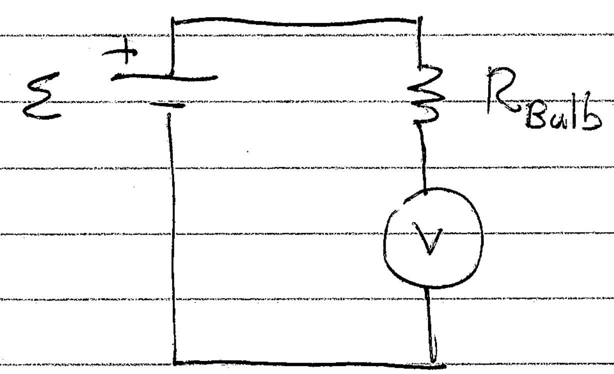
① Phys 2426 2017-07-20 Lec 11

Hooking up a voltmeter in series.

- A voltmeter blocks current.
- In series, $I_1 = I_2 = \ldots$



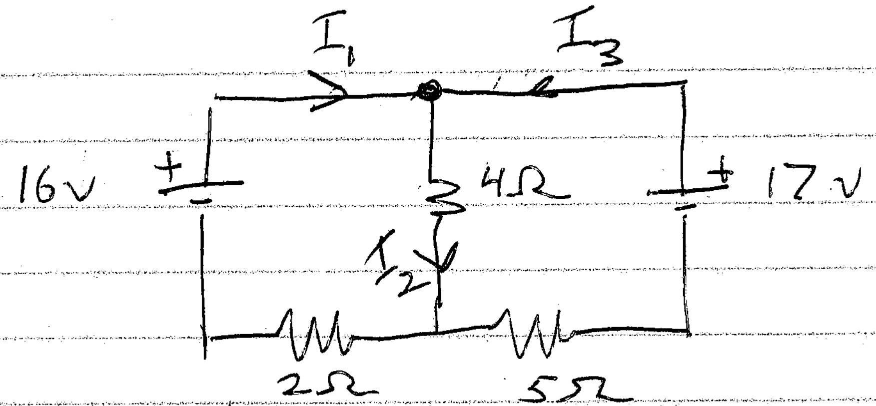
$$R_{eq} = R_B + R_V = \infty$$

$$I = 0$$

(Bulb is off.)

$$\mathcal{E} + \underbrace{\cancel{\Delta V_{Bulb}}}_{0} + \Delta V_{meter} = 0$$

(2)



Klunky schematic drawing.
Roger's Online Equation Editor

$$I_1 + I_3 = I_2$$

Left Loop: $+(16v) - 4I_2 - 2I_1 = 0$

Right Loop: $+(17) - 4I_2 - 5I_3 = 0$

$I_1 = 2A \leftarrow$ #23
$I_3 = 1A$
$I_2 = 3A$

#21 Subtract two loops, i.e. Outer Loop CW

#9: $R = \frac{\rho l}{A}$ Initially: All 1's

Final: $R = \frac{1\left(\frac{1}{2}\right)}{\left(\frac{1}{2}\right)^2} = 2$

(3)

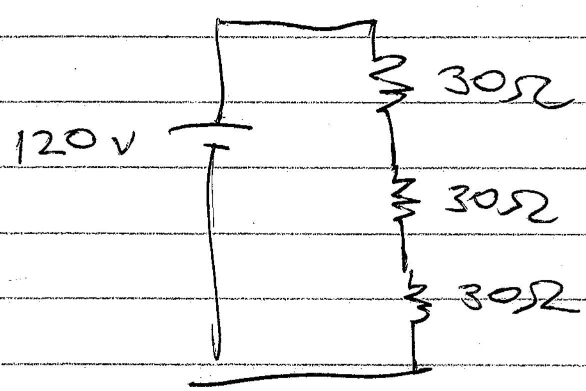
$$R_1 = \frac{\rho l_1}{\pi r_1^2} \qquad R_2 = \frac{\rho l_2}{\pi r_2^2}$$

$$0.4 = \frac{\rho l_1}{\pi r_1^2} \qquad R_2 = \frac{\rho \frac{1}{2} l_2}{\pi (r_1/2)^2}$$

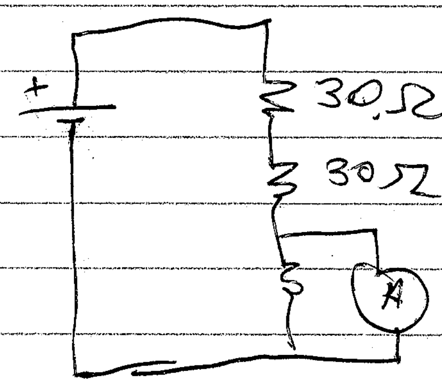
$$R_2 = \left(\frac{\rho l_2}{\pi r_1^2}\right) \frac{1/2}{(1/2)^2}$$

$$R_2 = (0.4)\left(\frac{4}{2}\right)$$
$$= 0.8$$

#16 Ammeter hooked up wrong.
- Ammeter allows free flow of current.



$$I = \frac{120V}{90\Omega} = 1.3A$$



$$I = \frac{120V}{60\Omega} = 2A$$

4

#10 Discharging

$$V = V_o e^{-t/\tau}$$

At 10% of initial, $V = 0.1 V_o$

$$0.1 = e^{-t/\tau}$$

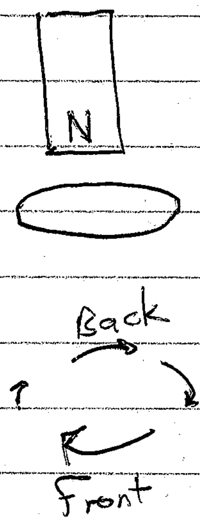
$$\ln(0.1) = -t/\tau$$

$$-\ln(0.1)\,\tau = t$$

$$-(-2.3)\tau = 2.3\tau = t$$

Lenz's Law

- Coils hate change.
- If there is magnetic flux, and we try to reduce the flux, the coil will try to boost the magnetic field to restore the flux.



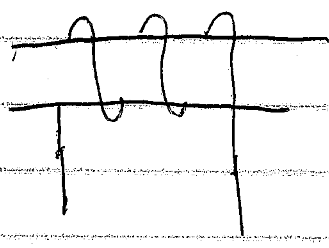
Drop the ring.
- Flux was downward.
- Field is decreasing.
- EMF tries to push I so B_{ind} is down.

Current in ring will be CW as viewed from top.

Ex: Magnetic braking.

Inductors

Recall the Solenoid



$B = \mu_0 N I / \ell$

$\Phi_B = NBA$

Total flux includes factor of N.

Total of all turns

$$\Phi_B = \left(\frac{\mu_0 N^2 A}{\ell}\right) I$$

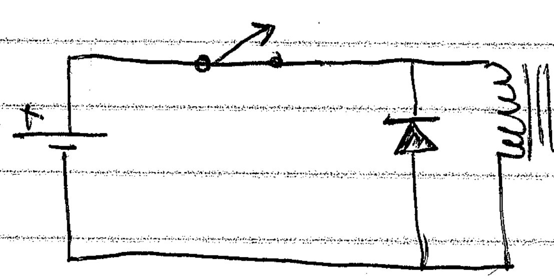
$$\Phi_B = L\, I$$

L = Inductance in henries

$$\mathcal{E} = -\frac{d\Phi_B}{dt} = -L\frac{dI}{dt}$$

Emf when current changes

Resistor $\Delta V = -IR$



$$\text{Energy} = \frac{1}{2} L I^2$$

$$\text{Cap Energy} = \frac{1}{2} C V^2$$