Name: ______________________________ Phys 12

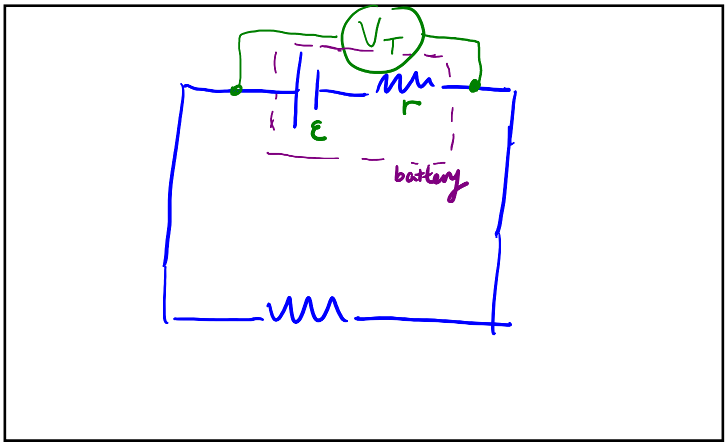
7.3 A battery's EMF and internal resistance

Your electrical power source can generate a potential difference called the electromotive force (EMF). Be careful, this is not actually a force, it's a potential difference.

What happens to your battery over time? Why?

From a chemical perspective, your positive terminal (cathode) acquires too many electrons that it can no longer accept electrons. This is when the battery dies. The voltage **(terminal voltage)** across your battery decreases over time because of chemical deposits inside your battery on one of the electrodes. For details, you can look into galvanic cells. If you're learning oxidation/reduction in chemistry 12, you'll know what we're talking about!

From the physics perspective, we model the battery containing an internal resistor that increases until the potential difference drop inside the battery is the same as battery's EMF itself. This internal resistance increases due to increased chemical deposits over time/usage of battery.



$V_T = \varepsilon - Ir$

V_T = terminal voltage (V)
ε = electromotive force (V)
I = current through battery (A)
r = battery's internal resistor (Ω)

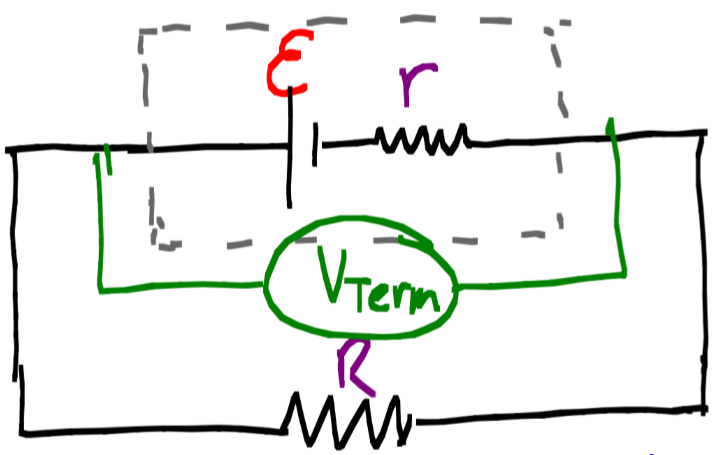
To recharge your battery, you need to change the direction of your current, so:

$V_T = \varepsilon + Ir$

Ex. 1: Calculate the following if the EMF of the battery is 9.0V and the internal resistance is 0.220Ω:

a) The current through the battery if the terminal voltage is 8.8V. (ANS: 0.91A)

b) The current if R = 5.5Ω. (ANS: 1.6A)



a) $V_T = \varepsilon - Ir$

$I = \dfrac{\varepsilon - V_T}{r}$

$= \dfrac{9.0V - 8.8V}{0.220\Omega}$

$= \boxed{0.91 A}$

b) $V_T = IR = \varepsilon - Ir$

$\varepsilon = IR + Ir$

$\varepsilon = I(R+r)$

$I = \dfrac{\varepsilon}{R+r} = \dfrac{9.0V}{0.220 + 5.5}$

$= \boxed{1.6 A}$

HW: Worksheet 7.3 ALL