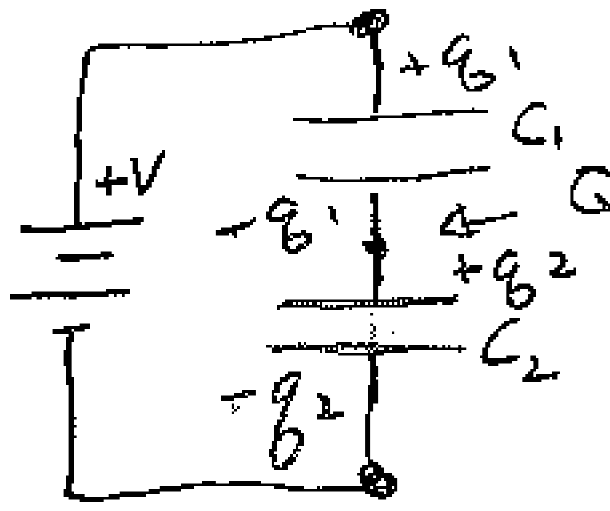
non-zero q on series caps

suppose



Q_{tot} here $= (q_2 - q_1)$

know $V = \frac{q'}{C_1} + \frac{q^2}{C_2}$

$$Q_{tot} = q_2 - q_1$$

$$Q_{tot} + q_1 = q_2$$

$$V = \frac{q'}{C_1} + \frac{(Q_{tot} + q_1)}{C_2}$$

$$\left(V - \frac{Q_{tot}}{C_2}\right) = \frac{q'}{C_1} + \frac{q'}{C_2} = q'\left(\frac{C_2 + C_1}{C_2 C_1}\right)$$

$$\frac{C_2 C_1}{C_1 + C_2}\left(V - \frac{Q_{tot}}{C_2}\right) = q'$$

if $Q_{tot} = 0$ (get back C_{eq})

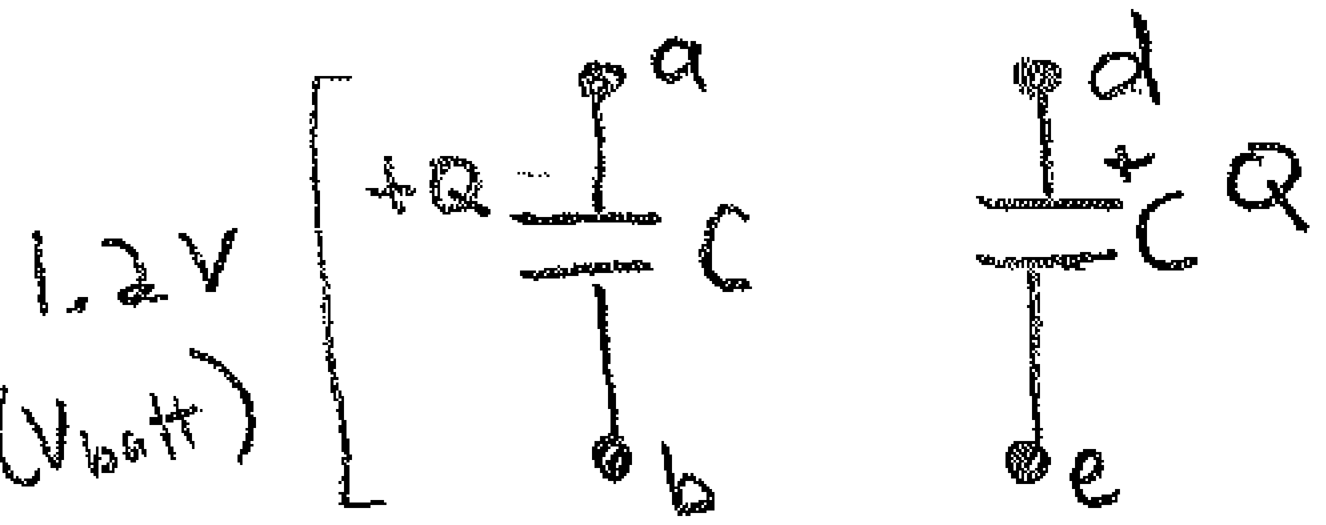
if not .. now $V_1 = q'/C_1 = \frac{C_2}{C_1 + C_2}\left(V - \frac{Q_{tot}}{C_2}\right)$

$$V_2 = q^2/C_2 = \frac{1}{C_2}\left(Q_{tot} + \frac{C_2 C_1}{C_1 + C_2}\left(V - \frac{Q_{tot}}{C_2}\right)\right)$$

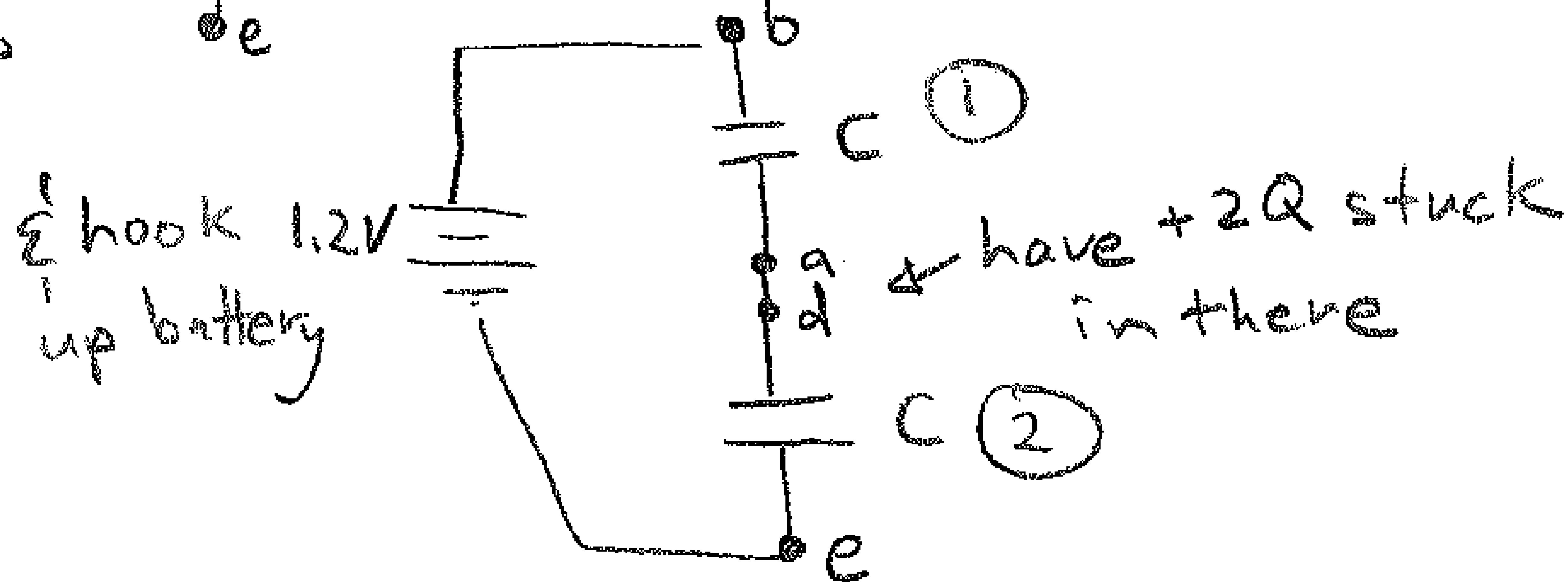
$$= \frac{Q_{tot}}{C_2} + \left(\frac{C_1}{C_1 + C_2} V\right) - \frac{C_1}{C_1 + C_2}\left(\frac{Q_{tot}}{C_2}\right)$$

if $Q_{tot} < 0$, easy to get more ΔV across C_1 than you expect (& hence less across C_2)

Take the example from class. Consider 2 equal capacitors, both charged up to 1.2V;



now hook them up



$$V_1 = \frac{C_2}{C_1 + C_2}\left(V_{batt} - \frac{Q_{tot}}{C_2}\right)$$

$Q_{tot} = 2Q$

$Q = C V_{batt}$

$C_1 = C_2 = C$

$$V_1 = \frac{C}{C+C}\left(V_{batt} - \frac{2CV_{batt}}{C}\right)$$

$$= \frac{1}{2}\left(V_{batt} - 2V_{batt}\right) = -V_{batt}/2 \quad \left(V_2 = \frac{3}{2}V_{batt}\right.$$

If we had connected e to b $Q_{tot} = -2Q$

& $V_1 = \frac{3}{2}V_{batt}$ $\left(V_2 = -\frac{1}{2}V_{batt}\right.$

& we might have just exceeded the dielectric strength!