26-5) a) $r_1 = 0.4\,m$, $r_2 = 1.0m$, $q_{total} = 7.0\,\mu C$

$$\frac{q_1}{q_2} = \frac{r_1}{r_2}$$, since both spheres must be at the same electric potential ; see Ex 25.9.

Setting $q_2 = q_{total} - q_1 \Rightarrow \frac{q_1}{q_{total} - q_1} = 0.4 \Rightarrow \boxed{q_1 = \frac{2}{7} q_{total} = 2.0\mu C}$

$\Rightarrow \boxed{q_2 = 5.0\mu C}$

26.5) b) $V_{total} = V_1 + V_2 = 2V_1$, since $V_1 = V_2$.

$V_1 = k_e \frac{q_1}{r_1} = 4.495\,kV \Rightarrow \boxed{V_{total} = 8.99\,kV}$

26-7) a) $A = 7.60\,cm^2 = 7.6 \times 10^{-4}\,m^2$; $d = 1.80\,mm = 1.80 \times 10^{-3}\,m$; $\Delta V = 20.0\,V$

26-7) b) $\Delta V = Ed$; $\varepsilon_0 = 8.854 \times 10^{-12}\,C^2/N\cdot m^2$

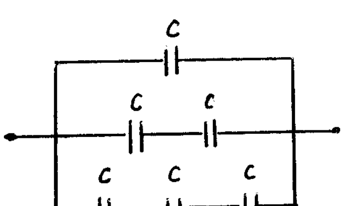
$\Rightarrow \boxed{E = \frac{\Delta V}{d} = 11.1\,kV, \text{ towards the neg. plate}}$

$E = \frac{\sigma}{\varepsilon_0} \Rightarrow \boxed{\sigma = \varepsilon_0 E = 9.83 \times 10^{-8}\,C/m^2}$

26-7) c) $\boxed{C = \frac{\varepsilon_0 A}{d} = 3.74\,pF}$

26-7) d) $\boxed{C\Delta V = Q = 74.767\,pC}$

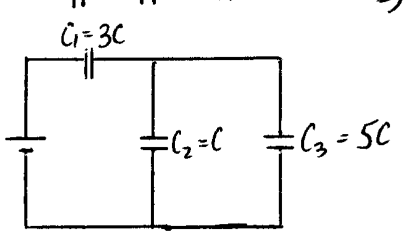
26-18)



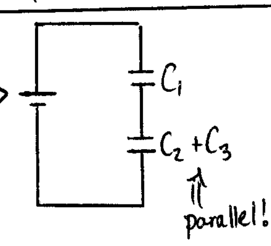
$\frac{1}{C_{eq,1}} = \frac{1}{C}$; $\frac{1}{C_{eq,2}} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C} \Rightarrow \frac{1}{C_{eq,3}} = \frac{3}{C}$

$\Rightarrow \boxed{C_{eq,tot} = C + \frac{C}{2} + \frac{C}{3} = \frac{11C}{6}}$

26-22) a)



$\Rightarrow$



$\Rightarrow \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2 + C_3} = \frac{1}{2C}$

$\Rightarrow \boxed{C_{eq} = 2C}$

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26-22) b) Charges on capacitors connected in series are the same.
" " " " " parallel " different.

$$Q_{23} = (C_2 + C_3)\Delta V = Q_2 + Q_3 \Rightarrow Q_3 > Q_2, \text{ since } C_3 > C_2 \text{ ; parallel combo}$$

$$Q_1 = Q_2 + Q_3, \text{ series combo} \Rightarrow \boxed{Q_1 > Q_3 > Q_2}$$

26-22) c) $\Delta V_2 = \Delta V_3$, parallel combo

$$\Delta V_{tot} = \frac{Q}{C_1} + \frac{Q}{C_2 + C_3} = \Delta V_1 + \Delta V_{23} \Rightarrow \boxed{\Delta V_1 > \Delta V_2 = \Delta V_3}$$

$Q = Q_1 = Q_2 + Q_3$

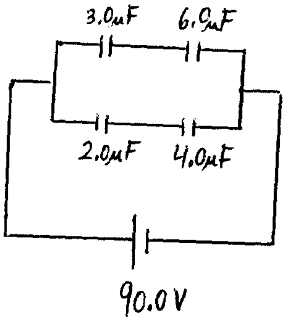
since $C_1 < C_2 + C_3$
and $Q_1 > Q_3 > Q_2$

26-22) d) The important observation to make is that <u>the potential difference across the battery remains the same</u>. With that in mind:

If C_3 increases, then ΔV_3 decreases $\left(\Delta V_3 = \frac{Q_3}{C_3}\right)$. <u>$Q_3$ is unchanged.</u>
Since $\Delta V_2 = \Delta V_3$, then ΔV_2 also decreases. Since C_2 is unchanged, <u>Q_2 must decrease</u> to satisfy the above cond'n.

With $\Delta V_{tot} = \Delta V_1 + \Delta V_2 + \Delta V_3$ & the cond'n at the very top (as well as noting that ΔV_2 & ΔV_3 decrease), one can conclude that ΔV_1 must increase. Since C_1 remains the same, it follows that <u>Q_1 must increase</u>.

26-54) a)



$$C_{eq} = \left[\frac{1}{\frac{1}{2} + \frac{1}{4}} + \frac{1}{\frac{1}{6} + \frac{1}{3}}\right]\mu F = \boxed{\frac{10}{3}\mu F}$$

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26-54)b) The potential difference across each of the two pairs in parallel is the same and is equal to 90 V.

$$\Delta V_{tot} = 90.0\,V = \frac{Q}{C_1} + \frac{Q}{C_2} \Rightarrow \boxed{\begin{array}{l} \Delta V_{3.0\mu F} = \Delta V_{2.0\mu F} = 60.0\,V \\ \Delta V_{6.0\mu F} = \Delta V_{4.0\mu F} = 30.0\,V \end{array}}$$

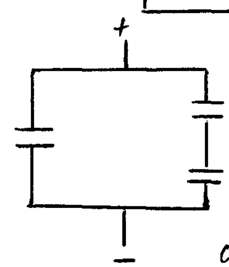
for either upper or lower series combo!

26-54)c) $\Delta V_{upper} = 90.0\,V = \frac{Q_{upper}}{3.0\mu F} + \frac{Q_{upper}}{6.0\mu F} \Rightarrow \boxed{Q_{upper,1} = Q_{upper,2} = 180\,\mu C}$

$\Delta V_{lower} = 90.0\,V = \frac{Q_{lower}}{2.0\mu F} + \frac{Q_{lower}}{4.0\mu F} \Rightarrow \boxed{Q_{lower,1} = Q_{lower,2} = 120\,\mu C}$

26-54)d) $U = \frac{1}{2}C(\Delta V)^2 = \frac{1}{2}\left(\frac{10}{3}\mu F\right)(90.0\,V)^2 \doteq \boxed{13.5\,mJ}$

26-61)a) Figure P26.61 looks just like



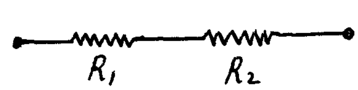
overall, the combo's parallel!

$$\Rightarrow C_{total} = \frac{\varepsilon_0 A K_1}{2d} + \frac{\varepsilon_0 \left(\frac{A}{2}\right)}{\left(\frac{d}{2}\right)\left(\frac{1}{K_2} + \frac{1}{K_3}\right)} \Rightarrow \boxed{C_{total} = \frac{\varepsilon_0 A}{d}\left(\frac{K_1}{2} + \frac{K_2 K_3}{K_2 + K_3}\right)}$$

26-61)b) Plugging in the given values yields $\boxed{C_{total} = 1.76\,pF}$

27-24) $\rho_1 = 4.0\times 10^{-3}\,\Omega\cdot m$, $\rho_2 = 6.0\times 10^{-3}\,\Omega\cdot m$

$l_1 = 0.25\,m$, $l_2 = 0.40\,m$, $A = (3.0\times 10^{-3}\,m)^2$

Figure P27.24 looks just like: 

$$\Rightarrow R_{total} = \frac{1}{A}(\rho_1 l_1 + \rho_2 l_2) \doteq \boxed{377.77\,\Omega}$$

27-46)a) $\mathcal{P} = I^2 R = I^2 \rho_{Cu} \cdot \frac{l}{A} = \frac{(20.0A)^2(1.7\times 10^{-8}\,\Omega\cdot m)(1.0\,m)}{\pi(1.0265\times 10^{-3}\,m)^2} \doteq \boxed{2.05\,W}$

27-46)b) $\mathcal{P}_{Al} = \mathcal{P}_{Cu} \cdot \frac{\rho_{Al}}{\rho_{Cu}} \doteq \boxed{3.41\,W} > \mathcal{P}_{Cu} \Rightarrow$ Copper is safer than Aluminum!

Note: Silver wiring is normally considered to be the safest (due to its' low resistivity), but it is too expensive to implement in everyday circuits.

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27-54)a) $R = \frac{(\Delta V)^2}{\mathcal{P}}$; $R_1 = \frac{(120V)^2}{100W} \doteq \boxed{144\ \Omega}$; $R_2 = \frac{(120V)^2}{25W} \doteq \boxed{576\ \Omega}$

27-54)b) $I = \frac{\Delta V}{R} \Rightarrow \Delta t = \frac{QR}{\Delta V} = \frac{(1C)(576\ \Omega)}{120\ V} \Rightarrow \boxed{\Delta t = 4.80\ sec}$

$U = Q\Delta V$ ⇒ Due to the potential difference, the potential energy is lower upon exit.

27-54)c) $\mathcal{P} = I\Delta V = \frac{U}{\Delta t} \Rightarrow \Delta t = \frac{U}{\mathcal{P}} = \frac{1\ J}{25W} \doteq \boxed{0.04\ sec}$

bulbs get hot!!!

Energy enters w/current (due to $U = Q\Delta V$) and exits via emission of heat & light.

27-54)d) $\text{Cost} = \frac{\$0.07}{kWh}\cdot\frac{25W}{1000W}\cdot kW\cdot\frac{30\ days}{1\ day}\cdot 24h \doteq \boxed{\$1.26}$

The company sells energy, what else!?!

$\text{Cost (one SI)} = \frac{\$0.07}{kW\cdot h}\cdot\frac{kW}{1000W}\cdot\frac{h}{3600s} \doteq \boxed{1.94\times10^{-8}\ \$/J}$

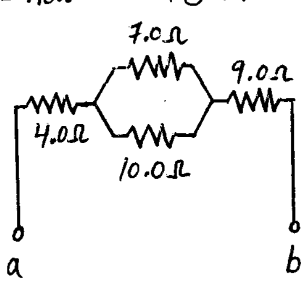
28-4)a) $\mathcal{E} = 12.6\ V$; $r = 0.08\ \Omega$; $R = 5.0$ Ohms

$\mathcal{E} = IR + Ir \Rightarrow I = \frac{\mathcal{E}}{R+r} \Rightarrow \Delta V = IR = \frac{\mathcal{E}R}{R+r} \simeq \boxed{12.40\ V}$

28-4)b) Since an add'l 35.0 A is taken from the battery, then:

$I_{new} = \frac{\mathcal{E} - I'r}{R+r}$, where $I' = 35.0\ A$

$\Rightarrow I_{new} = 1.93\ A \Rightarrow \boxed{\Delta V = I_{new}R \simeq 9.65\ V}$

28-6)a) 

$R_{eq} = 4.0\Omega + \left(\frac{1}{7.0\Omega} + \frac{1}{10.0\Omega}\right)^{-1} + 9.0\Omega \doteq \boxed{\frac{291}{17}\ \Omega}$

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28-6)b) $\Delta V = I R_{eq} \Rightarrow \boxed{I_{\substack{4.0\Omega \\ 9.0\Omega}} = \frac{\Delta V}{R_{eq}} = \frac{34.0V}{R_{eq}} \simeq 1.99\text{ A}}$, for the 4.0Ω & 9.0Ω resistors (since current thru resistors in series is the same).

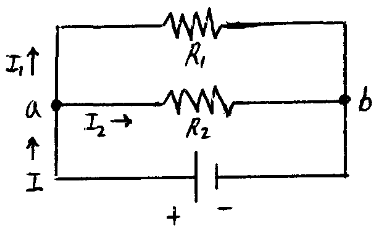
Now, the equiv. resistance of the two resistors in ∥ is: $R_{eq,\parallel} = \left(\frac{1}{7.0\Omega} + \frac{1}{10.0\Omega}\right)^{-1} = \frac{70}{17}\Omega$

The pot. diff. (ΔV) across the two in ∥ is the same: $\Delta V_{\parallel} = I R_{eq,\parallel} \simeq 8.18\Omega$

for the 7.0Ω resistor: $\boxed{I_7 = \frac{\Delta V_{\parallel}}{7.0\Omega} \simeq 1.17\text{ A}}$

for the 10.0Ω resistor: $\boxed{I_{10} = \frac{\Delta V_{\parallel}}{10.0\Omega} \simeq 0.82\text{ A}}$

28-18)a) $R_1 = 11.0\Omega$; $R_2 = 22.0\Omega$; $\Delta V = 33.0$ V



Two resistors in parallel: $\Delta V_1 = \Delta V_2 = \Delta V$

Using $\mathcal{P} = \frac{(\Delta V)^2}{R}$, , & the fact that $R_1 < R_2$ shows that $\boxed{\mathcal{P}_1 > \mathcal{P}_2 \text{ ; more power to the } 11.0\ \Omega \text{ resistor}}$

28-18)b) $R_{eq} = \left(\frac{1}{11.0\Omega} + \frac{1}{22.0\Omega}\right)^{-1} \simeq 7.33\ \Omega$

$\mathcal{P}_{battery} = \frac{(\Delta V)^2}{R_{eq}} = \boxed{148.5\text{ W}}$

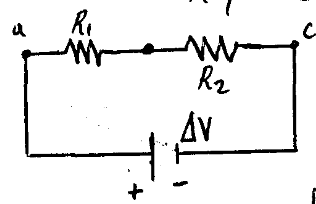
$\mathcal{P}_{11} = \frac{(\Delta V)^2}{11.0\Omega} = 99\text{W}$

$\mathcal{P}_{22} = \frac{(\Delta V)^2}{22.0\Omega} = 49.5\text{W}$

$\mathcal{P}_{battery} = \mathcal{P}_{11} + \mathcal{P}_{22}$

$\Rightarrow \boxed{\mathcal{P}_{battery} = 148.5\text{W}}$

28-18)c)



Two resistors in series: $I_1 = I_2 = I$

From the relation $\mathcal{P} = I^2 R$, & $R_2 > R_1$ we see that

$\boxed{\mathcal{P}_2 > \mathcal{P}_1 \text{ ; } 22.0\ \Omega \text{ resistor uses more power}}$

28-18)d) $\Delta V = I R_{eq} \Rightarrow I = \frac{33.0\text{ V}}{11.0\Omega + 22.0\Omega} = 1\text{ A} \Rightarrow \mathcal{P}_1 = I^2 R_1 = 11.0\text{W}$; $\mathcal{P}_2 = I^2 R_2 = 22.0\text{W}$

$\mathcal{P}_{total} = \mathcal{P}_1 + \mathcal{P}_2 = \boxed{33.0\text{ W}}$

$\mathcal{P}_{battery} = I\Delta V = (1\text{A})(33.0\text{V}) = \boxed{33.0\text{ W}}$

28-18)e) $\boxed{\mathcal{P}_{parallel} > \mathcal{P}_{series}}$