\cdot b\,w = 2\int_0^{\frac{b}{2}} \frac{2U_{max}}{b}x\,dx\cdot w$

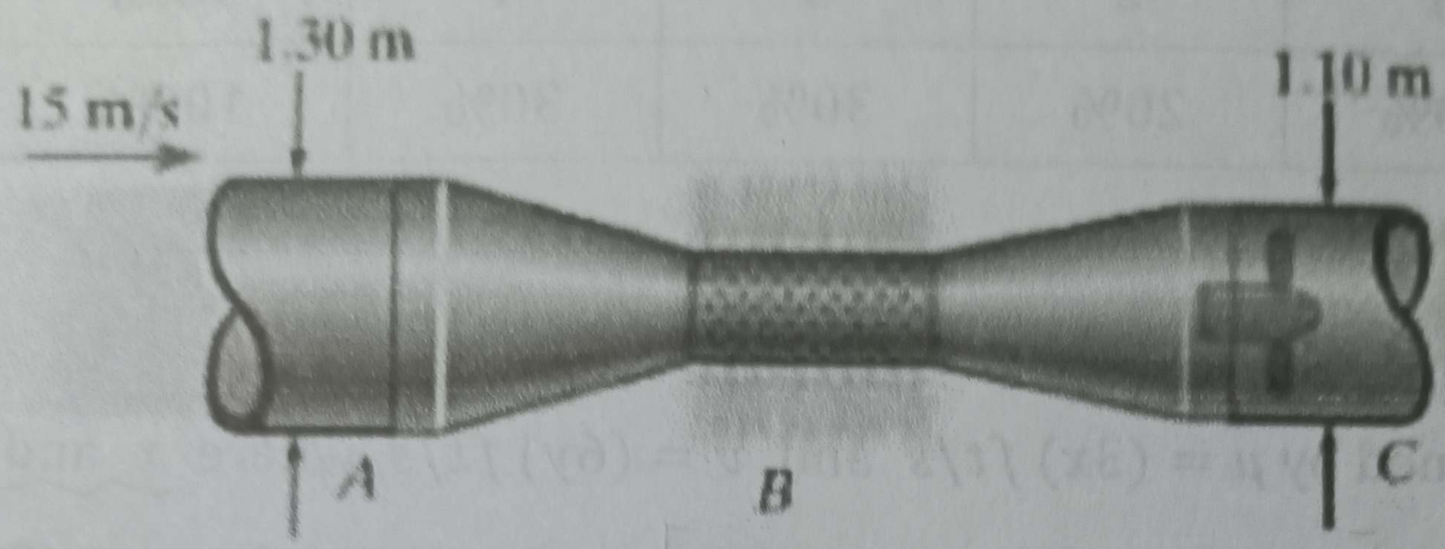
$V_{avg} = \frac{2\times\frac{bU_{max}}{4}}{b} = \frac{1}{2}U_{max}$

$VD = V_{avg}\cdot wb$

$= \frac{1}{2}U_{max}bw$

Q3.4 The wind tunnel is designed so that the lower pressure outside the testing region draws air out in order to reduce the boundary layer or frictional effects along the wall within the testing tube. Within region B there are 2000 holes, each 3 mm in diameter. If the pressure is adjusted so that the (average velocity) of the air through each hole is $40m/s$, determine the (average velocity) of the air exiting the

tunnel at C. Assume the air is incompressible



DDL 2022/4/18

解：$\int \rho \vec{v} d\vec{A} = 0$

$+ V_A A_A - V_B A_B - V_C \cdot A_C = 0$

$$V_C = \frac{V_A \cdot A_A - V_B \cdot A_B}{A_C} = \frac{15\pi(\frac{1.30}{2})^2 - 40 \times 2000 \times (\frac{3\times10^{-3}}{2})^2\pi}{\pi(\frac{1.10}{2})^2} = 20.36 m/s$$