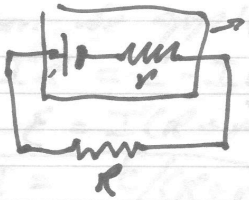
Electromotive Force

→ battery sets up voltage on circuit

→ current constant in magnitude & direction
'DC', direct current

→ battery is source of 'emf'
- maximum possible voltage battery can provide between its terminals

→ batteries generally have some internal resistance, r



→ battery

→ if r=0, terminal voltage = $\mathcal{E}$ (emf)

→ in reality
$r>0$, $\mathcal{E} \neq V_{term}$

"lose voltage" by amount Ir when goes thru r
→ lower potential after r

$\Delta V = \mathcal{E} - Ir$
↳ terminal voltage
$\mathcal{E}$ → open circuit voltage

R is 'load resistance'
→ can be appliance

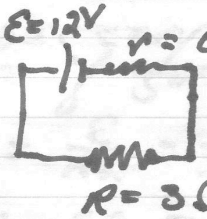
$\Delta V = IR = \mathcal{E} - Ir$

$\mathcal{E} = I(R+r)$

$$\boxed{I = \mathcal{E}/(R+r)}$$

if $R \gg r$, ignore r

Ex. 28.1



a) current in circuit? ΔV of battery?

$$I = \frac{\varepsilon}{R+r} = \frac{12V}{3.05\Omega} = \boxed{3.93A}$$

$$\Delta V = \varepsilon - Ir = 12V - (3.93A)(0.05\Omega)$$
$$= \underline{11.8V}$$

or $\Delta V = IR = (3.93A)(3\Omega)$
$= \underline{11.8V}$

b) power delivered to load resistor, R

$$P = I^2R = (3.93A)^2(3\Omega)$$
$$= \underline{46.3W}$$

c) as battery ages, r ↑
→ what if gets to 2Ω

$$I = \frac{\varepsilon}{R+r} = \frac{12V}{3\Omega+2\Omega} = \underline{2.4A}$$

$$\Delta V = \varepsilon - Ir = 12V - (2.4A)(2\Omega)$$
$$= \underline{7.2V} \quad (< \underline{11.8V} \text{ when new})$$

Ex 28.2

→ when is power to load resistance highest

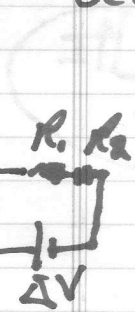
$$P = I^2R = \frac{\varepsilon^2 R}{(R+r)^2} \quad \left(\text{where } I = \frac{\varepsilon}{R+r}\right)$$

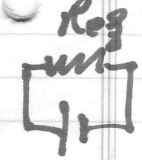
→ peaks when

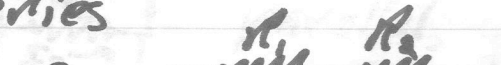
$$\boxed{r = R}$$

Series + Parallel circuits

→ series







$I_1 = I_2$

→ same charge passes thru both resistors

→ potential drop divided between resistors

$$\Delta V = IR_1 + IR_2$$

$$= I(R_1 + R_2) = IR_{eq}$$

$$R_{eq} = R_1 + R_2$$

In general,

$$R_{eq} = R_1 + R_2 + R_3 + \ldots$$

when in series