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ESP 110 Winter 2006

MIDTERM EXAM

I. Write on 6 of the following 8 short answer problems. Identify the concept, contrast, or idea stated and *describe why it is important to the study of environmental science*. A brief answer of 2 or 3 pithy sentences making good main points will suffice. 6 points each.

1. Second law of thermodynamics

2. Photochemical reactions

3. Stable isotopes versus radioisotopes

NAME:_____

4. 5 day BOD test

5. Thermal stratification

6. Nitrogen versus phosphorus limited lakes

7. Artesian aquifer

NAME:_____

8. Bioremediation

II. Solve the following three problems for 13 points each. Show your work neatly for full and partial credit

1. A phosphorus limited lake with a surface area of $10 \times 10^6 m^2$ is fed by a rather polluted stream with a flow of $5\ m^3 s^{-1}$ carrying phosphorus at a concentration of $10\ mg\ L^{-1}$. The settling velocity of P in the lake is $5 \times 10^{-6} m\ s^{-1}$. What proportion of the P in the polluted stream will be stripped out by the lake and buried in the lake's sediments?

NAME:_____

2. The BOD_5 of some wastewater is 250 mg/l. What is the ultimate carbonaceous BOD? The reaction rate constant *k* you know to be about 0.25 day^{-1}.

3. Consider a dry canyon streambed with groundwater flowing in the alluvium beneath the stream. The water table is 1 m below the surface of the streambed and you estimate that the rock floor below the stream bed in about 10m deep. The walls of the canyon are about 30m wide. Several test pits up and down the stream show that the top of the water table is always about 1 m below the streambed. A survey shows that the streambed drops about 1 m per 100m. The alluvium in the streambed is a mixture of sand and gravel, so you estimate the hydraulic conductivity to be about 400 m d^{-1}. Roughly how much water is flowing below the dry streambed?

NAME:_____

Some equations of possible interest

$$\frac{[C]^c\,[D]^d}{[A]^a\,[B]^b} = K$$

$$E = h\upsilon = \frac{hc}{\lambda}$$

$$BOD_t = L_0\left(1 - e^{-kt}\right)$$

$$L_t = L_0 e^{-kt}$$

$$DO = DO_s - \frac{k_d L_0}{k_r - k_d}\left(e^{-k_d t} - e^{-k_r t}\right) + D_0 e^{-k_r t}$$

$$Q = KA\left(\frac{dh}{dL}\right)$$

$$v' = \frac{v}{\eta}$$

$$Q = Av = A'v'$$

$$R = \frac{v'}{v_s} \geq 1$$

$$Q_w C_w + Q_s C_s = C\,(Q_s + Q_w) - K\,C$$

$$QC_{in} + S = QC + Av_s C$$