23#: 31, 36, 45, 53

31 Look at 23-9 but use σ and subtract hole

$$\frac{dq}{Q} = \frac{2\pi r dr}{(\pi R_2^2 - \pi R_1^2)}$$

$$Q = \sigma A = \sigma(\pi R_2^2 - \pi R_1^2)$$

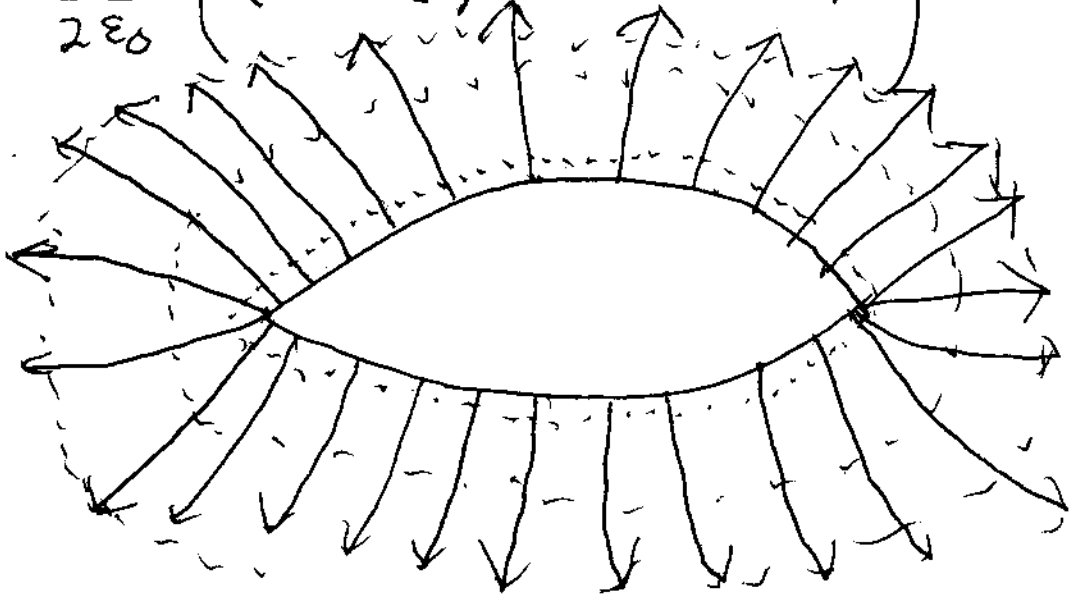
so $$\frac{dq}{\sigma} = 2\pi r dr$$

$$V = \frac{1}{4\pi\varepsilon_0}(2\pi\sigma)\int_0^{R_2} \frac{r dr}{(x^2+r^2)^{1/2}} \quad \text{(disk)}$$

(hole) $$- \frac{1}{4\pi\varepsilon_0}(2\pi\sigma)\int_0^{R_1} \frac{r dr}{(x^2+r^2)^{1/2}}$$

$$= \frac{\sigma}{2\varepsilon_0}\left((x^2+R_2^2)^{1/2} - (x^2+R_1^2)^{1/2}\right)$$

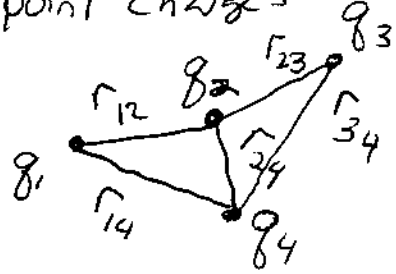
36



45) $V = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{Q}{r}$ $\quad \vec{E} = -\frac{dV}{d\ell}\hat{\ell}$ if $\ell \parallel E$

so $E = -\frac{d}{dr}\left(\frac{1}{4\pi\varepsilon_0}\frac{Q}{r}\right) = \frac{1}{4\pi\varepsilon_0}Q/r^2$ ✓

53) 4 point charges



$$U = \frac{Kq_1q_2}{r_{12}} + \frac{Kq_1q_3}{r_{13}}$$

$$+ \frac{Kq_1q_4}{r_{14}} + \frac{Kq_2q_3}{r_{23}} + \frac{Kq_2q_4}{r_{24}} + \frac{Kq_3q_4}{r_{34}}$$

6 terms!

(5 charges would have 10 terms

24-5) $Q = CV$
$\Delta Q = C\Delta V$ → $16\mu C = C(28V)$
$C = .57\mu F$

7. $Q = CV \Rightarrow C\left(\frac{W}{q}\right) = 2.0\,C$

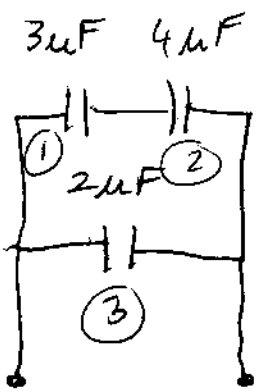
24-11) $V = \frac{Q}{4\pi\varepsilon_0 r_E}$ so $C = Q/V = 4\pi\varepsilon_0 r_E = 7.1\times10^{-4}\,F$

21 in series

$$\frac{1}{1600\,pF} = \frac{1}{3600\,pF} + \frac{1}{X}$$

$$\frac{6.25\times10^{-4}}{pF} = \frac{2.78\times10^{-4}}{pF} + \frac{1}{X} \qquad X = 2880\,pF$$

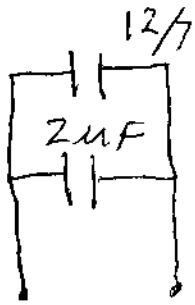
25)



← in series

$\frac{1}{C_{EQ}} = \frac{1}{3\mu F} + \frac{1}{4\mu F} = \frac{7}{12\mu F}$ so $C_{EQ} = \frac{12}{7}\,\mu F$

NOW



in parallel

$C_{EQ} = \frac{12}{7}\,\mu F + 2\,\mu F$

$= \frac{26}{7}\,\mu F$

$V_3 = 26V$

$Q = CV = (2\mu F)(26V) = 52\,\mu C$

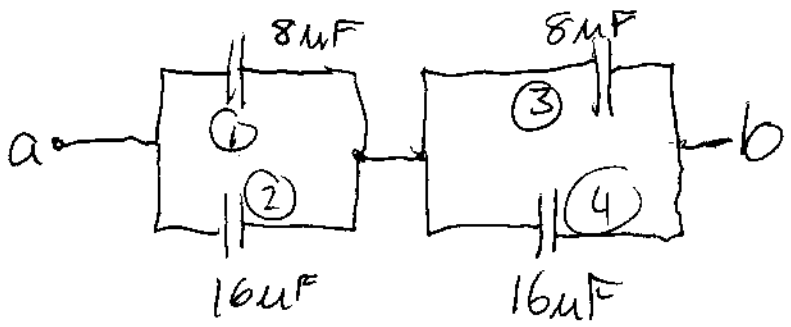
$V_1 + V_2 = 26\,V$ $\quad Q_1 = Q_2$ so $C_1V_1 = C_2V_2$

$V_1 + \frac{C_1}{C_2}V_1 = 26V$

$\frac{7}{4}V_1 = 26V$ $\quad V_1 = 14.86\,V$ $\quad V_2 = 11.14V$

$Q_1 = Q_2 = C_1V_1 = 44.6\,\mu C$

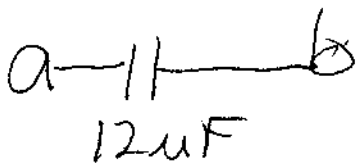
33)



$16+8=24$

$\frac{1}{24}+\frac{1}{24}=\frac{2}{24}$

$C_{EQ}=12\mu F$



$Q_3=30\mu C=Q_1$

$Q_{12}=Q_{34}$

$V_{12}=V_{34}$ $V_{AB}=V_{12}+V_{34}$

$V_{AB}=\frac{Q_{AB}}{C}$

$V_3=V_4$ $\frac{Q_3}{C_3}=\frac{Q_4}{C_4}$ $\frac{30\mu C}{8\mu F}=\frac{Q_4}{16\mu F}$

$Q_4=60\mu C$

$Q_2=60\mu C$

$V_3=V_1=\frac{30\mu C}{8\mu F}=3.75V$ ✓

$V_2=V_4=\frac{60\mu C}{16\mu F}=3.75V$

$V_{AB}=7.5V$

24-45) In parallel:

$C_1 + C_2 = .35\mu F$

$U = \frac{1}{2}CV^2 = 2.5 \times 10^{-5} J$

In series:

$\frac{1}{C_{EQ}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{.15\mu F} + \frac{1}{.20\mu F} = \frac{6.67}{\mu F} + \frac{5}{\mu F}$

so $C_{EQ} = .0857\mu F$

$U = \frac{1}{2}CV^2 = 6.2 \times 10^{-6} J$

Charge $Q = CV$

parallel $= (.35\mu F)(12V) = 4.2\mu C$

series $= (.0857\mu F)(12V) = 1.0\mu C$

55) $U = \frac{1}{2}Q^2/C$

$U/U_0 = \frac{C_0}{C} = \frac{1}{K}$ so $U = U_0/K = \frac{2.33 \times 10^3 J}{7}$

$= 330 J$

Ch 25

5) $V = IR = 750V$

9) $V = IR$ so $R = \frac{V}{I} = 16\Omega$

$I = \frac{\Delta Q}{\Delta t}$ so $\Delta Q = I\Delta t = 7.5A\,(15m)\left(\frac{60s}{min}\right)$

$= 6.8 \times 10^3 C$

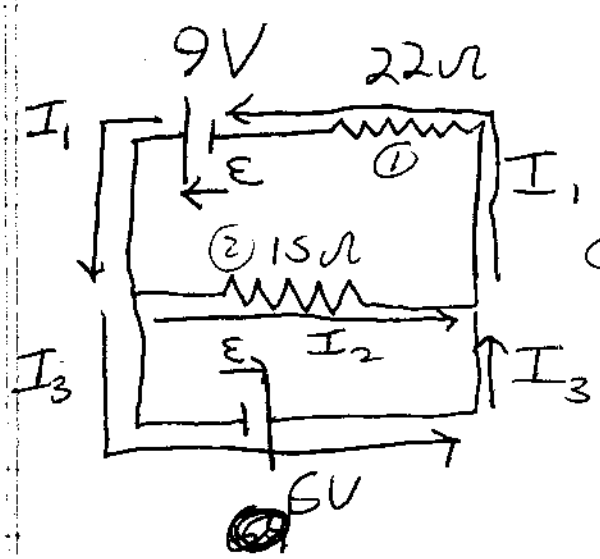
26

#7 $R_{series} = 25\Omega + 70\Omega = 95\Omega$

$\frac{1}{R_{parallel}} = \frac{1}{25\Omega} + \frac{1}{70\Omega} = \frac{.0543}{\Omega}$

so $R_{parallel} = 18.4\Omega$

25)



① $I_1 = I_2 + I_3$

outer loop

$9V + 6V - I_1(22\Omega) = 0$

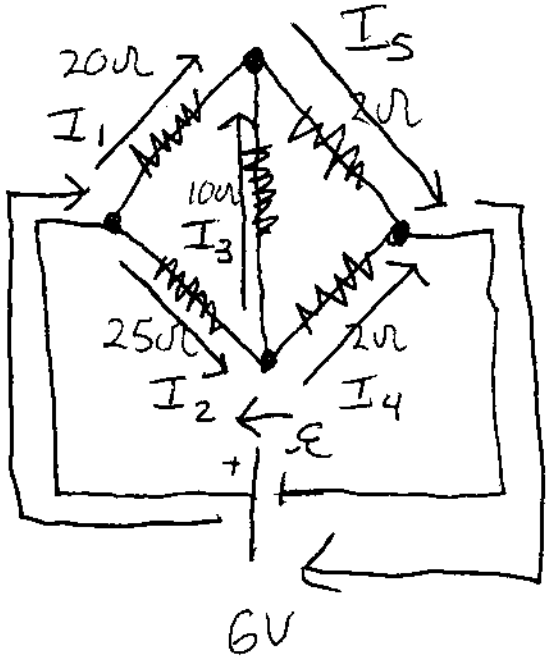
Bottom loop

$6V + I_2(15\Omega) = 0$

$I_1 = .68A \quad I_2 = -.4A$

so $I_3 = +1.08A$

29



$I = I_1 + I_2$

$I_2 = I_3 + I_4$

$I = I_5 + I_6$

diamond

$$I_4(2\Omega) + I_2(25\Omega) - I_1(20\Omega) - I_5(2\Omega) = 0$$

Top

$$-I_1(20\Omega) - I_5(2\Omega) + 6V = 0$$

Bottom

$$-I_2(25\Omega) - I_4(2\Omega) + 6V = 0$$

Left Triangle

$$-I_1(20\Omega) + I_3(10\Omega) + I_2(25\Omega) = 0$$

Right triangle

$$-I_5(2\Omega) + I_4(2\Omega) - I_3(10\Omega) = 0$$