

Electronic Instrumentation

Problem sheet: pH

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A pH sensor is based on the chemical potential (unit: volt) of a acid reaction which, in turn, is based on the concentration (unit: 1/liter) of hydrogen ions, $[H^+]$. More precisely, $pH = 14 - {}^{10}\text{Log}([H^+])$ and the resulting voltage is $V_{\text{sensor}} = 100 \text{ mV} \times (7 - pH)$.

The sensor is placed in a 3 liter solution with a pH of 5. To measure voltages we have a multimeter with 4 digits resolution (for example, at a scale of 20 V the resolution is 0.01 V) and a minimum scale of 20 mV.

- Design an electronic circuit to prepare the signal to work with the highest possible resolution in pH.
- What is this resolution in terms of number of hydrogen ions (ΔN_{H^+}) of the system of a)?
- A pH sensor needs a high-impedance amplifier to work properly. Explain why.