

CEE/ESM 479/579

Fate and Transport

Problem Set 1

1. (4 pts) A water analysis determines that a pond sample contains 3.3 mg/L of nitrate ion (NO_3^-). What is the concentration in terms of:
 - a. Milligrams of nitrogen (N) per liter?
 - b. Molar concentration of nitrate?
 - c. Parts per billion of nitrate (as nitrate)?
 - d. Normality in meq/L

2. (3 pts) Atrazine is a common herbicide that flows from agricultural soils into streams and lakes, where it slowly breaks down at some internal sink rate. At the Wievel Reservoir, streams entering the reservoir have an average concentration of atrazine of 8.0 mg/L. Wievel Reservoir has a nearly steady volume of $3.0 \times 10^5 \text{ m}^3$ and the total annual inflow from all streams is $1.5 \times 10^5 \text{ m}^3$. Due to evaporation, the annual outflow of water from the reservoir is somewhat less at $1.2 \times 10^5 \text{ m}^3$. Groundwater inflow and outflow are negligible. The average concentration of atrazine in the outflow is 6.2 mg/L. What is the internal sink rate for atrazine in Wievel Reservoir, expressed as mass loss per cubic meter of water per day?

3. (3 pts) What is the (steady state) flux of:
 - a. Chloride (Cl^-) in a river where the average velocity is 15 cm/s and the chloride concentration is 205 μM ?
 - b. In a stratified estuary (discussed later in class) there is a horizontal freshwater-saltwater interface, where the chloride gradient is marked by a vertical change in chloride from 25 ppt (parts per thousand) in the heavier, saltier lower water, to 0.5 ppt in the fresher, lighter, upper water, over a vertical distance of 1.5 m. Assume there is no turbulent mixing across this stratified estuary gradient, so all mixing is molecular diffusion.. What is the flux across the interface?
 - c. Ammonia (NH_3) in a 15 m long canal that connect a hog-manure holding pond with 350 mg-N/L and a natural pond with 5 mg-N/L. There is no advective flow in the canal, but wind-induced turbulence creates a longitudinal diffusion coefficient of 1.5 m^2/s . Express this as the flux of *ammonia*, not N.