WORKSHOP 7.2

30.54 The potential difference is 9V

a) $Q = C\Delta V$; $C = \frac{\varepsilon_0 A}{d} \Rightarrow |Q| = \frac{\varepsilon_0 A |\Delta V|}{d}$

$$= \frac{\varepsilon_0 (.02m)^2 (9V)}{(.001m)}$$

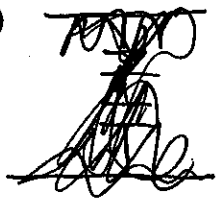
$$\boxed{Q = 3.2 \times 10^{-11} C}$$

b) The charge remains the same, Q is conserved

$$\frac{d_i}{d_f} \cancel{Q} = \cancel{\varepsilon_0} \cancel{A} V_i \quad \frac{d_i}{d_f} = \frac{1}{2} \Rightarrow \boxed{V_f = 2V_i = 18V}$$

$$\cancel{\varepsilon_0} \cancel{A} V_f$$

30.63 a) All in series: $C_0 = 12\mu F$



in series $C_{tot} = \left(\frac{1}{C_0} + \frac{1}{C_0} + \frac{1}{C_0}\right)^{-1} = \frac{C_0}{3} = \frac{12}{3}\mu F = 4\mu F$

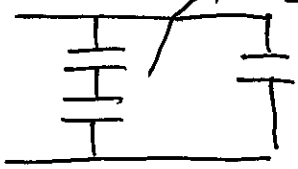
b)

$C_{eq} = 2C_0 = 24\mu F$

$C_{eq} = \left(\frac{1}{2C_0} + \frac{1}{C_0}\right)^{-1} = \frac{2C_0}{3}$

$= 8\mu F$

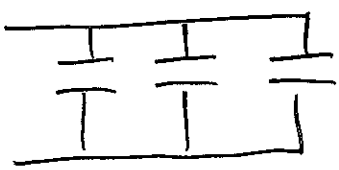
c)



$C_{eq} = \left(\frac{1}{C_0} + \frac{1}{C_0}\right)^{-1} = \frac{C_0}{2}$

$$\boxed{C_{eq} = \frac{C_0}{2} + C_0 = 18\mu F}$$

d) All in parallel



$$\boxed{C_{eq} = 3C_0 = 36\mu F}$$

30.71 a) $U_c = \frac{1}{2}C(\Delta V)^2$; $\Delta V = \frac{Q}{C}$; $U_c = \frac{1}{2}\frac{Q^2}{C}$; $C = \frac{\varepsilon_0 A}{d}$

$$\boxed{U_c = \frac{1}{2}\frac{(d)Q^2}{\varepsilon_0 A} = \frac{1}{2}\frac{(.001m)(10\times10^{-9}C)}{\varepsilon_0\,(.1m)^2} = 5.6\times10^{-7}J}$$

b) Energy goes like $U_c \propto d$

d doubled $\Rightarrow$ U_c doubled $\quad \boxed{U_c^{new} = 1.1\times10^{-6}J}$

c) work had to be done in moving the plates apart. This work increased the stored E in the capacitor.

30.73 First the total E stored was $E = P\cdot\Delta t = (10W)(10\times10^{-6}s)$ (P: power)

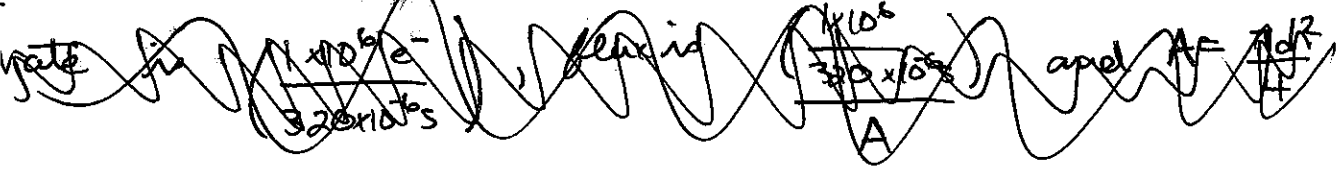
$= 10\times10^{-5}J$

This is the E stored in the capacitor, and

$$E = U_c = \frac{1}{2}C(\Delta V)^2 \Rightarrow 10\times10^{-5}J = \frac{1}{2}C(3V)^2$$

$$\boxed{C = 2.2\times10^{-5}F = 22\mu F}$$

31.3 ~~[illegible]~~ Read Chap 31.1



$A = \frac{\pi D^2}{4} = \frac{N_e}{n v_d \Delta t}$ wire is silver $\Rightarrow n = 5.8\times10^{28}e^-/m^3$

$$D = \sqrt{\frac{4N_e}{\pi n v_d \Delta t}} = \sqrt{\frac{4\times(1\times10^6 e^-)}{\pi(5.8\times10^{28}e^-/m^3)(8\times10^{-4}m/s)(320\times10^{-6}s)}}$$

$$= 93\times10^{-4}m = .93mm$$

$$\boxed{D = .93mm}$$

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$D = 1.6\text{mm}$ $\quad v_d = 2\times10^{-4}\ \text{m/s}$ $\quad n_{\text{aluminum}} = 6\times10^{28}\ e^-/\text{m}^3$

$$\Delta t = 24\text{hours} \times \frac{3600\text{s}}{1\text{hr}} = 86{,}400\text{s}$$

$$\text{Rate} = A n v_d = \frac{\pi D^2}{4} n v_d = \pi \frac{(.0016)^2 (6\times10^{28}\ e^-/\text{m}^3)(2\times10^{-4}\ \text{m/s})}{4}$$

$$\boxed{(\text{Rate})\Delta t = 2\times10^{24}\ e^-}$$