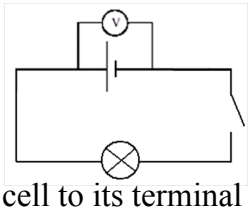
Internal Resistance of Cells

Electromotive force (emf): total energy per unit charge supplied around a circuit by the cell

Terminal Voltage (V_{term}): potential difference across the terminals of the cell

1. Compare the terminal voltage of the cell when the switch is open to the terminal voltage when it is closed.



2. Compare the emf of the cell to its terminal voltage when the switch is:

   a) open b) closed

3. Explain these observations.

Internal resistance (r): the resistance supplied by the materials within the cell

think of a cell as . . . a perfect emf and a small resistor

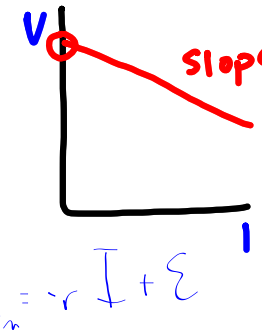
Mathematical model:

$\varepsilon = I R_T$

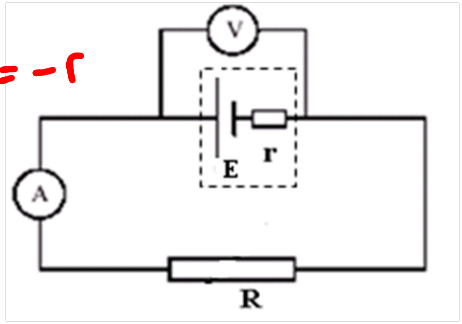
$\varepsilon = I (R + r)$

$\varepsilon = IR + Ir$

V_{TERM}



$V_{TERM} = -rI + \varepsilon$



4. Use the math model to make some inferences about the behavior of a circuit containing a cell with internal resistance.

a) Emf = V_{term} . . . when no current is flowing (when R is infinite or open circuit) or if it is an ideal cell (r = 0)

b) When R>>r . . . emf = IR + Ir emf ≈ IR emf ≈ Vterm

c) When R = 0 . . . emf = Ir I = emf/r I = I_{max}

5. A resistor is connected to a 12 V source and a switch. With the switch open, a voltmeter reads the potential difference across the battery as 12 V yet with the switch closed, the voltmeter reads only 9.6 V and an ammeter reads 0.40 A for the current through the resistor. Calculate the internal resistance of the source and the maximum possible current.

6. A resistor R and a filament lamp L are connected in series with a battery. The battery has an emf of 12 V and internal resistance 4.0 Ω. The potential difference across the filament of the lamp is 3.0 V and the current in the filament is 0.20 A. Determine the resistance R.

Resistance: ratio of potential difference applied across a piece of material to the current through the material

Ohm's Law: for a conductor at constant temperature, the current flowing through it is proportional to the potential difference across it over a wide range of potential differences
Relationship:

Georg Simon Ohm
(1787 – 1854)