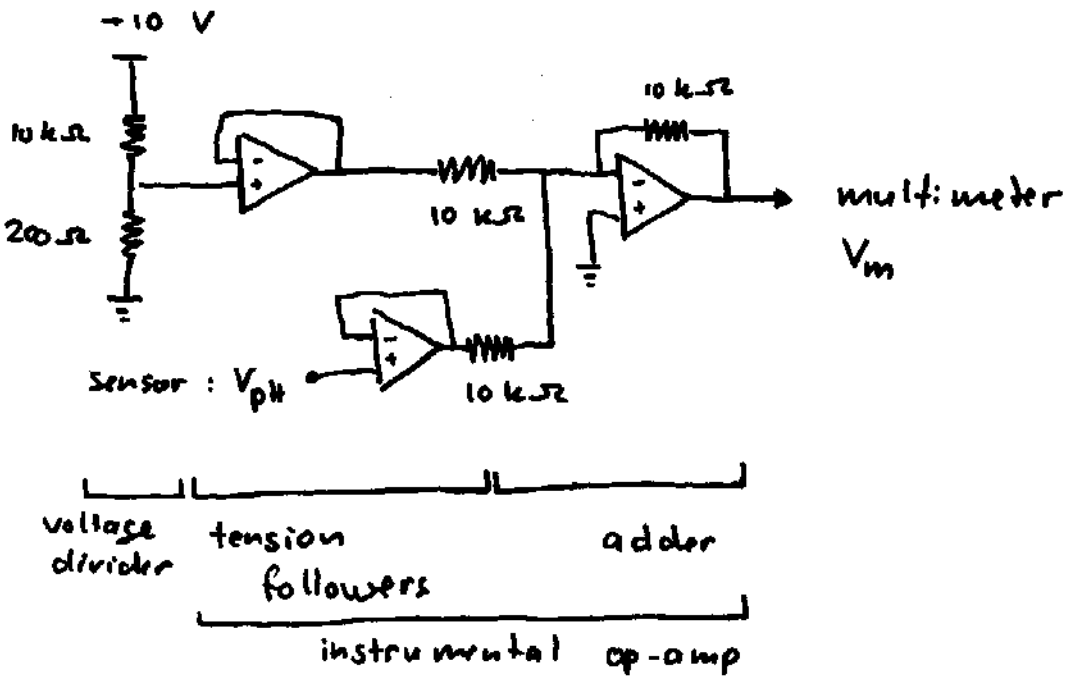
(3) a) The signal at a pH of 5 is equal to +200 mV. To get highest resolution we have to subtract this voltage.



b) $\Delta N_{H^+} = \dfrac{\Delta V_m}{dV_m/dN_{H^+}}$, $\Delta V_m = 0{,}01$ mV

$$\frac{dV_m}{dN} = \frac{dV_m}{dpH}\cdot\frac{dpH}{dN} = \frac{dV_m}{dV_{pH}}\cdot\frac{dV_{pH}}{dpH}\cdot\frac{dpH}{d[N]}\cdot\frac{d[N]}{dN}$$

$\dfrac{dV_m}{dV_{pH}} = 1$ (see circuit above)

$\dfrac{dV_{pH}}{dpH} = 100$ mV

$\dfrac{dpH}{dN} = \dfrac{1}{\ln(10)}\cdot\dfrac{1}{[N_{H^+}]}$

$\dfrac{d[N_{H^+}]}{dN_{H^+}} = \dfrac{1}{3l}$

$$\frac{dV_m}{dN_{H^+}} = \frac{100\text{ mV}}{\ln(10)}\cdot[N_{H^+}]\cdot\frac{1}{3l}$$

$pH = 5 \Rightarrow [N_{H^+}] = 10^9 / liter$

$\frac{dV_m}{dN_{H^+}} = 1.45 \cdot 10^{-11} V / atom\ H^+$

$\Rightarrow \Delta N_{H^+} = \frac{10\ \mu V}{1.45 \times 10^{-11} V}$ atoms $H^+ = 6.9 \times 10^5$ atoms

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(4) See lecture notes

- thermo couple
- PT 100
- thermistor
- diode
- mechanical sensor
- spectrum analyzer

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(5) See lecture notes