Chem. 447---answers to Exam #1 --Fall 2001

1. a) 1
   b) 3
   c) 3
   d) 2
   e) 2
   f) all answers were graded as correct--wording in question incorrect
   g) 2
   h) 1

2. a. $R_{tot} = 2000 + 4000 + R_{1,2(eq)} = 6500$ ohms

therefore: $V_{R4} = 7\text{Volts}\ (2000/6500)e^{-0.05(6500*\ 5x10\text{-}6)}$

$V_{R4} =$ **0.464** Volts at 0.05 sec

b. $V_{R1/R2}$ without meter = 7 V (500/6500) = **0.538 Volts**

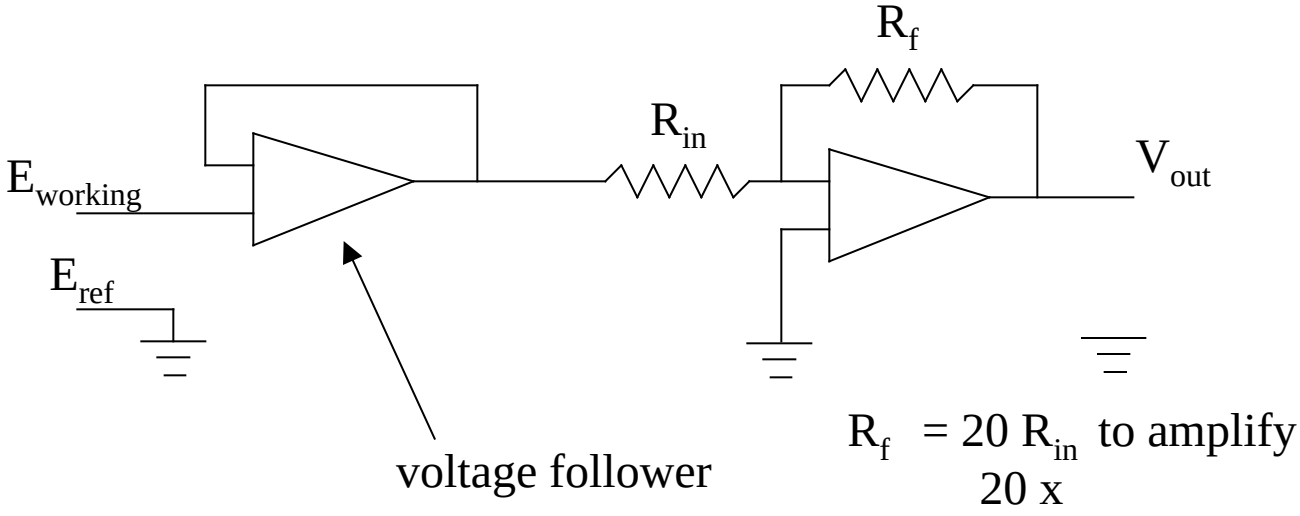
with meter, must recaculate R_{total} using new $R_{R1/R2/Rm\ (eq)}$

$R_{(eq)} = 495$ ohms; therefore $R_{total} = 6495$ ohms

then--$V_{R1/R2}$ = 7 V (495/6495) = **0.533 Volts**

% error = ((0.538-0.533)/0.538) x 100 = **0.93 %**

3.



3. cont'd. ---Output of second operational amplifier could be measured with low impedance voltmeter, because the output signal will appear as if it is coming from low impedance source---not like the original signal $E_{working}$ that came from highly resistive glass pH electrode.

4. The minimal detectable signal is considered to be 3 x the noise = 3 (0.008) = 0.024 A

   $S_m = m_x C_m = 0.024 = 0.005 C_m$; therefore $C_{m,}$ the minimal detectable concentration is **<u>4.8 ppm</u>**

5. To determine selectivity coefficients, you need to calculate the sensitivity of the electrode to each species

   m_{gluc} = 100 nA/mM; m_{acet} = 75 nA/5 mM = 15 nA/mM; m_{asc} = 120 nA/mM

   therefore; $k_{gluc/acet} = m_{acet}/m_{gluc} = 15/100 =$ **<u>0.15</u>**

   $k_{gluc/asc} = m_{asc}/m_{gluc} = 120/100 =$ **<u>1.2</u>**

   measured signal --$S = m_{gluc} (C_{gluc} + k_{gluc/acet}C_{acet} + k_{gluc/asc}C_{asc})$

   absolute error = $k_{gluc/acet}C_{acet} + k_{gluc/asc}C_{asc} = 0.15\ (3) + 1.2\ (1) =$ **<u>1.65 mM</u>**

   % error = 1.65 /5.0 X 100 = **<u>33%</u>**

6. a) increase
   b) decrease
   c) increase
   d) increase
   e) remain the same

7. Definitions;

a) matrix effects: when the chemical or physical composition of the sample causes the instrument response sensitivity (slope) toward the analyte to be different in the presence of the sample than in standards containing the analyte.

b) combination pH electrode: Design in which the working glass electrode and external reference electrode are combined into a single body that contains both electrodes.

c) electrode of the second kind: metal electrode that responds indirectly to ions or other species that are in equilibrium via formation of complexes or insoluble salts with an ionized form of the metal.

d) flicker noise---a type of noise in analytical instruments which increases at low frequencies---sometimes called 1/f noise. Due to slow drift in outputs of electronic circuits within instruments.