# pH measurements

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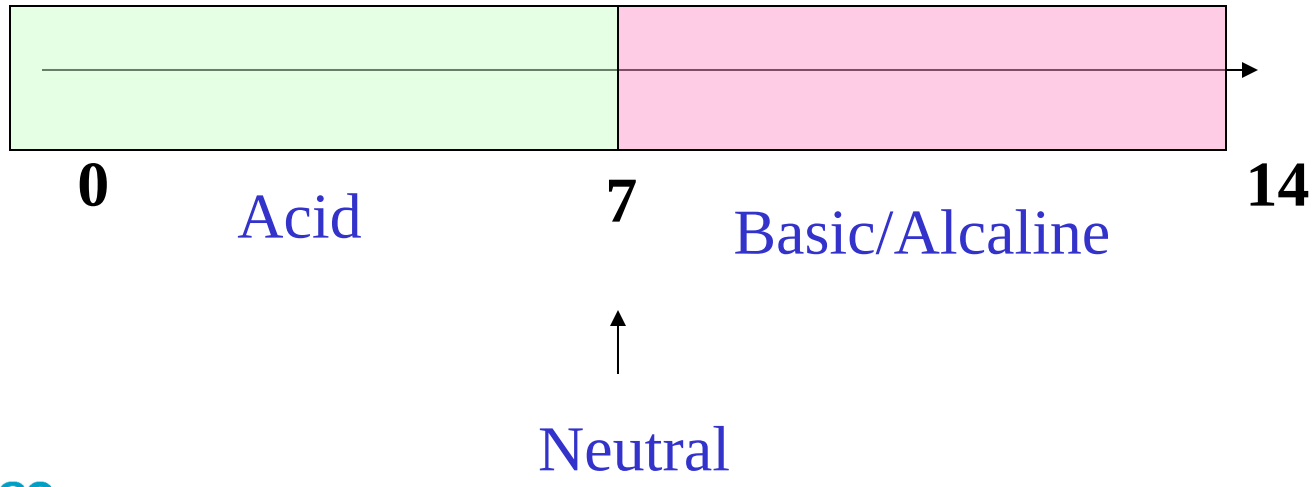
- When you need to be sure...

# Generalities

# What is pH ?

pH indicates the degree of **acidity or basicity** of a solution



# History of pH

pH was introduced in **1909** — **SORENSEN**

"pH" — **PONDUS HYDROGENI**

pH : — **$- \log [H^+]$**

**$[H^+] =$** — **$10^{-pH}$**

# History of pH

In 1924, a new parameter called ‘activity ’ is taken into account

$$pH = - \log a_{H}+$$

# Concentration in $H^+$

| | pH | Concentration in $H^+$ (mol/l) | Concentration in $OH^-$ (mol/l) |
|---|---|---|---|
| **Acid** | **0** | 1 | 0.00000000000001 |
| | **1** | 0.1 | 0.000000000001 |
| | **2** | 0.01 | 0.000000000001 |
| | **3** | 0.001 | 0.00000000001 |
| | **4** | 0.0001 | 0.0000000001 |
| | **5** | 0.00001 | 0.000000001 |
| | **6** | 0.000001 | 0.00000001 |
| | **7** | 0.0000001 | 0.0000001 |

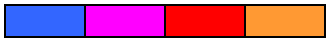
# Concentration in $H^+$

| | pH | Concentration in $H^+$ (mol/l) | Concentration in $OH^-$ (mol/l) |
|---|---|---|---|
| **Basic** | **7** | 0.0000001 | 0.0000001 |
| | **8** | 0.00000001 | 0.000001 |
| | **9** | 0.000000001 | 0.00001 |
| | **10** | 0.0000000001 | 0.0001 |
| | **11** | 0.00000000001 | 0.001 |
| | **12** | 0.000000000001 | 0.01 |
| | **13** | 0.0000000000001 | 0.1 |
| | **14** | 0.00000000000001 | 1 |

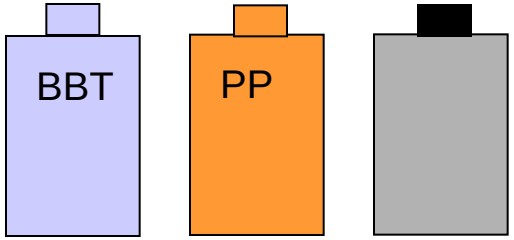
# pH measurements

# How to measure pH?

- pH **paper**



- Colour **indicator**




- Accurate measurement:
**electrochemical measurement**

# Equipment to measure pH



Measuring system and pH Standards

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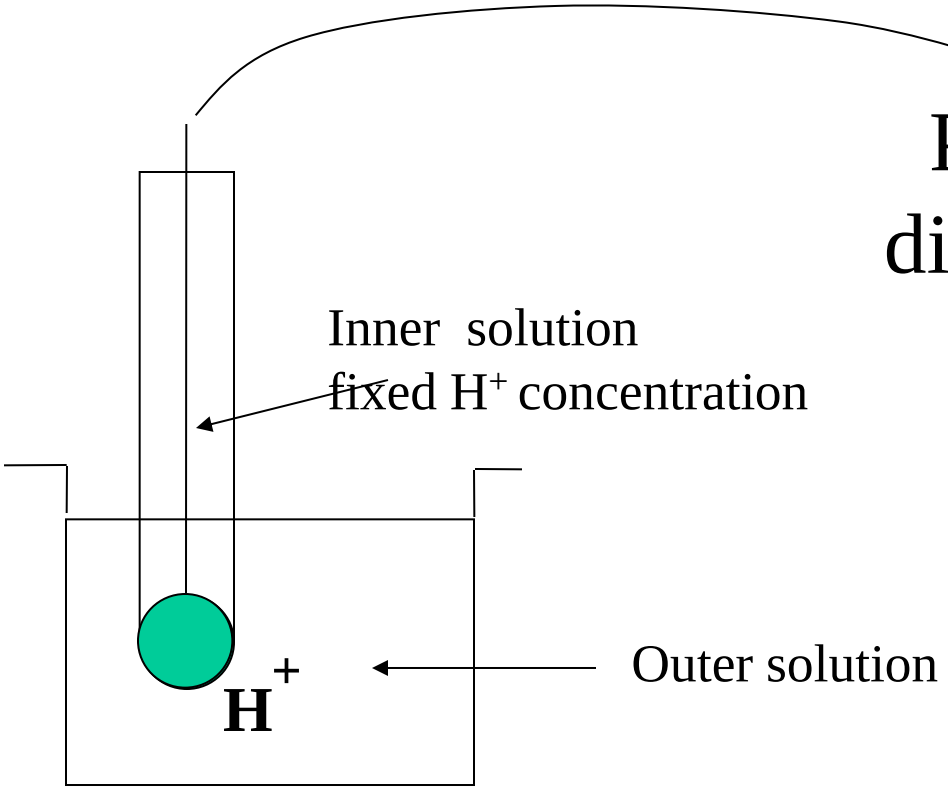
# Indicator electrode




Potential expresses pH difference between inner and outer solutions

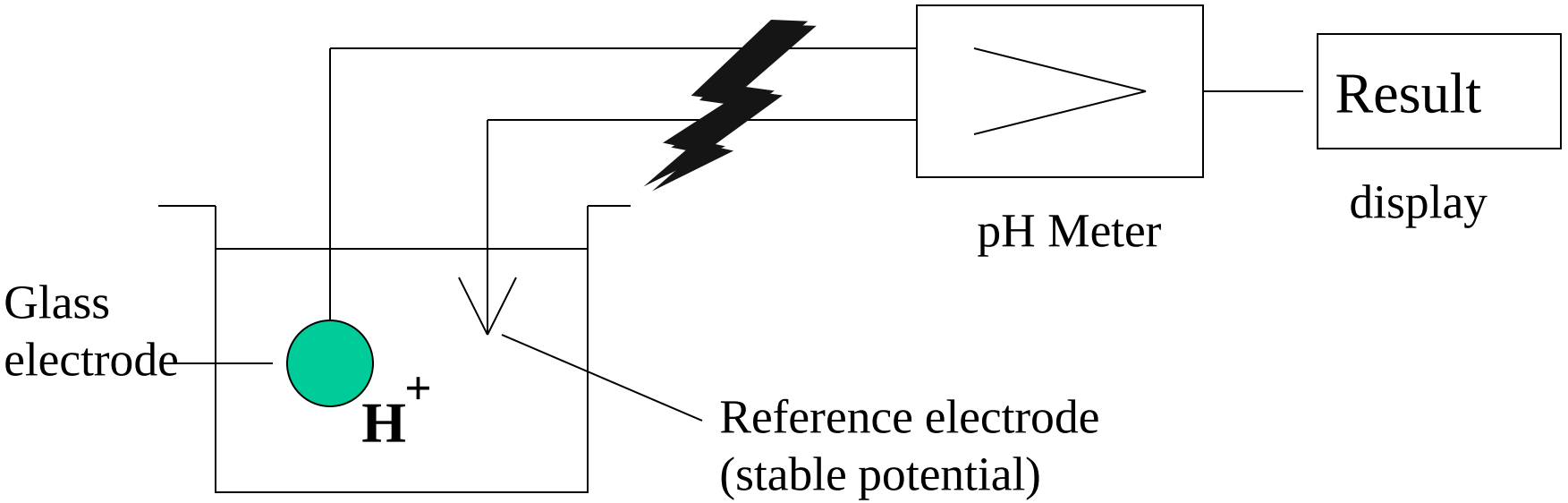
# Electrodes: Indicator/ Reference

INDICATOR ELECTRODE → POTENTIAL VARIES

REFERENCE ELECTRODE → FIXED POTENTIAL

→ Measurement = POTENTIAL DIFFERENCE

# Principle scheme

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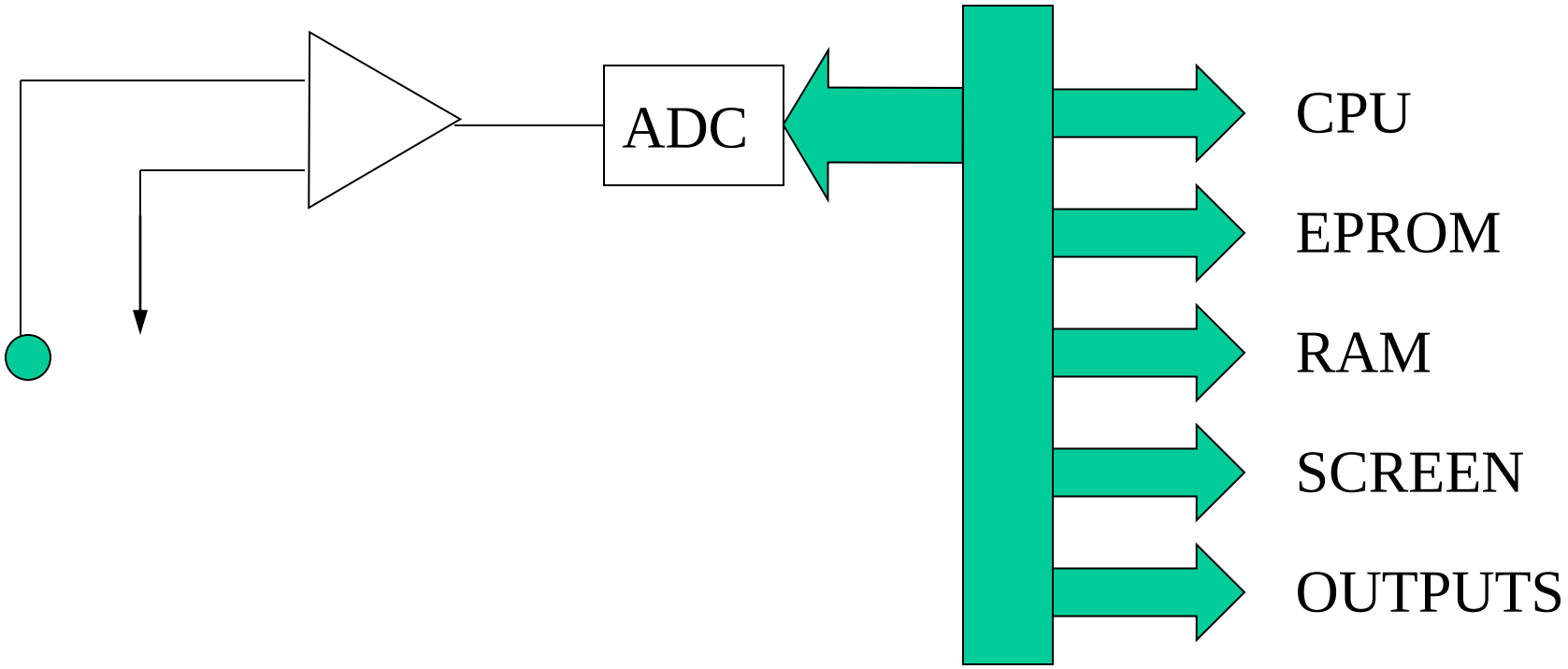
# The pH meter

**Is it only a voltmeter...**



# Nernst law

The electrode response follows the **Nernst law** :

$$\mathbf{E = Eo + 2.3RT/nF * \log (aH+)}$$

*Eo = constant potential*

*R = gaz constant*

*T = Temperature (Kelvin)*

*F = Faraday constant*

*n = ionic charge*

# Calibration of the measuring chain

✉ **Bracket** the pH value to measure

✉ **3 pH units** of difference

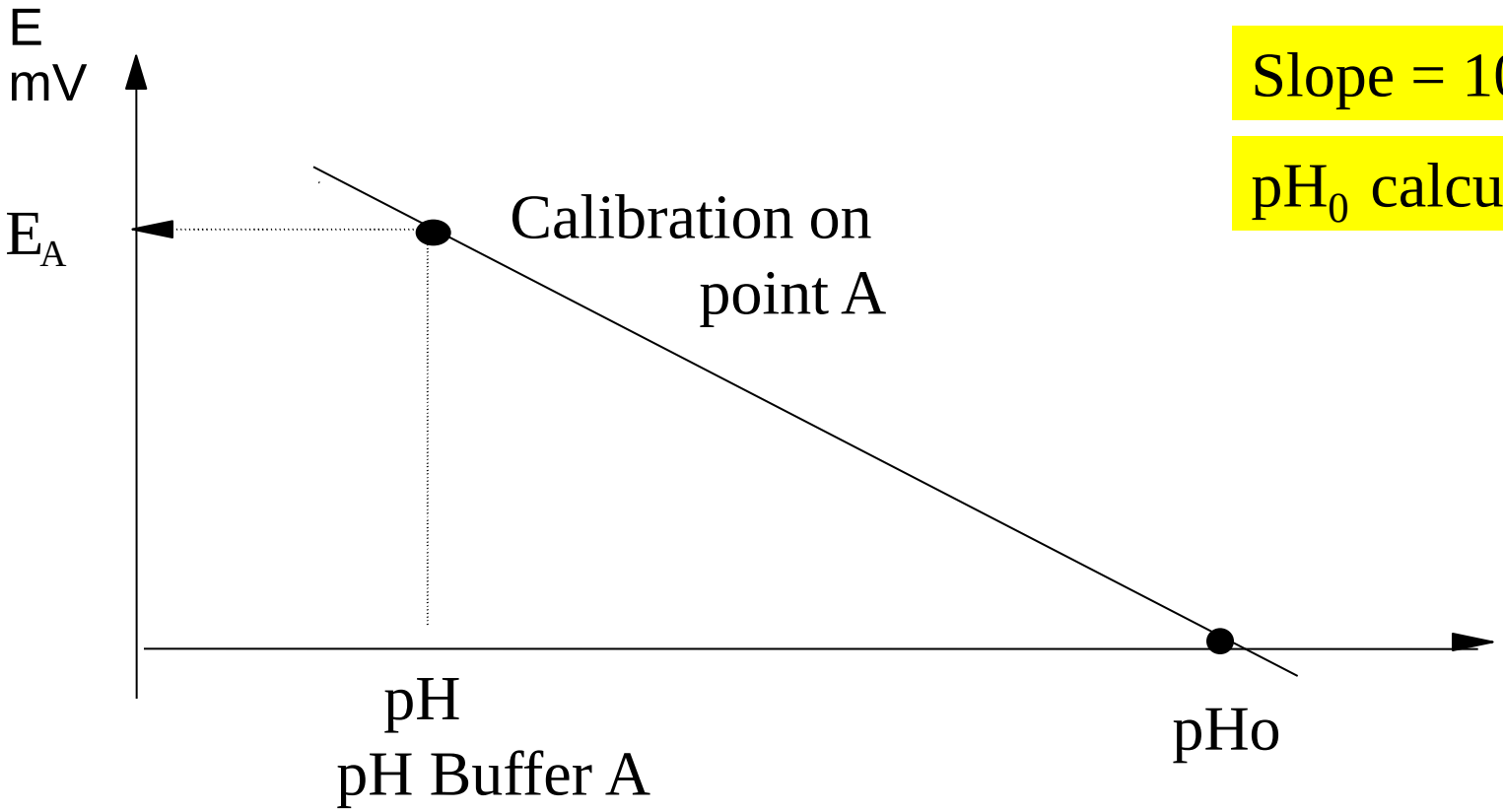
✉ **1 calibration per day** (more if big temperature difference between morning and afternoon)

✉ For accurate measurements

**Standards temperature = Sample temperature**

(used thermostated baths if needed)

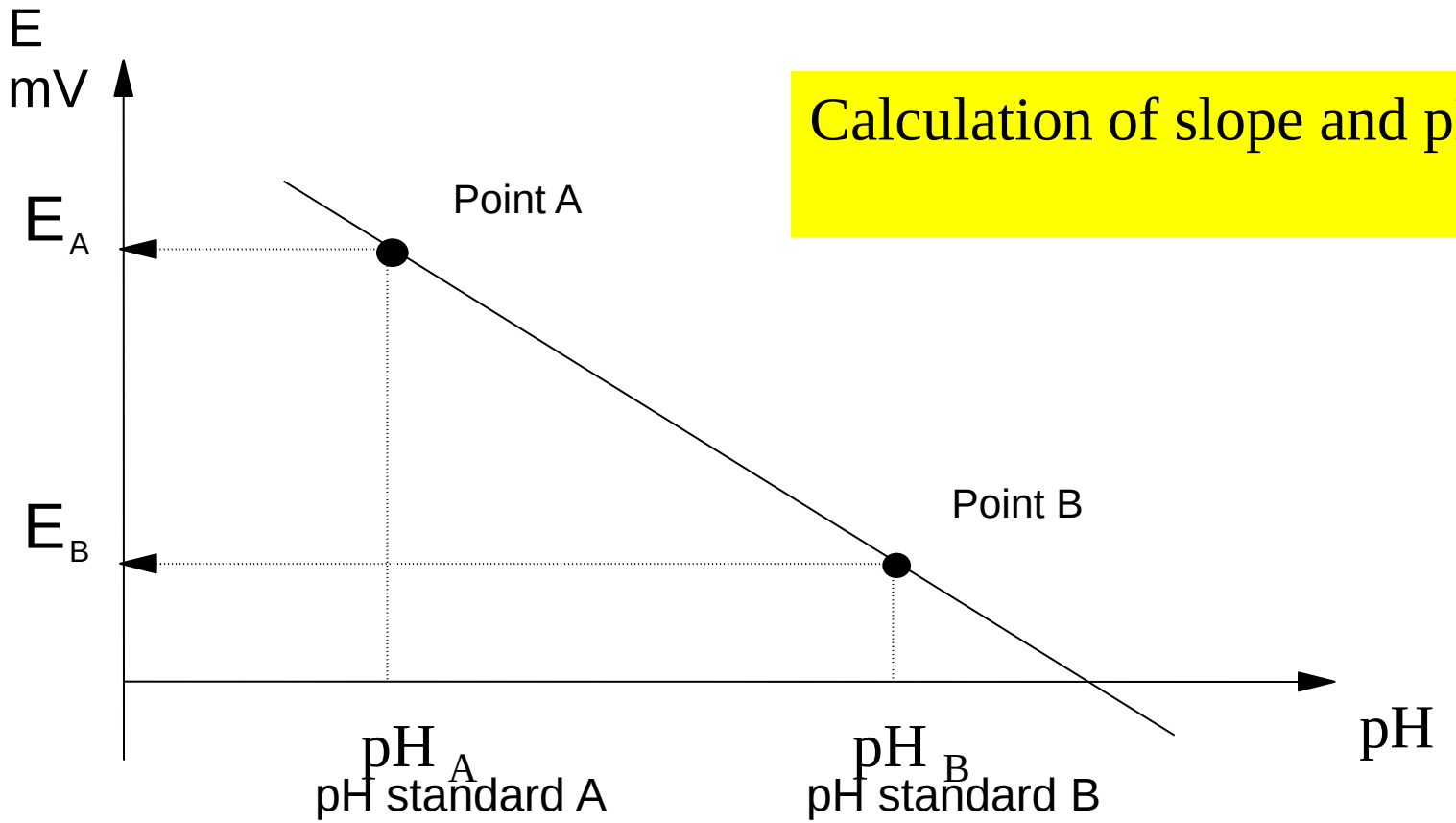
# 1 point calibration




Slope = 100%

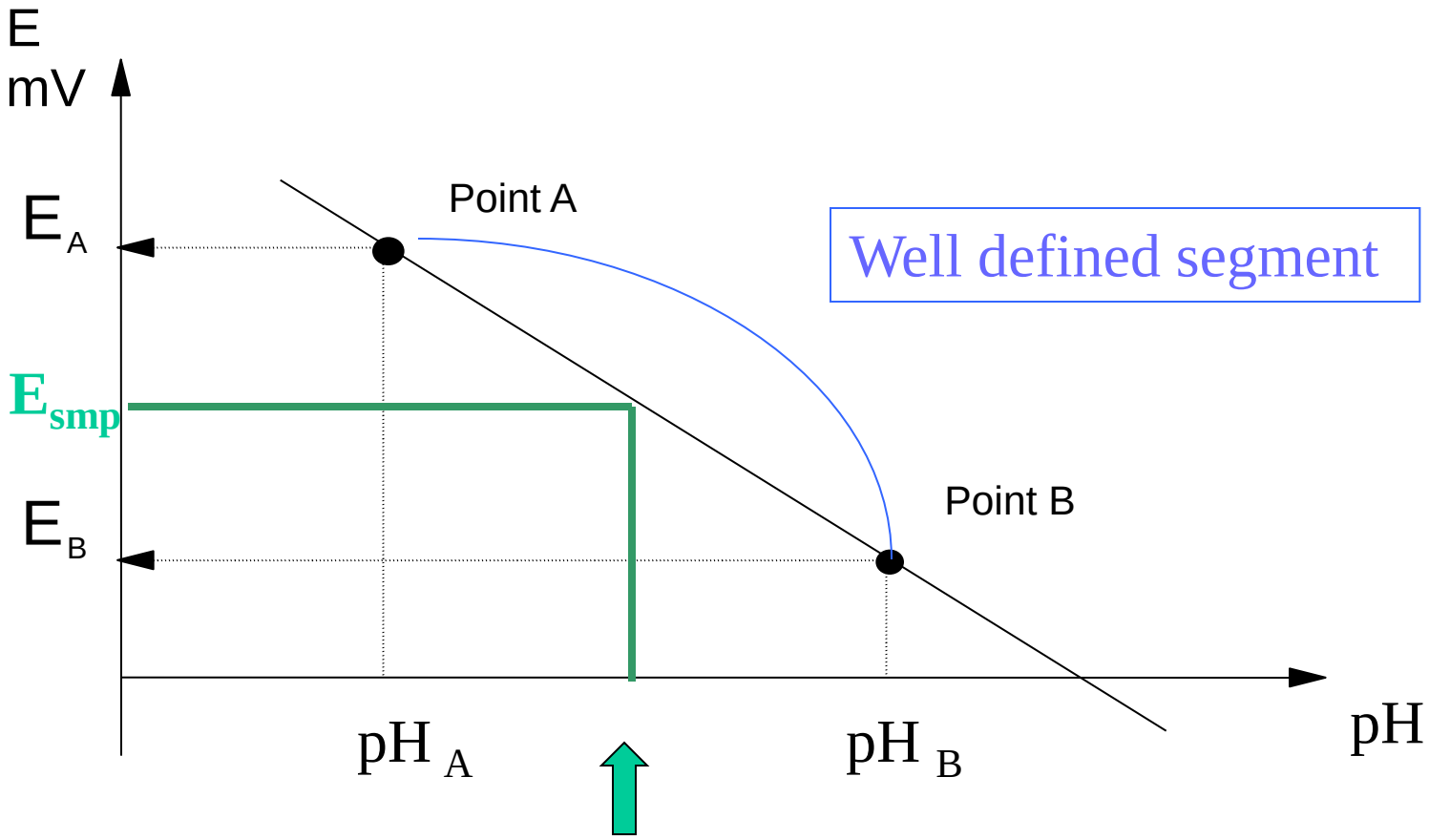
$pH_0$ calculation

# 2-point calibration




Calculation of slope and $pH_0$

# Measurement on sample

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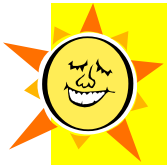
# First calibration result: $pH_0$

**pHo** pH value ⟺ E = 0 mV

$pH_0$ # 7

# $pH_0$ values



$pH_0 = X \pm 0.1$

$pH_0$ = information on the measuring chain

If variation of $pH_0$ is high, 0.1 pH, the electrode has to be checked

$6 < pH_0 < 7,5$ in Radiometer Analytical 's Meters

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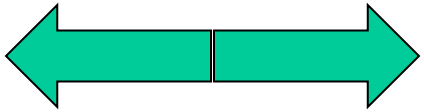
# Calibration result : slope

$$\textbf{Slope \%} = \frac{\text{MEASURED VARIATION}}{\text{THEORETICAL VARIATION}}$$

pH varies

**1 UNIT**



POTENTIAL varies

**59.16 mV**

100 % ⟺ 59.16 mV at 25°C

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# Slope values

Ideal slope = 100%

Slope = information on electrode membrane

If slope < 95%, electrode is bad

95% < slope < 102% in our meters

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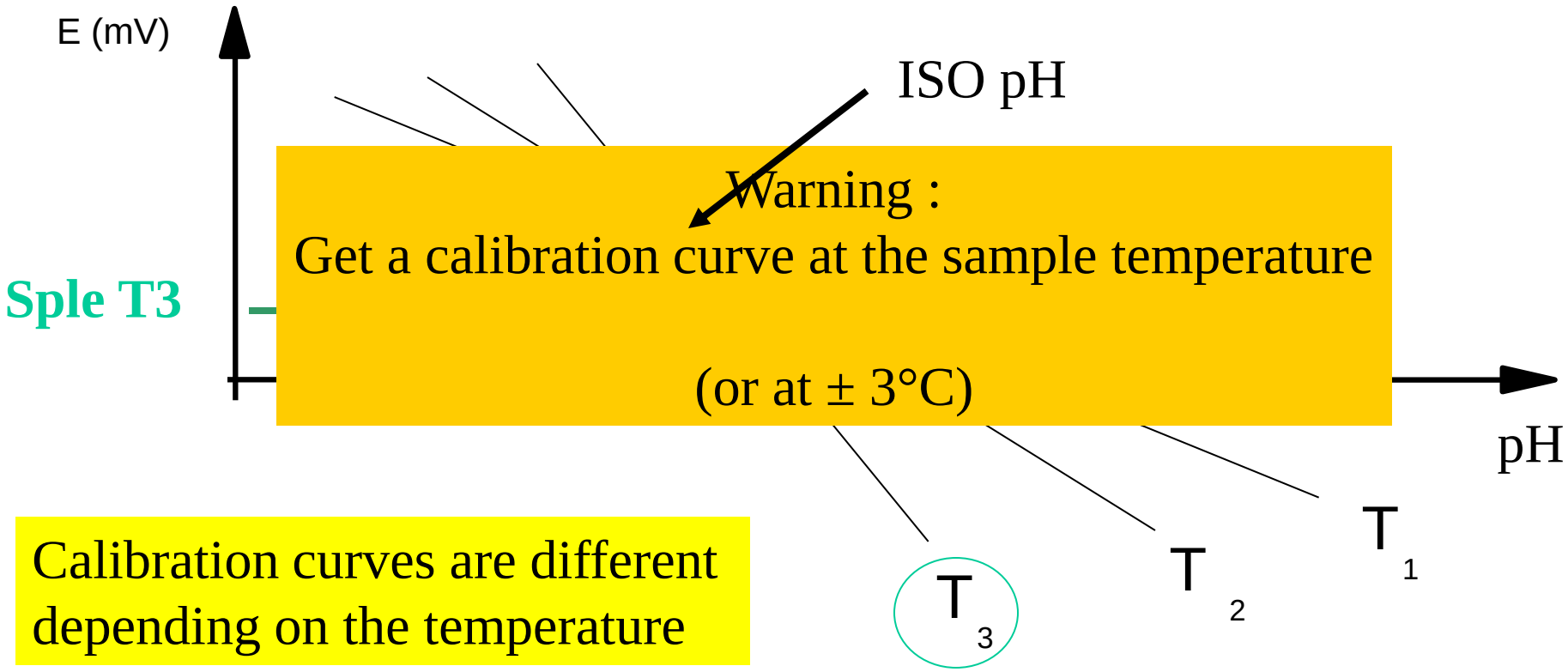
# Slope and $pH_0$

Slope and $pH_0$ change with time

**Perform regular calibrations**

# Temperature effects




Calibration curves are different depending on the temperature

# Other parameters

Other parameters which have an effect on pH measurement :

- Cleaning of **glassware**
- Quality of **distilled water**
- **Stirring** regular and reproductible
- Position of the **electrodes**

# The end