


**CE 3305 Engineering Fluid Mechanics**  
**Exercise Set 8**  
**Spring 2014**

1. Problem 4.6, pg 157
2. Problem 4.8, pg 157
3. Problem 4.30, pg 159 

4.6) For a given hypothetical flow, the velocity from  $t=5s$  to  $t=10s$ , the velocity was  $u=3m/s$ ,  $v=-4m/s$ . A dye streak was started at a point in the flow field at  $t=0$  and the path of a particle in the fluid was also traced from that same point starting at the same time. Draw to scale the streakline, pathline of the particle, and streamlines @ time  $t=10s$

### GIVEN:

A dye streak was started, and a particle was released.

For  $0 \leq t \leq 5s$ ,  $u=2m/s$ ,  $v=0$

For  $5 \leq t \leq 10s$ ,  $u=3m/s$ ,  $v=-4m/s$

### UNKNOWN:

For  $t=10s$ , draw to scale the streakline, pathline of the particle, and streamlines.

### SOLUTION:

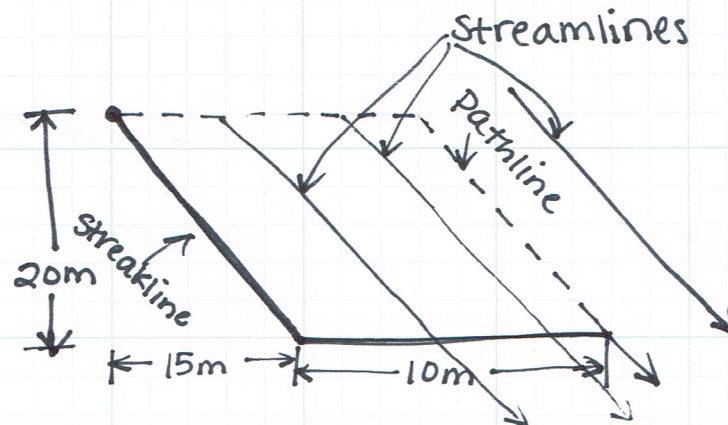
From  $0 < t < 5$ , the dye in the streakline moved to the right for a distance of 10m.

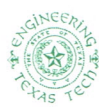
at the same time a particle is released from the origin and travels 10m to the right.

From  $5 < t < 10$ , the original line of dye is transported in whole downward to the right while more dye is released from the origin.

The pathline of the particle proceeds from its location at  $t=5sec$  downward to the right.

At 10 sec, the streamlines are





4.8) A ~~1D~~ velocity field is given mathematically as  
 $V = 2i + 4yj$

The <sup>↑</sup>field is:  
velocity

- a) 1D in x
- b) 1D in y
- c) 2D in x and y

Solutions:

The vector is representing a field that varies in 2  
( $i, j$ ) dimensions.

Answer is C



4.30) Liquid flows through this two-dimensional slot with a velocity of  $V = 2\left(\frac{q_0}{b}\right)\left(\frac{t}{t_0}\right)$ , where  $q_0$  and  $t_0$  are reference values. What will be the local acceleration at  $x = 2B$  and  $y = 0$  in terms of  $B, t, t_0$ , and  $q_0$ ?

KNOWN:

Flow in a two-dimensional slot.

$$V = 2\left(\frac{q_0}{b}\right)\left(\frac{t}{t_0}\right)$$

$$x = 2B$$

$$y = 0 \text{ in}$$

UNKNOWN:

An expression for local acceleration midway in nozzle.

SOLUTION:

$$V = 2\left(\frac{q_0}{b}\right)\left(\frac{t}{t_0}\right)$$

$$\text{where } b = B/2$$

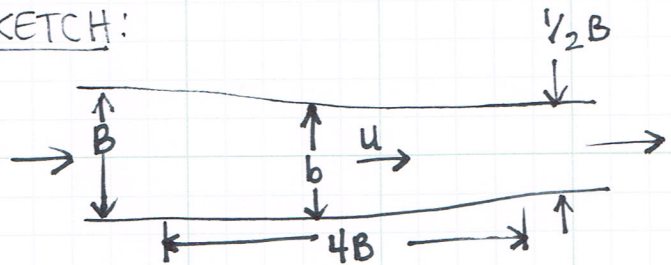
$$V = 4\left(\frac{q_0}{B}\right)\left(\frac{t}{t_0}\right)$$

$$a_x = \frac{\partial V}{\partial t}$$

at the  
end  
of the  
nozzle

$$a_x = \frac{4q_0}{Bt_0}$$

SKETCH:



midway

$$a_x = \frac{dV}{dt} = \left[ \frac{2q_0 t}{t_0 (1/8 x)} \right] = \frac{2q_0}{t_0 (1/8 x)}$$

$$x = 2B$$

$$\Rightarrow a_x = \frac{2q_0}{t_0 (B - B/2 (2B/4B))}$$

$$= \frac{2q_0}{t_0 (B - B/4)}$$

$$a_x = \frac{8}{3} \left( \frac{q_0}{t_0 B} \right)$$