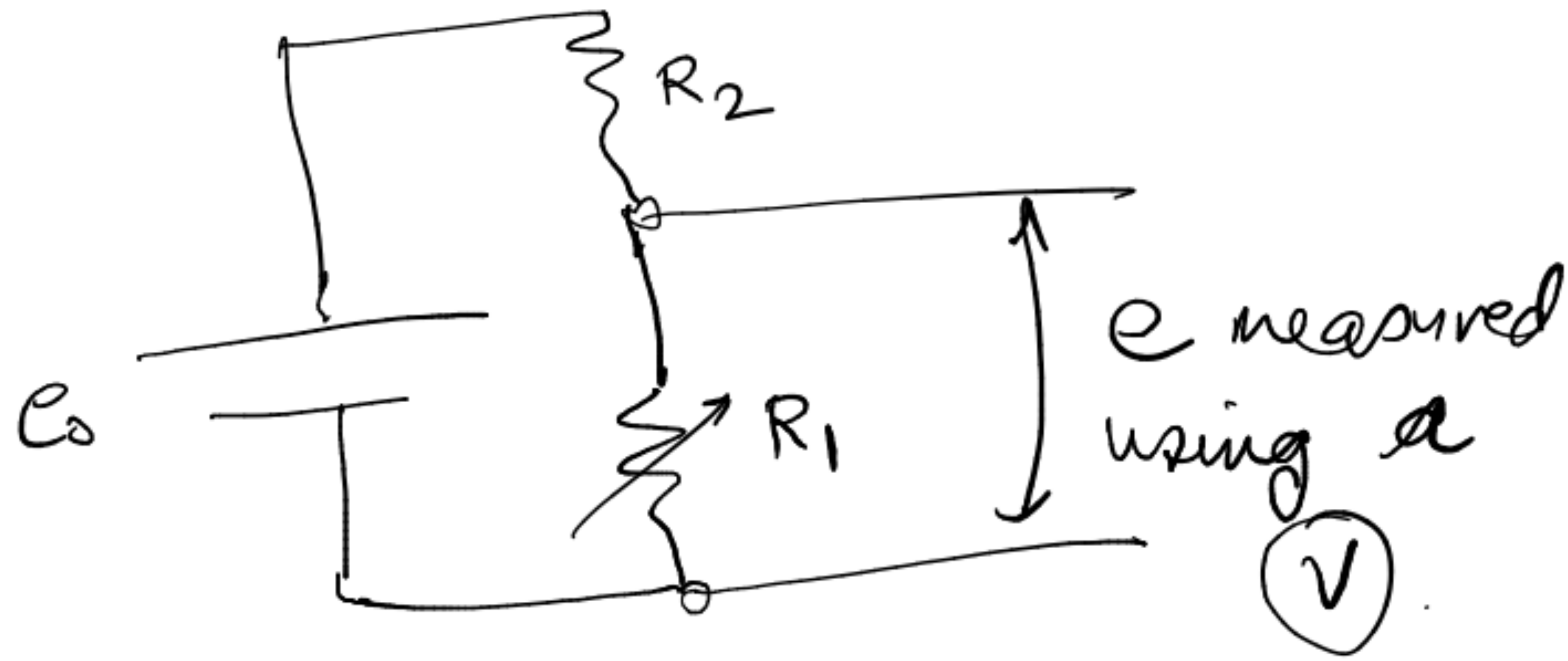
AS 3520

Lecture 4

Potentiometric circuit:



$R_1 \longrightarrow R_1 + \Delta R_1$ (post straining)

$e \longrightarrow e + \Delta e$ (" ")

$$\frac{\Delta e}{e_0} = \frac{S}{4} \varepsilon$$

$e_0 \to 3V$, $S \to 2$, $\varepsilon \to 10 \times 10^{-6} = 10^{-5}$

$\Delta e = 1.5 \times 10^{-5} V.$

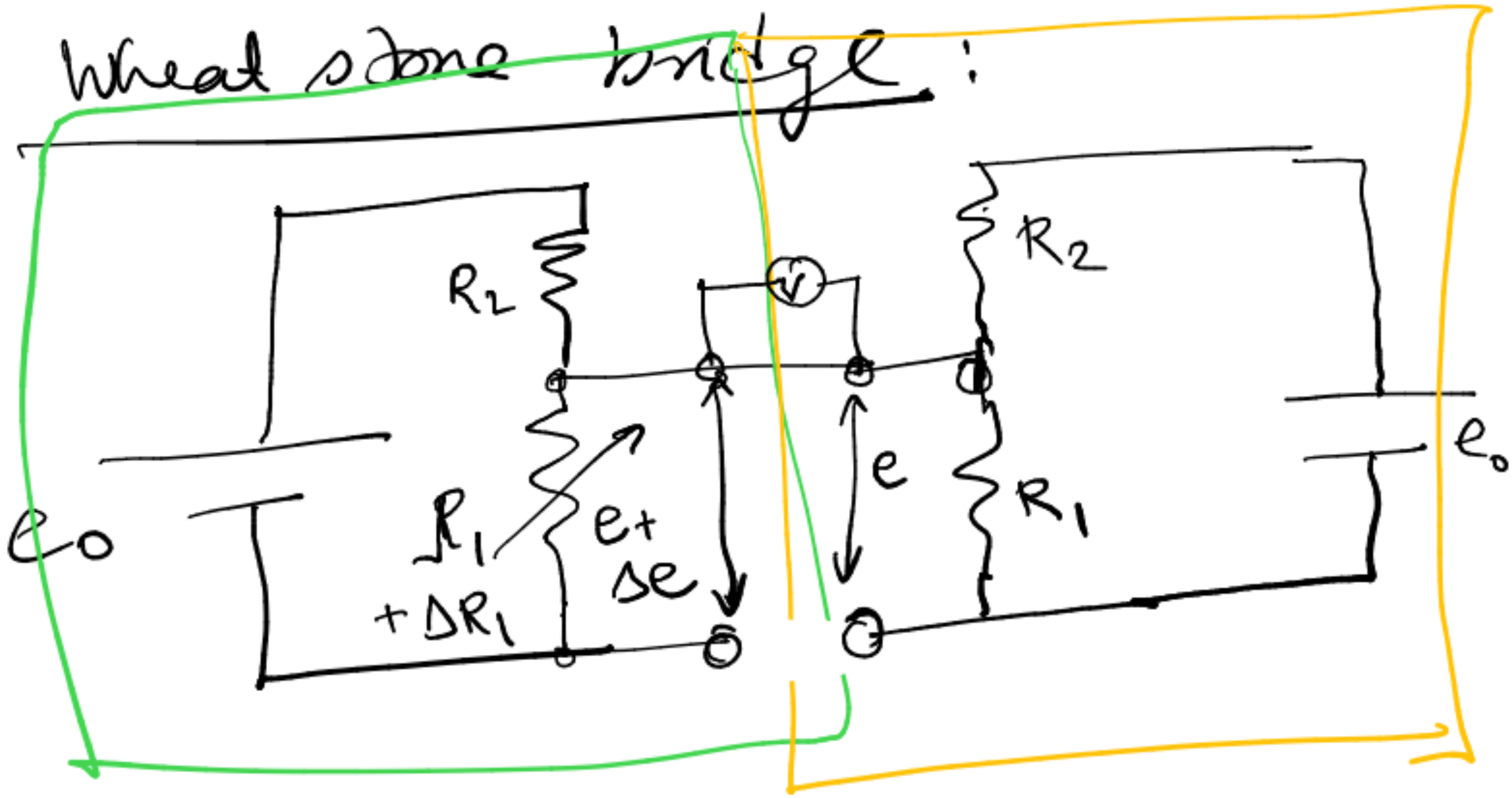
The Ⓥ should have a range $\sim 1V$; yet have sensitivity $\sim 10^{-5}$ V.

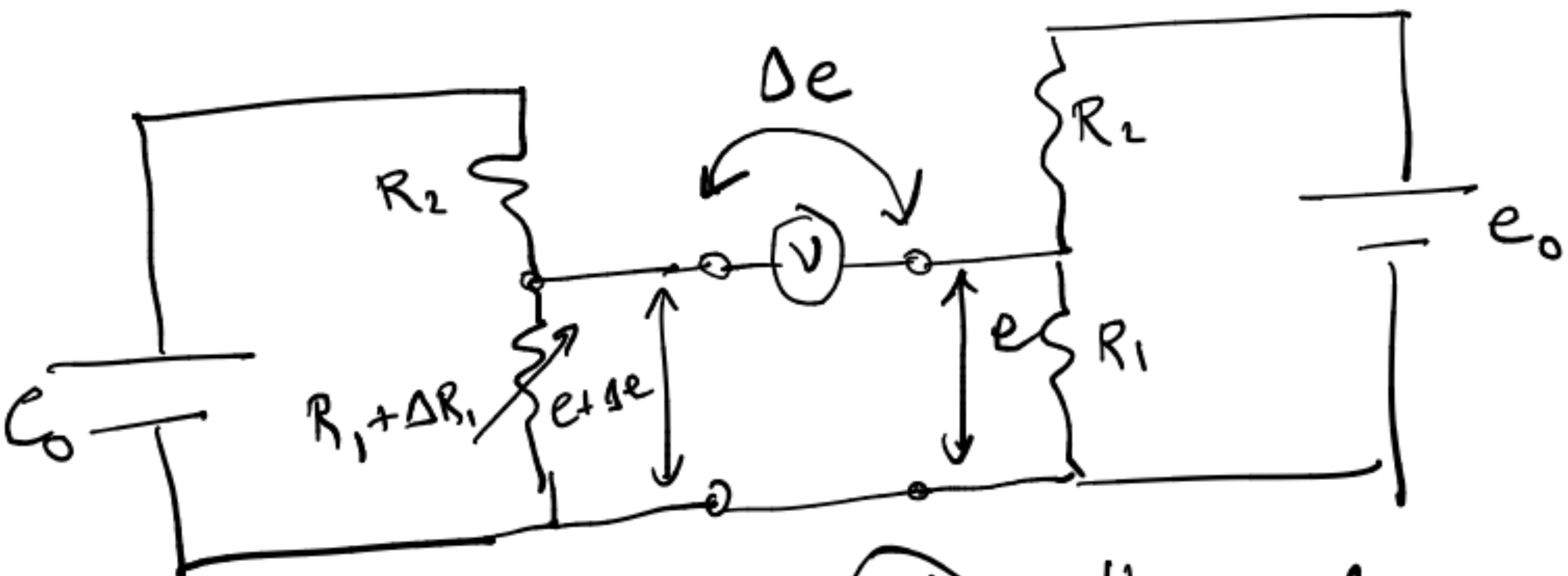
— Such a Ⓥ does not exist.

— We cannot use the simple potentiometric circuit for strain gauging.

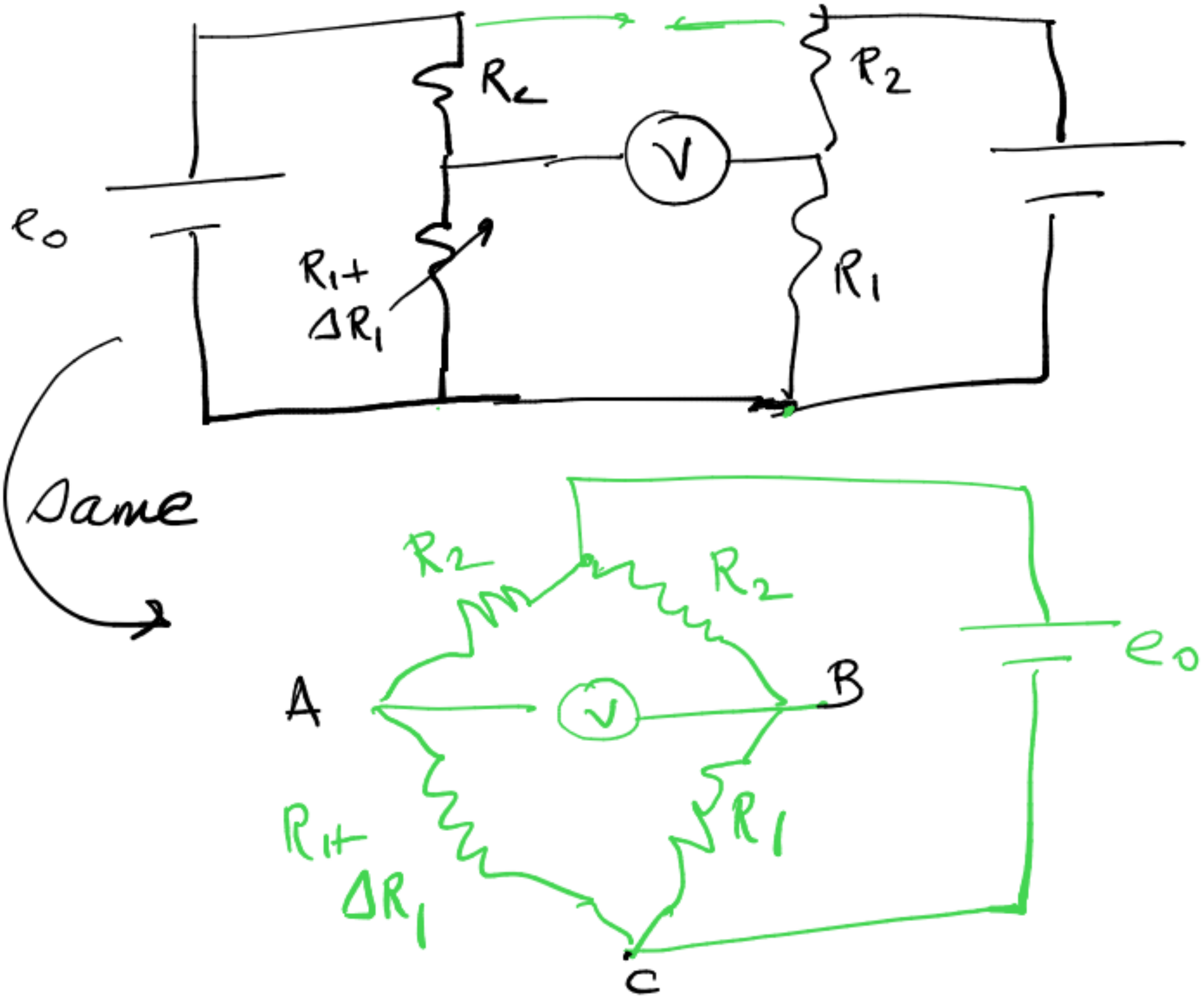
The wheatstone bridge is simply 2 potentiometric circuits arranged so that they cancel each other's base voltage

Wheatstone bridge :





When $\Delta R_1 = 0$, Ⓥ will read $\Delta e = 0$ (null measurement).



$$V_{AC} = \frac{R_1 + \Delta R_1}{R_1 + \Delta R_1 + R_2}$$

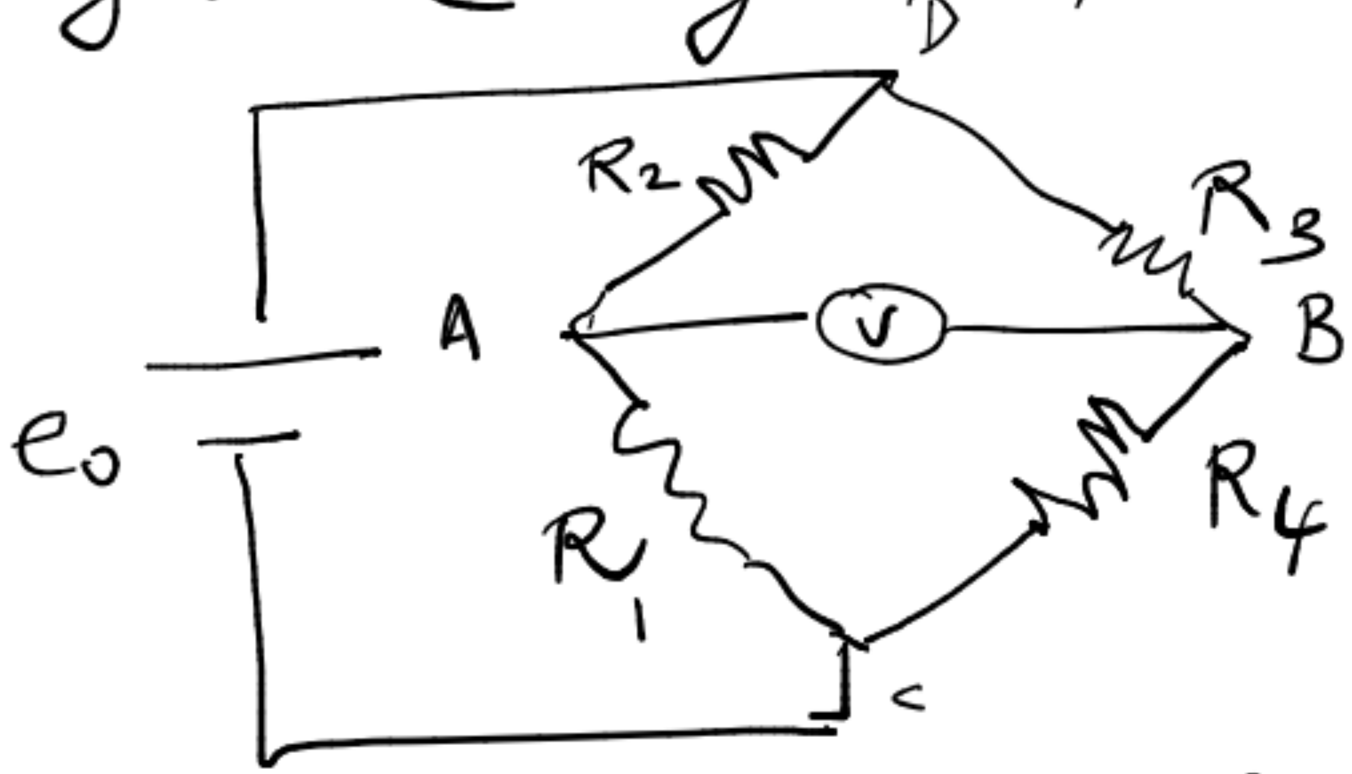
... voltage divider formula

$$V_{BC} = \frac{R_1}{R_2 + R_1}$$

when $\Delta R_1 = 0$ (no strain)

$V_A = V_B \Rightarrow$ (V) will read zero.

A balanced Wheatstone bridge is one where (V) leads zero @ zero strain.



In a balanced W.B.

$$\frac{R_1}{R_1 + R_2} = \frac{R_4}{R_3 + R_4}$$ || Voltage divider from A to C

Or: $$\frac{R_2}{R_1 + R_2} = \frac{R_3}{R_3 + R_4}$$ || V.D formula from A to D.

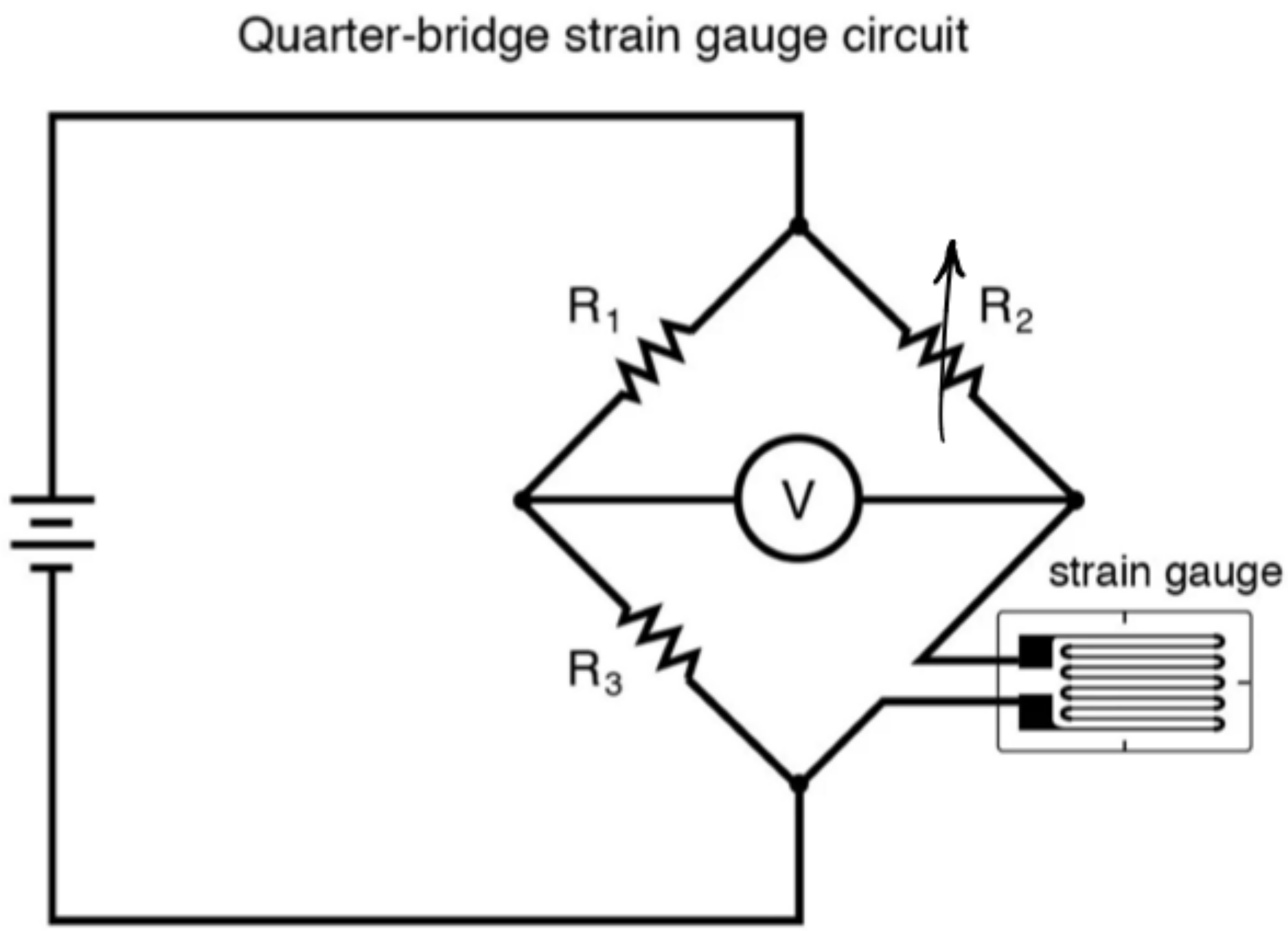
Multiply:

$$\boxed{\frac{R_1 R_2}{(R_1 + R_2)^2} = \frac{R_3 R_4}{(R_3 + R_4)^2}}$$ (A)

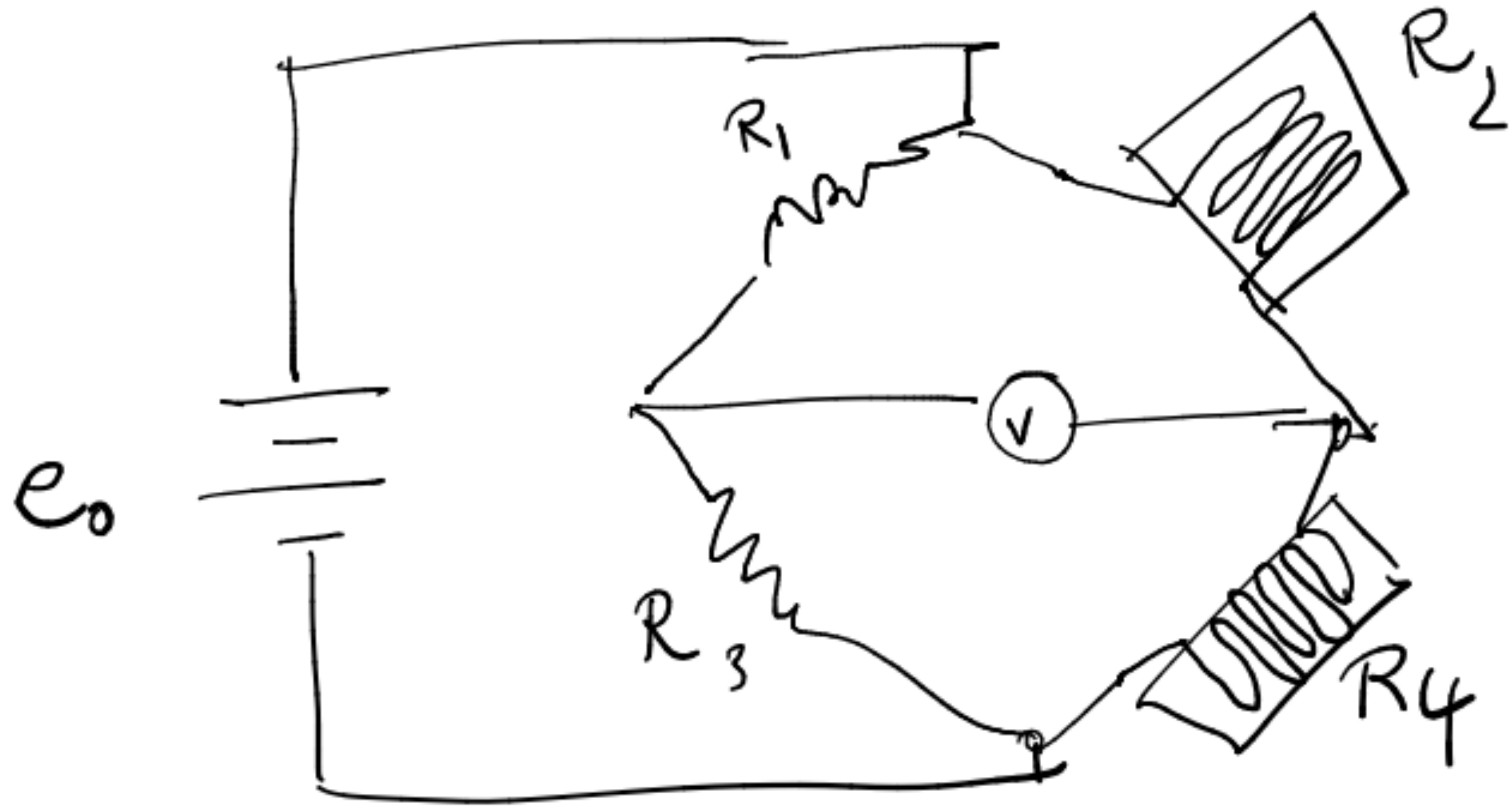
W.B can be used in one of 3 ways for strain measurement.

- Quarter bridge — 1 strain guage.
- Half bridge — 2 strain guages.
- Full bridge — 4 Strain guages

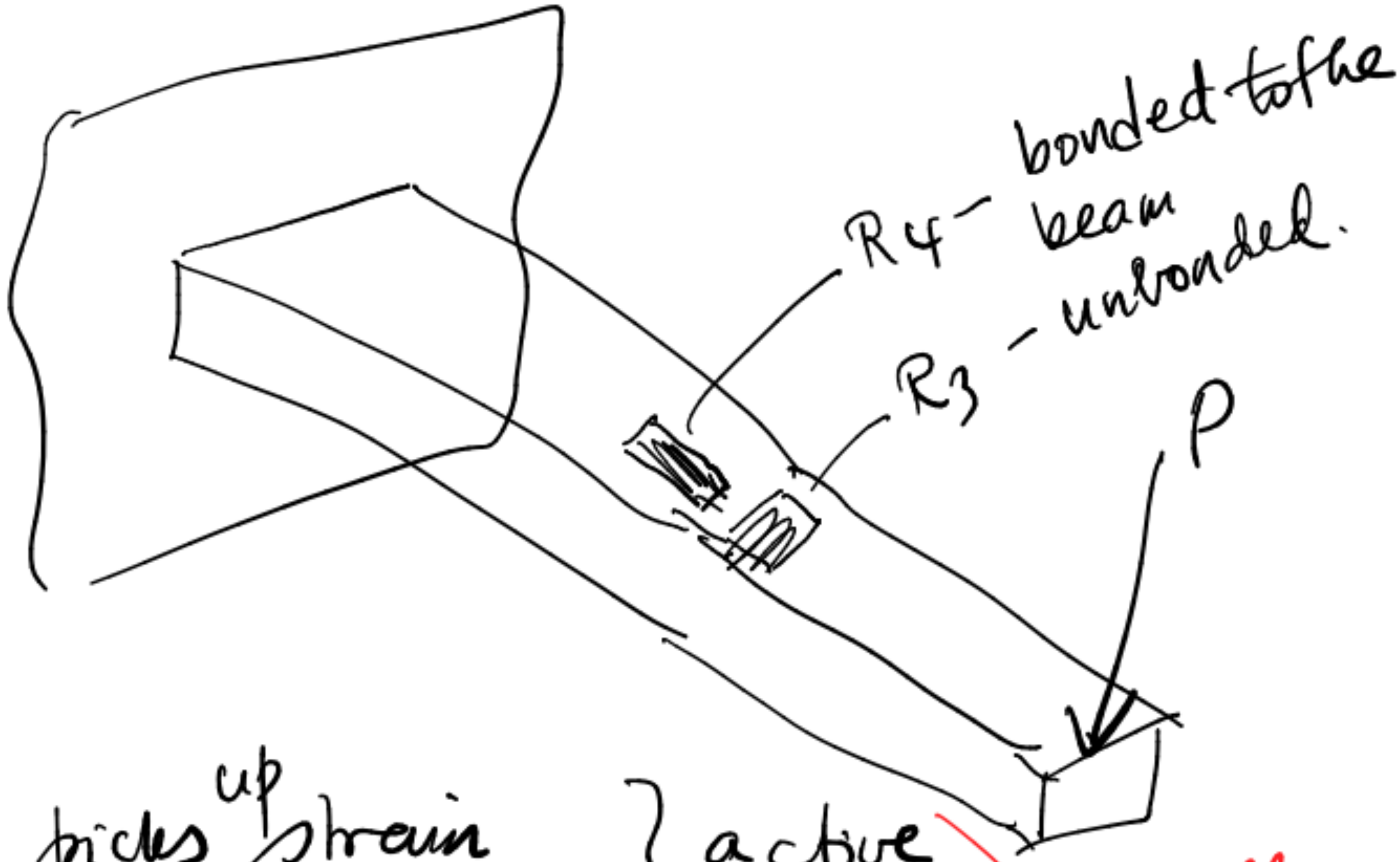
Quarter bridge :



$R_4 + \Delta R_4$.



R_2, R_4 are strain guages.
R_1, R_3 are regular resistors.
If R_2, R_4 strain guages are identical, R_1, R_3 should be selected equal. for bridge balance.



R_4 - picks up strain from the beam } active guage

R_2 - does not pick up strain from the beam } passive guage

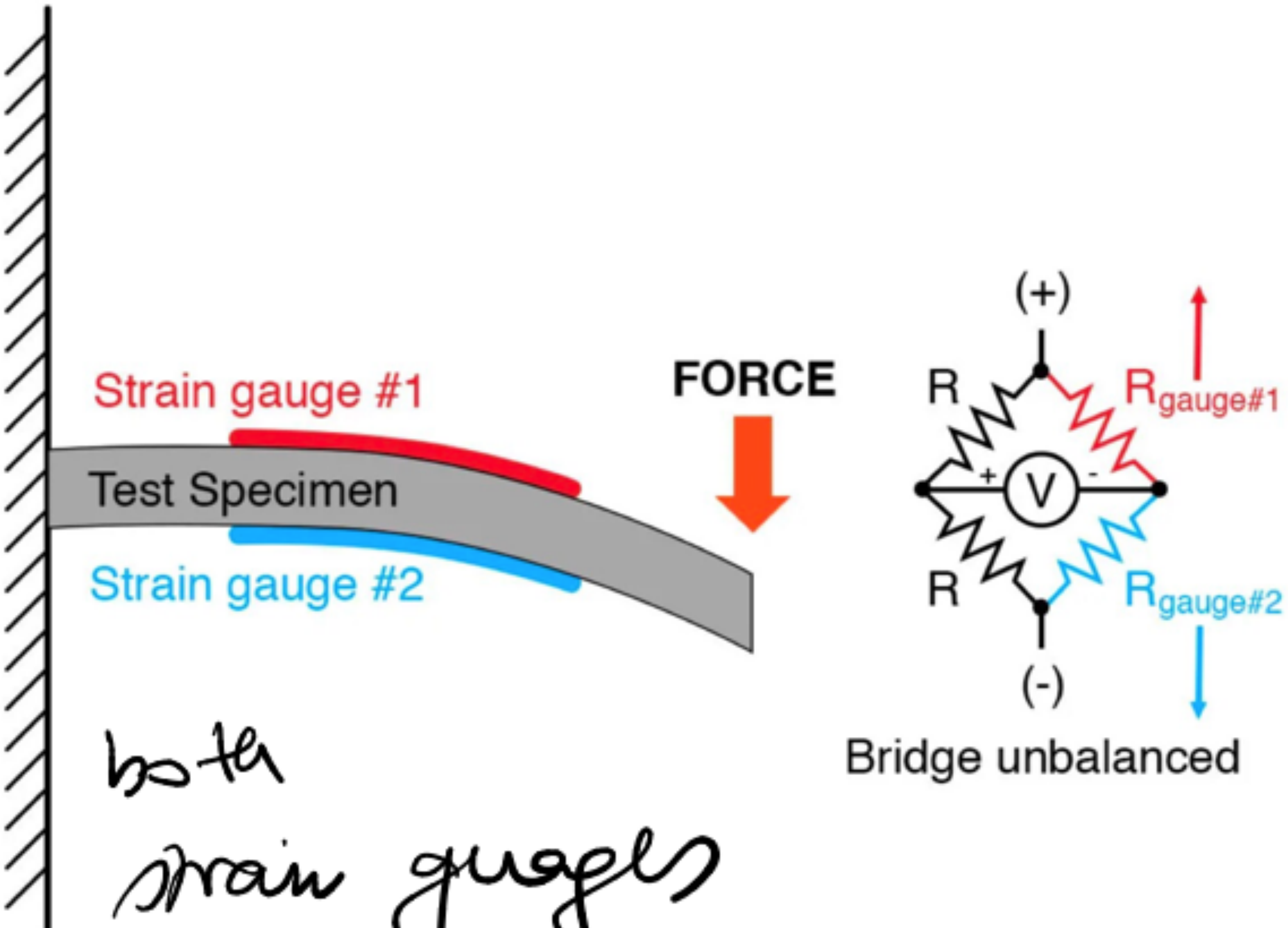
} equally affected by temperature.

⇒ Any change in R_2, R_4 due to temperature variation will be equal

⇒ Bridge remains balanced under temperature changes.

The half-bridge configuration auto-corrects for temperature even when the strain guages are not auto-correcting.

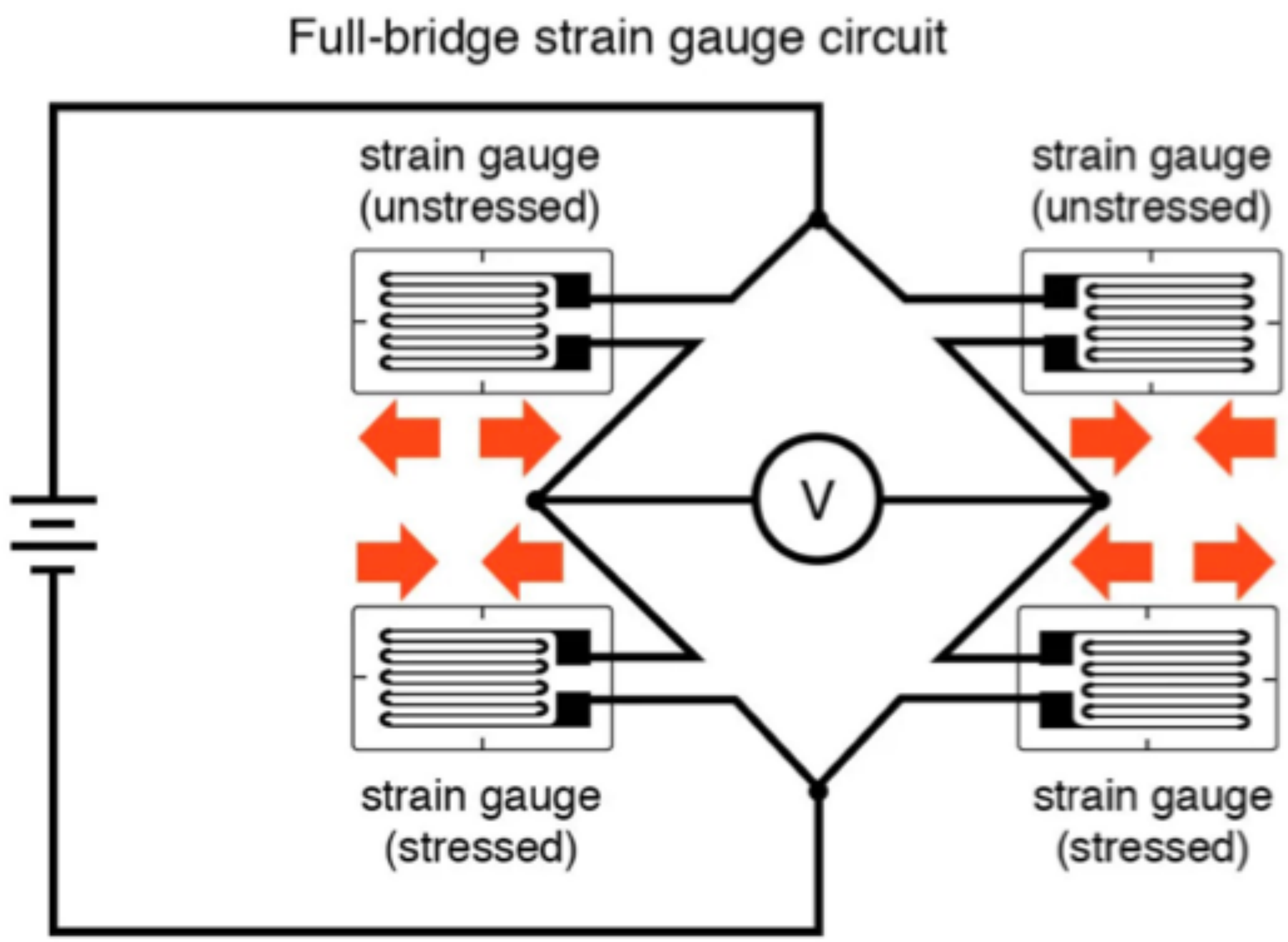
Another ½ bridge configuration:

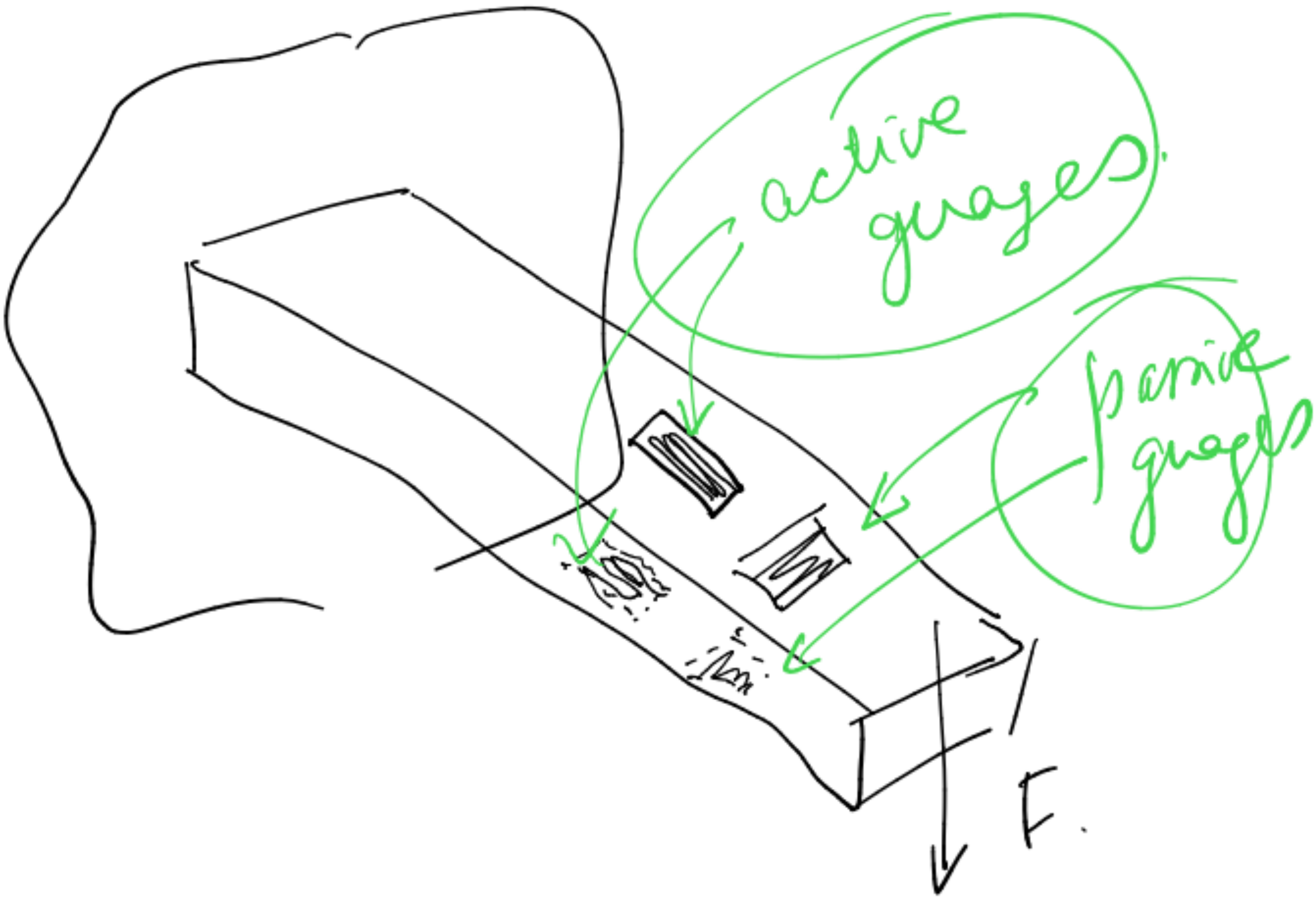


both strain guages are bonded — they are both active.

We will derive the relation between (V) reading & ΔR_1, ΔR_2 later.

Full-bridge Configuration:





Next time:

Deive a relation between Ⓥ meter reading & changes in the strain guage resistances.