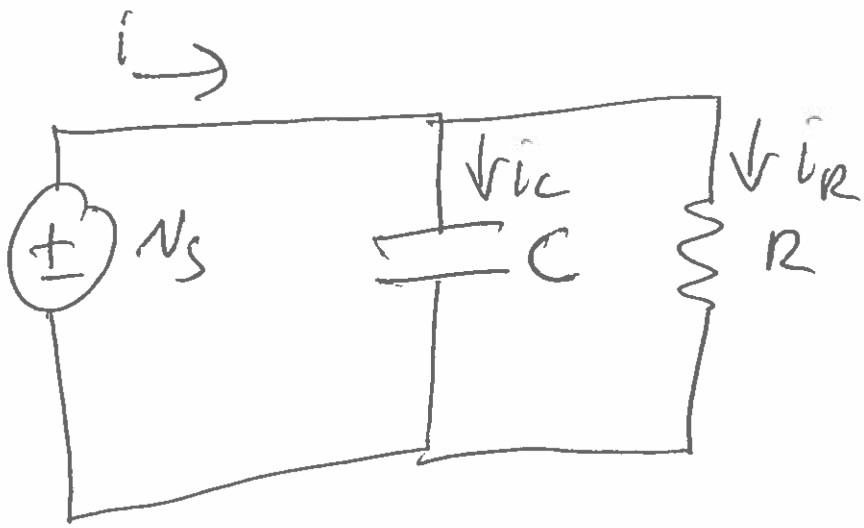
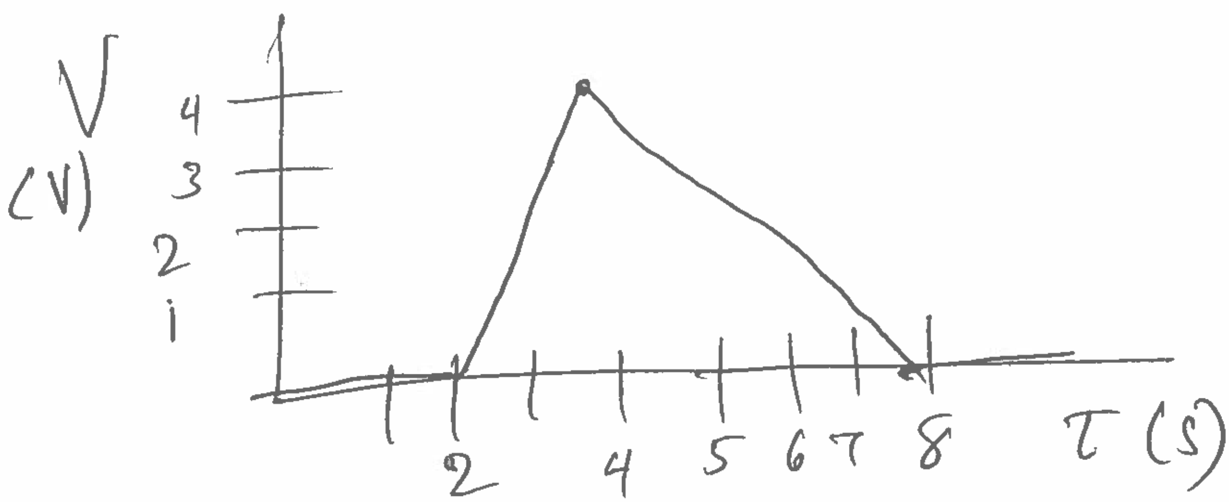


$$C = 1\,F \qquad R = 1\,\Omega$$

$$i = ? \quad \text{if} \quad V_s = \begin{cases} 0 & 0 \le t \le 2 \\ 2t-4 & 2 \le t \le 4s \\ 8-t & 4 \le t \le 8s \\ 0 & t \geq 8s \end{cases}$$



$$i = i_C + i_R$$

$$i_R = \frac{V_s}{R} = \begin{cases} 0 & 0 \le t \le 2S \\ 2t-4 & 2 \le t \le 4S \\ 8-t & 4 \le t \le 8S \\ 0 & t \geq 8S \end{cases}$$

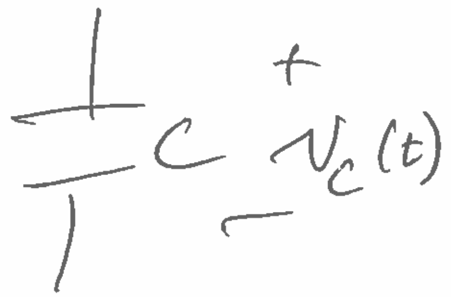
$$i_C = C\frac{dV}{dt} \quad C = 1F$$

$$i_C = \begin{cases} 0 = \frac{d0}{dt} = 0 \\ 2 = \frac{d}{dt}(2t-4) = 2 \\ -1 = \frac{d}{dt}(\cancel{8}-t) = -1 \\ 0 \end{cases}$$

$$i = i_C + i_R = \begin{cases} 0 & 0 \le t \le 2s \\ 2t-2 & 2 \le t \le 4\ s \\ 7-t & 4s \le t \le 8s \\ 0 & t \geq 8S \end{cases}$$

---

eg/



$$v_c(t) = 12\cos(2t + 30^\circ)\ V$$

$$C = 0.125\ F$$

$$i_c = ?$$

$$i_c = C\frac{dv}{dt} = (0.125\ F)\frac{dv}{dt}$$

$$\frac{dv}{dt} = \frac{d}{dt}\left(12\cos(2t + 30^\circ)\right)$$

$$= -12\sin(2t + 30^\circ)(2)$$

$$= -24\sin(2t + 30^\circ) \cancel{= -24\cos(2t + 120)}$$

$$\cancel{\sin\ \cancel{\cos}(A+B) = \cancel{\cos(A)\sin(B)}\ \sin(A)\cos(B) + \sin(B)\cos(A)}$$

$$\cancel{\sin(120) = \cos(60^\circ)}$$

$$\frac{dV}{dt} = -24 \sin(2t + 30^\circ)$$

~~$\sin(2t + 30 + 90$~~

$$i = (.125\,F)(24) \cos(2t + 120^\circ)$$

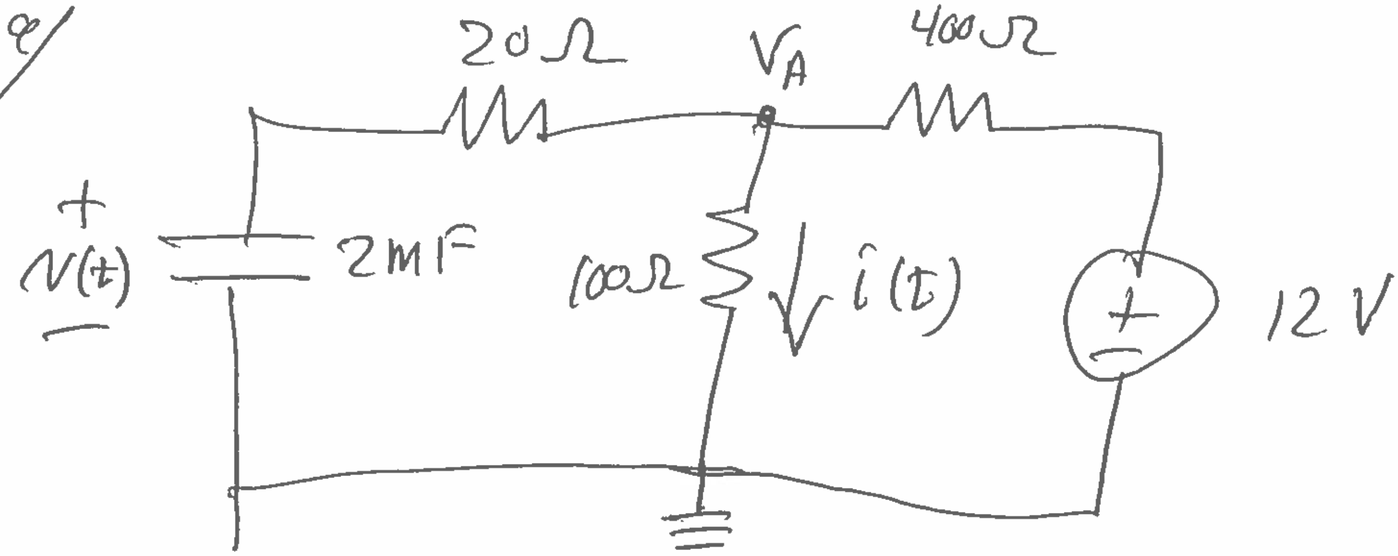
$$\cos(2t + 120^\circ) = -\sin(2t + 30)$$

$$i = 3 \cos(2t + 120^\circ)$$

$$V = 12 \cos(2t + 30^\circ)$$

i is 90° ahead of V

eg/



$$v(t) = 2.4 + 5.6e^{-5t} \text{ V}$$

for $t \geq 0$

$i(t) = ?$

$$i(t) = \frac{V_A}{100\Omega}$$

$$0 = V_a\left(\frac{1}{100\Omega} + \frac{1}{20\Omega} + \frac{1}{400\Omega}\right) - 12V\left(\frac{1}{400\Omega}\right)$$

$$- v(t)\left(\frac{1}{20\Omega}\right)$$

$$0 = V_a\left(\frac{4+20+1}{400\Omega}\right) - \frac{12V}{400\Omega} - \frac{v(t)\,20}{400\Omega}$$

$$0 = 25V_A - 12V - 20\,v(t)$$

$$V_A = \frac{12V + 20(2.4 + 5.6e^{-5t})}{25}$$

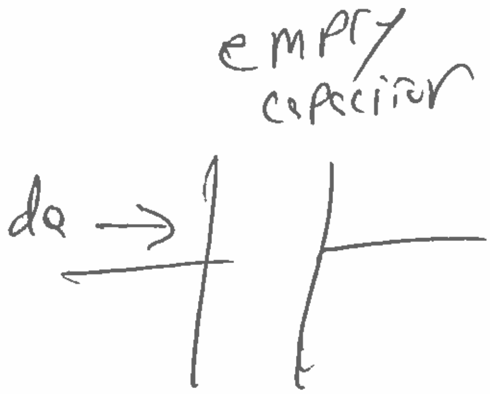
$$V_A = \frac{60V + 112e^{-5t}}{25}$$

$$i(t) = \frac{60V + 112Ve^{-5t}}{2500\,\Omega}$$

$$i(t) = 24 + 44.8e^{-5t}\ \text{mA}$$

Energy Storage in a Capacitor

$$W_C = ?$$



Work to put first dQ on plates?

$$W_{\substack{\text{first} \\ dQ}} = 0$$

once on plates $dQ \Rightarrow dV$

next dQ must overcome dV to be on plates

$$W = \int \vec{F} \cdot d\vec{s}$$

$$dF = dQ\,E$$

$$\text{Energy} = \int \text{Power}\, dt$$

$$= \int i\, v\, dt$$

$$= \int \frac{dQ}{dt} v\, dt$$

$$= \int v\, dQ$$

$$= \int \frac{Q}{C} dQ = \frac{1}{C} \int Q\, dQ$$

$$W = \frac{1}{C} \frac{1}{2} Q^2 = \frac{Q^2}{2C}$$

Using $Q = CV$

$$W = \frac{1}{2} C V^2 = \frac{1}{2} Q V = \frac{1}{2C} Q^2$$

Energy stored in capacitor

$$W = \frac{1}{2} C V^2 \qquad V = \underbrace{E}_{\text{electric field}}\,\underbrace{d}_{\text{plate separ.}}$$

$$W = \frac{1}{2} C \left(E^2 d^2\right)$$

$$C_{\text{Parallel plate}} = \frac{\varepsilon_0 A}{d}$$

$$W = \frac{1}{2} \frac{\varepsilon_0 A}{d} E^2 d^2 = \frac{1}{2} \varepsilon_0 \underbrace{(Ad)}_{\text{volume}} E^2$$

$$\frac{W}{Vol} = U_E = \frac{1}{2} \varepsilon_0 E^2$$

$$U_B = \frac{1}{2\mu_0} B^2$$

Light Intensity $\propto E^2$

If light is incoherent ~~$I_{TOT} = I_1$~~

$$E_{TOT}^2 = E_1^2 + E_2^2$$

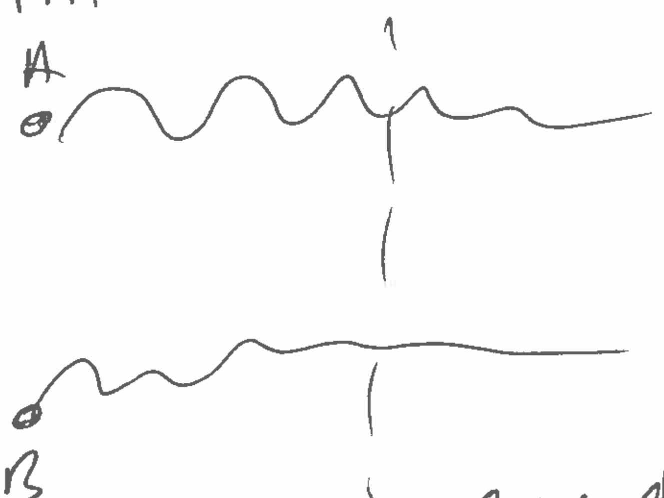
If light is coherent

$$E_{TOT}^2 = (E_1 + E_2)^2$$

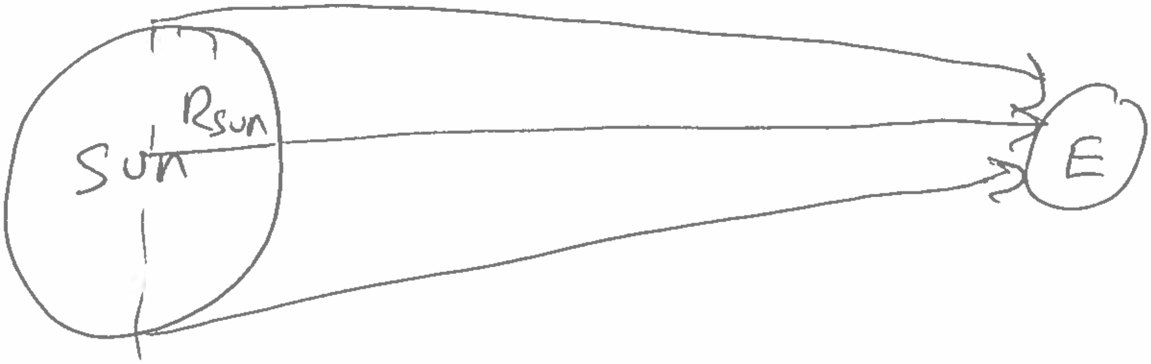
$$= E_1^2 + E_2^2 + \underbrace{2E_1E_2\cos\phi}_{\text{is source of interference fringes}}$$

Coherent light is in phase both spatially and temporaly

Spatial Phase



Travel same distance
They are in phase

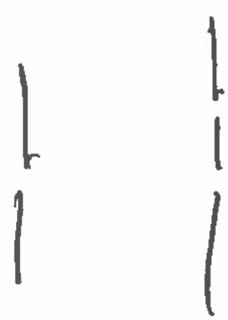


$R_{sun} \sim 10^8 m$

Light from edge of sun hitting Earth same time as light from center traveled $\sim 10^8 m$ more

So it is 1-3 seconds older then light from center $\Rightarrow$ not in phase because of time difference.

Young Double Slit



Single