

ESCI 342 – Atmospheric Dynamics I
Answers to Selected Exercises for Lesson 12

2. A vertically oriented vortex tube is in your bathtub. The tube is circular with a radius of 5 cm. The tube is rotating clockwise (as viewed from above) with a tangential velocity of 0.5 cm/s.

- a. Calculate the average vorticity of the tube.

Answer: 0.2 s^{-1}

- b. As the tube moves over the drain it is stretched, and its radius shrinks to 1 cm. What is the new average vorticity?

Answer: 1 s^{-1}

3. Calculate the vorticity of the following flows at point $(x,y) = (1\text{m},2\text{m})$.

a.
$$\begin{aligned} u &= u_0 xy \\ v &= v_0 y \end{aligned} \quad u_0 = 2 \text{ m}^{-1} \text{ s}^{-1}, v_0 = 1 \text{ s}^{-1} \quad \text{Answer: } -2 \text{ s}^{-1}$$

b.
$$\begin{aligned} u &= u_0 y \\ v &= v_0 x \end{aligned} \quad u_0 = 2 \text{ s}^{-1}, v_0 = 1 \text{ s}^{-1} \quad \text{Answer: } -1 \text{ s}^{-1}$$

c.
$$\begin{aligned} u &= u_0 \\ v &= v_0 x^2 \end{aligned} \quad u_0 = 2 \text{ m s}^{-1}, v_0 = 1 \text{ m}^{-1} \text{ s}^{-1} \quad \text{Answer: } 2 \text{ s}^{-1}$$

d.
$$\begin{aligned} u &= u_0 \\ v &= v_0 \cos kx \sin ly \end{aligned} \quad u_0 = 2 \text{ m s}^{-1}, v_0 = 1 \text{ m s}^{-1}, k = 2.1 \text{ m}^{-1}, l = 0.9 \text{ m}^{-1}$$

Answer: -1.8 s^{-1}