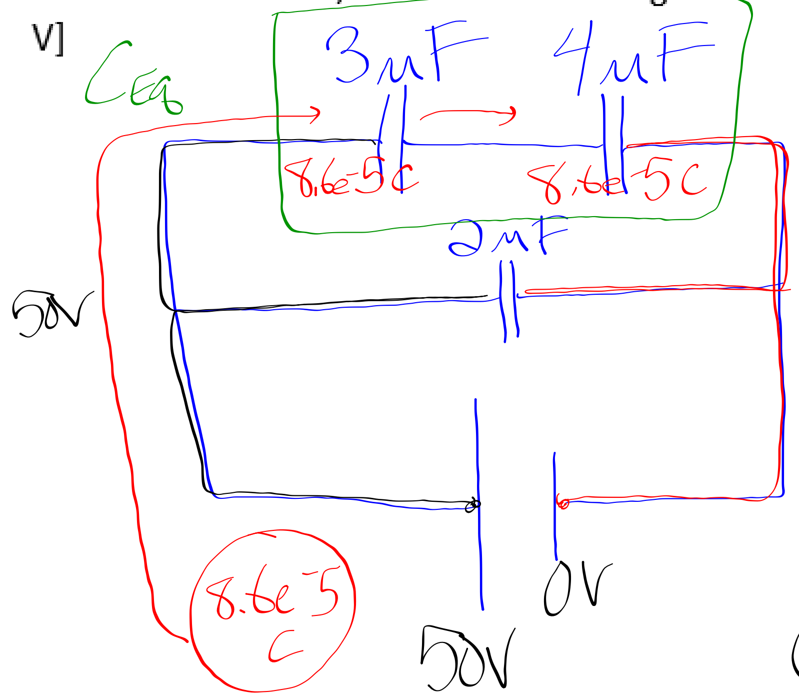
3. A 3.0 μF and a 4.0 μF capacitor are connected in series to a 9.0V battery and this combination is connected in parallel to a 2.0 μF capacitor. (a) What is the net capacitance? (b) if 50V is applied across the whole network, calculate the voltage across each capacitor. [**(a)** 3.71 μF; **(b)** V_3 = 28.6 V, V_4 = 21.4 V]

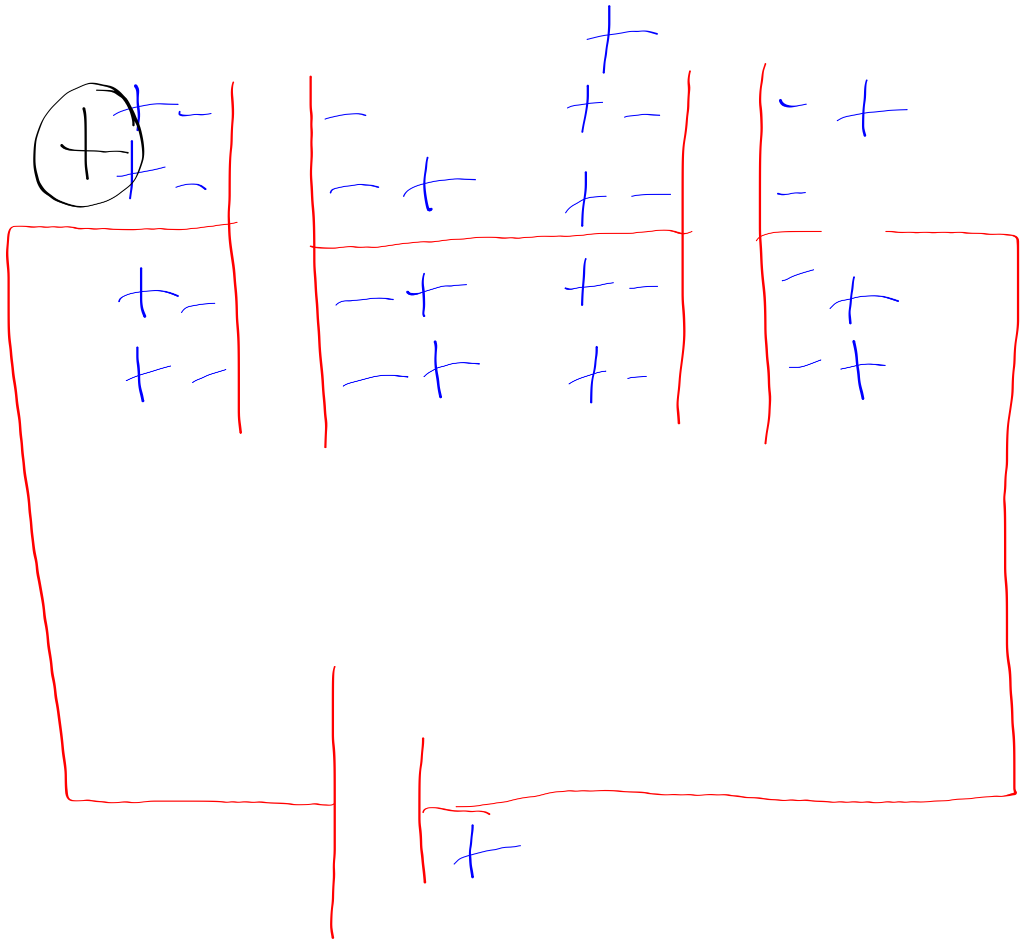


$$C_T = 2\mu F + \underbrace{\frac{1}{\frac{1}{3\mu F} + \frac{1}{4\mu F}}}$$

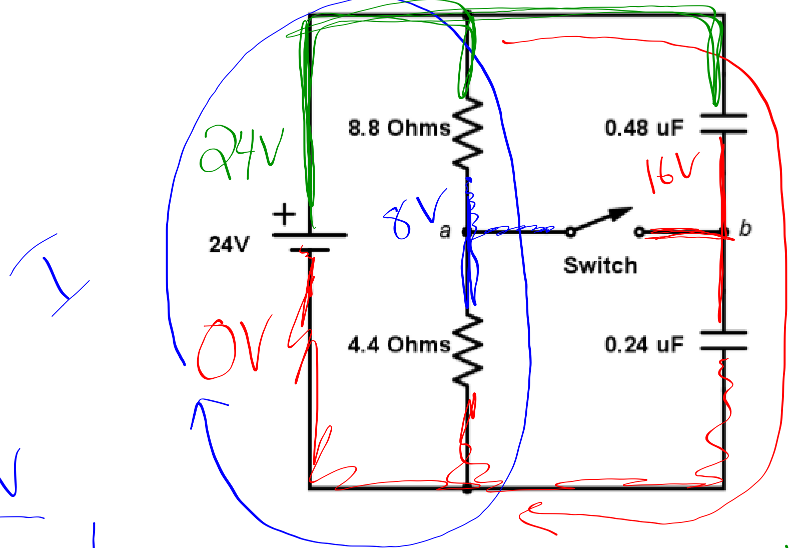
$$3.71\mu F = 2\mu F + \underbrace{\boxed{1.71\mu F}}_{= C_{eq}}$$

$$Q = CV$$
$$= (1.71)(50)$$
$$= 8.6e{-5}\ C$$

$$Q = CV$$
$$8.6e{-5}\ C = (3e{-6}\ F)V$$
$$\boxed{V_3 = 28.7}$$



4. Two resistors and two capacitors are arranged as in the circuit below. At its steady state (after the capacitors are fully charged), with a potential difference of 24V from the power source, (a) what is the potential at point *a* with the switch open? (b) What is the potential at point *b* with the switch open? (c) When the switch is closed, at the steady state of the circuit, what is the final potential of point *b*? (d) How much charge flows through the switch when it is closed? [**(a)** 8V; **(b)** 16V; **(c)** 8V; **(d)** -5.8 μC]



OPEN

$R_T = 8.8 + 4.4$
$= 13.2\,\Omega$

$I = 0$

$V = IR$
$24 = I(13.2)$
$I = 1.81\,A$

$V_{8.8} = (1.81)(8.8) = \boxed{16V}$

OPEN

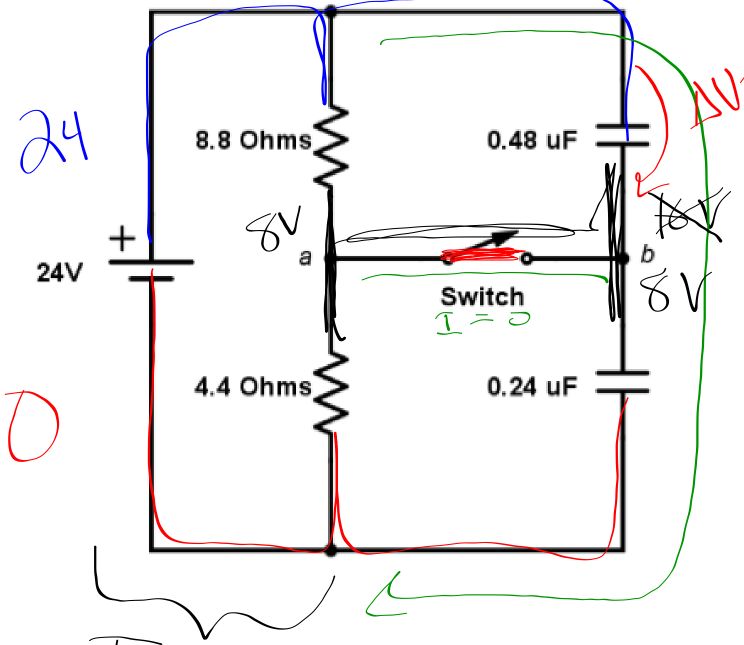
$$C_T = \frac{1}{\frac{1}{0.48e^{-6}} + \frac{1}{0.24e^{-6}}} = \underbrace{1.6e^{-7}\,C}_{Q_{TOT}}$$

$Q_{0.48} = C_{0.48} V_{0.48}$

$1.6e^{-7} = 0.48\,\mu F\,(V)$

$V = 8V$

4. Two resistors and two capacitors are arranged as in the circuit below. At its steady state (after the capacitors are fully charged), with a potential difference of 24V from the power source, (a) what is the potential at point *a* with the switch open? (b) What is the potential at point *b* with the switch open? (c) When the switch is closed, at the steady state of the circuit, what is the final potential of point *b*? (d) How much charge flows through the switch when it is closed? [**(a)** 8V; **(b)** 16V; **(c)** 8V; **(d)** -5.8 μC]



I = 1.81A

ΔV = 16V

CLOSED

I = 0

$Q_{0.48} = (0.48e{-6})16$

$Q_{0.48} = 7.7e{-6}\ C$

$Q_{0.24} = (0.24e{-6})(8)$

$Q_{0.24} = 1.92e{-6}\ C$

$\Delta Q_{0.48} = 7.54e{-6}\ C$

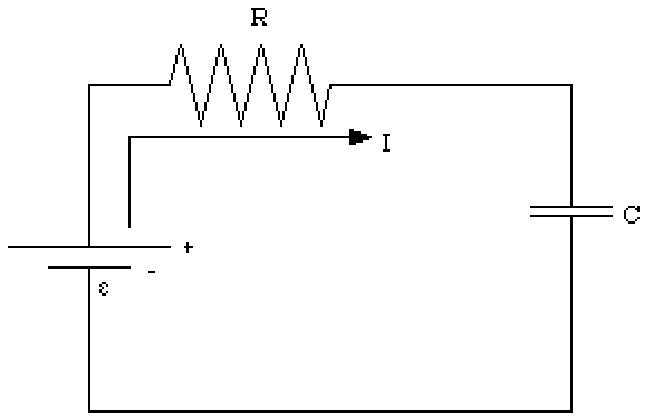
$\Delta Q_{0.24} = 1.76e{-6}\ C$

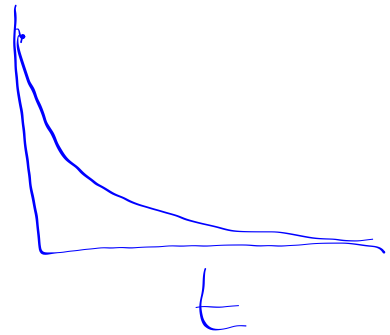
$\boxed{5.8e{-6}\ C}$

RC Circuits

- The rate at which capacitors charge and discharge can be calculated

- These curves are hyperbolic; they approach a limit (fully charged or fully discharged)

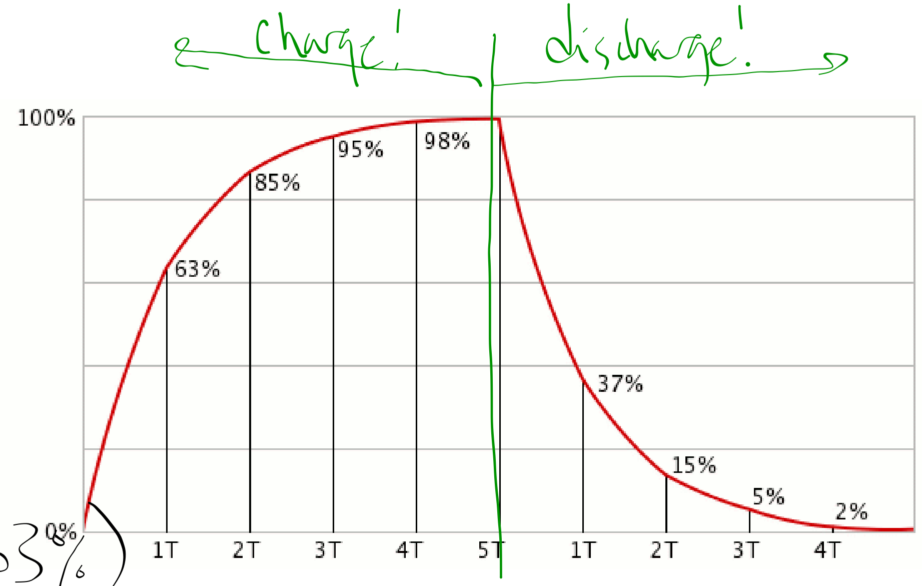




- The time constant of a circuit with capacitors and resistors (RC circuit) is:

$$\tau = \underbrace{R \cdot C}_{\text{second}}$$

(length of time to charge/discharge by 63%)



- It takes approximately 5 time constants to fully charge or fully discharge a capacitor

Cutoff Frequency:

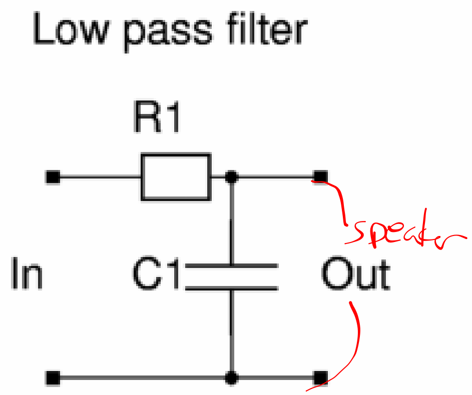
- RC circuits can act as filters for AC voltages

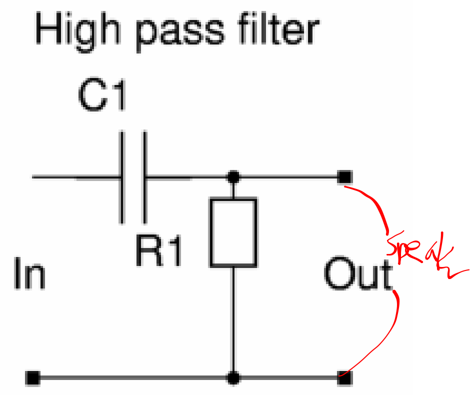
- The cutoff frequency is the AC rate (in Hz) at which the signal starts to be decreased

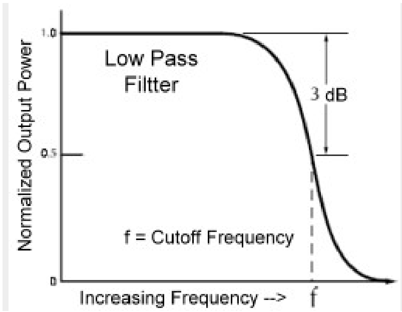
- Many signals (like audio signals) consist of complex AC waveforms

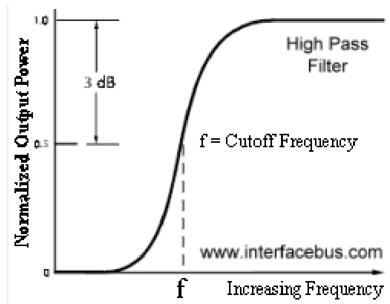
- The formula for determining cutoff frequency is dependent on the time constant of the RC circuit:

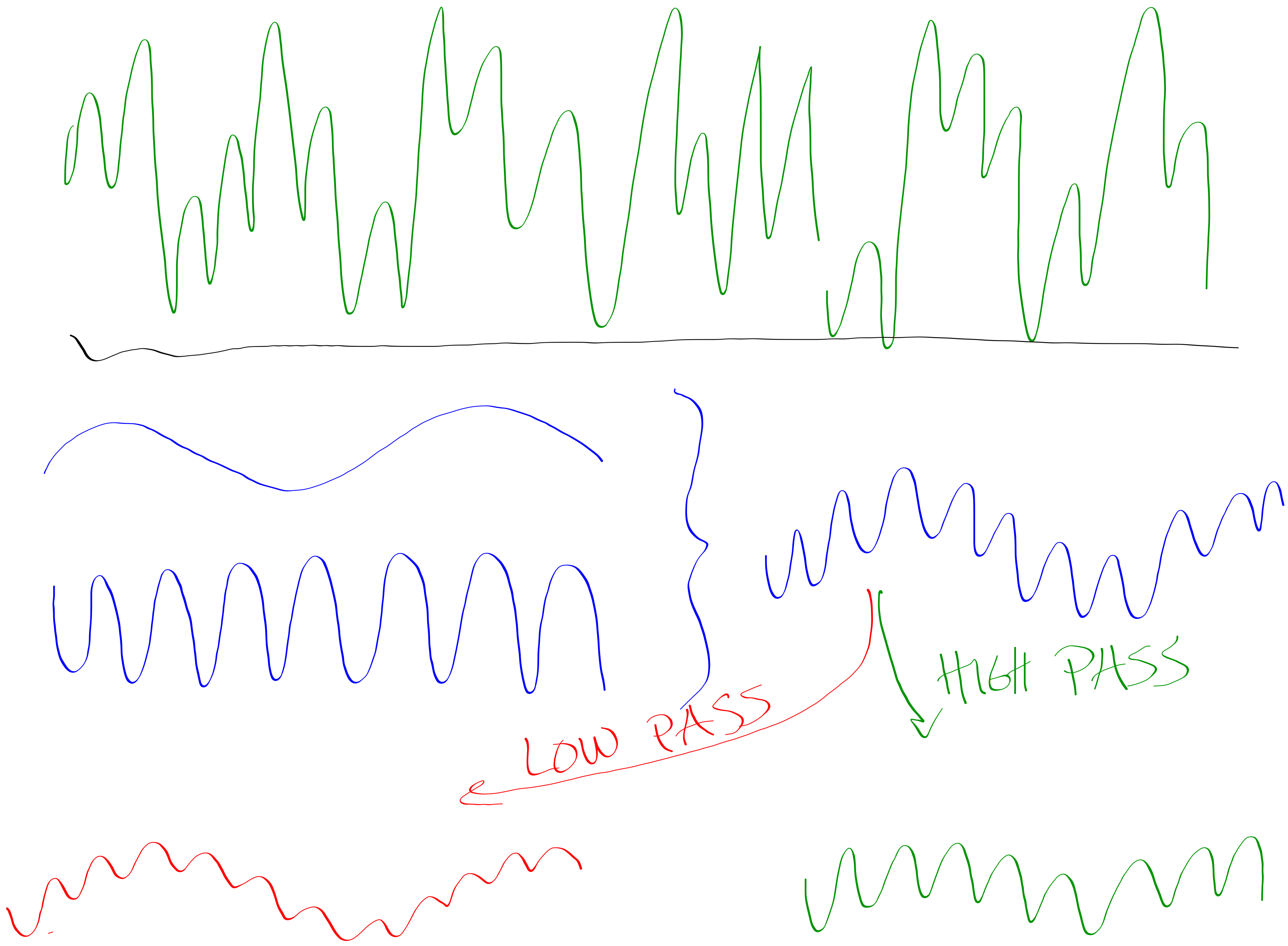
$$\text{cutoff} = \frac{1}{2\pi R \cdot C}$$










LOW PASS
HIGH PASS