Current Amps (A) → $I = \frac{\Delta Q}{\Delta t}$ ← Charge (c), ← Time (s)

Current = rate of flow of charge

-electrons in a wire
-electrons in beam
-ions (beam/solution)

NB: Δ = small change in

$N = \frac{I}{q} = \frac{\text{charge/sec}}{q}$

↑ No. of ions/ sec

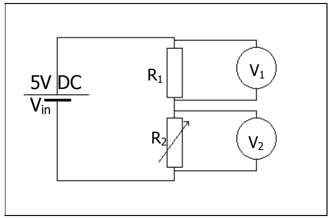
$E = ItV$

$E = I^2RT$

EMF: Electromotive force (E)

Chapter 2 Sensing

Potential Divider Circuits



If $R_1 = R_2$ then V_1 reads 2.5V, V_2 reads 2.5V

As R_2 increases then V_2 increases & V_1 decreases

$V_1 + V_2 \equiv 5V$

$\frac{R_1}{R_2} = \frac{V_1}{V_2}$

$\frac{V_2}{V_{in}} = \frac{R_2}{R_1 + R_2}$

$E = \frac{V^2}{R} \times t$

Power (P) - Energy transferred per unit of time.

J/s - watt

Any System → $P = \frac{\Delta E}{\Delta t}$

For electricity → $P = IV$ … $P = I^2R$ or… $P = \frac{V^2}{R}$

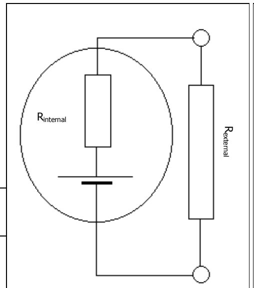
Making good sensors

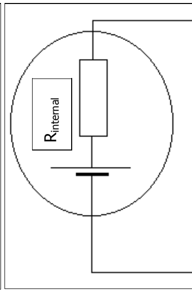
- High **resolution** -the smallest change the sensor can detect. Precision of a sensor depends upon resolution.
- Appropriate output for a given input (**Sensitivity**) -ratio of change of output to change of input. (Eg Oscilloscope mm/volt)
- Rapid **response time** –time taken to respond to a change in input.
- Small unsystematic fluctuations (random error) in results (Noise, random error, fluctuations) -present in all experiments, the size limits the precision of measurements. Averages improve the final results.
- Small **systematic error** –very hard to detect, include zero error and error due to disturbing influences. 'Smart' systems process information to compensate for disturbing influences.

Potential Difference - difference in energy per coulomb between two places in a circuit

$V = \frac{\Delta E}{\Delta Q}$ ← Energy transferred (J), ← Energy flowing (c)

P.d. J/c or Volts (V)





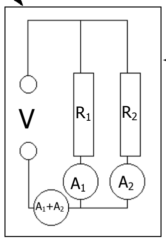
Output EMF (E)

No. of charge carriers, Drift, Area (m^3), Charge → $I = nAvq$

$V = IR$

$R = \frac{V}{I}$

$G = \frac{I}{V}$

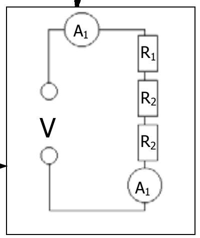


$G = G_1 + G_2 + G_3 \ldots$

$R = \frac{1}{G}$

$R = R_1 + R_2 + R_3 \ldots$

$G = \frac{1}{R}$



Source: High resistance

$R_{internal} \approx \infty$

$I \approx 0$

Output

$V = I \times R_{external} \approx 0$

Source : Some resistance

$I = \frac{E}{R_{external} + R_{internal}}$

Output

$V = I \times R_{external}$

$= E - I \times R_{internal}$

Source: Low resistance

$R_{internal} \approx 0$

$I = \frac{E}{R_{external} + R_{internal}}$

Output

$V = I \times R_{external} \approx E$

Ohm's Law –resistance and conductance

- The conductance or resistance can be calculated at any given p.d.
- If the conductance or resistance are constant, independent of the current or p.d., the conductor is said to obey Ohm's law, or to be 'ohmic'.
- Ohm's law thus says that the conductance, and resistance, of a given component is constant. The same value can be used in calculations what ever the current or p.d.
- Most metals are ohmic at constant temp.; ionised gases are not.

See also Chapter 4