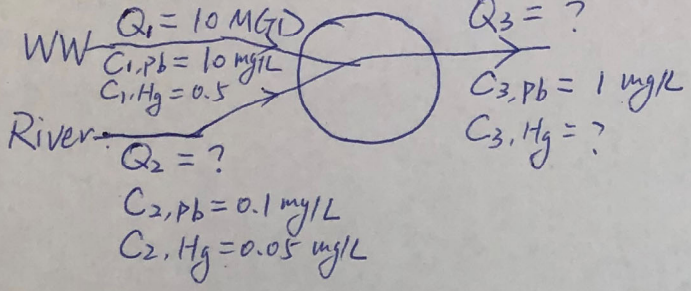
# CE 111 Midterm Exam 1 Answer Sheets Name Solution 2021

**Problem 1:**




MB for flow: $Q_1 + Q_2 = Q_3$

$10 + Q_2 = Q_3$

MB for Pb: $Q_1 C_{1,Pb} + Q_2 C_{2,Pb} = Q_3 C_{3,Pb}$.

$10 \times 10 + 0.1 Q_2 = 1 Q_3$

Solve for $Q_2$ & $Q_3$: $100 + 0.1 Q_2 = 10 + Q_2$

$$Q_2 = \frac{100 - 10}{1 - 0.1} = 100 \text{ MGD}$$

$Q_3 = 10 + 100 = 110$ MGD.

MB for Hg: $0.5 \times 10 + 0.05 \times 100 = 110\, C_{3,Hg}$

$$C_{3,Hg} = \frac{5 + 5}{110} = 0.09 \text{ mg/L}$$

**Problem 2:**

Two half reaction: $2NH_4^+ \rightarrow N_2 + 8H^+ + 6e^-$

$(2e^- + H^+ + HOCl \rightarrow Cl^- + H_2O) \times 3$

$2NH_4^+ + 6e^- + 3H^+ + 3HOCl \rightarrow N_2 + 8H^+ + 6e^- + 3Cl^- + 3H_2O$

$2NH_4^+ + 3HOCl \rightarrow N_2 + 5H^+ + 3Cl^- + 3H_2O$.

**Problem 3:**

(a) $pH = 7$, because $10^{-11} << 10^{-7}$.

(b) $pH = 14 - pOH = 14 - 3 = 11$, as NaOH is strong base.

(c) $Mg(OH)_2(s) \rightleftharpoons Mg^{2+} + 2OH^-$ $pK_s = 11.25$.

$x$ $2x$

$$K_s = 10^{-11.25} = \frac{x(2x)^2}{1} = 4x^3$$

$x = 1.12 \times 10^{-4}$ M

$pOH = -\log(2 \times 1.12 \times 10^{-4}) = 3.6$

$pH = 14 - 3.6 = 10.4$

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**Problem 4:** a, e, i

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**Problem 5:**

(a) Tracer results → PFR, $\bar{t} = 1h$. $V = Q\bar{t} = 200\ m^3/h \times 1 = 200\ m^3$

(b) PFR.

(c) $\frac{1}{C}$ vs $t$ is linear, so the reaction order is 2.

$$k = \frac{0.13 - 0.01}{6} = 0.02\ \frac{L}{mg \cdot h}$$

(d) $$C_{out} = \left(\frac{1}{C_{in}} + kt\right)^{-1} = \left(\frac{1}{100} + 0.02 \times 1\right)^{-1} = 33\ mg/L$$

(e) $$\bar{t}_{CFSTR} = \frac{V}{Q} = \frac{200\ m^3}{200\ m^3/h} = 1h$$

$$0.02 \times C_{out,CFSTR}^2 + C_{out,CFSTR} - 100 = 0$$

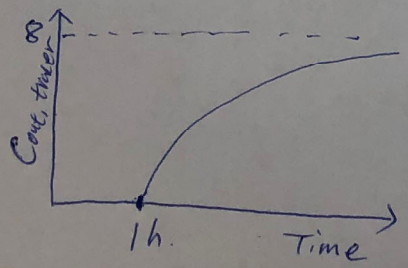
$$C_{out,CFSTR} = \frac{-1 + \sqrt{1 + 4 \times 0.02 \times 100}}{2 \times 0.02} = 50\ mg/L$$

$$C_{out} = \left(\frac{1}{C_{out,CFSTR}} + 0.02 \times 1\right)^{-1}$$

$$= \left(\frac{1}{50} + 0.02\right)^{-1}$$

$$= 25\ mg/L$$

(f)




**Signature:** _____

I pledge my honor that I have not violated the Berkeley Honor Code during this examination