(1) Partiendo de la definición de trabajo.

$$W = \int F \cdot ds \rightarrow F_e = q_0 E$$

$$W = \int q_0 E \cdot ds$$

$$W = q_0 \int E \cdot ds \rightarrow W = \Delta U$$

$$\Delta V = \frac{\Delta U}{q_0}$$

$$\Delta V = \int E \cdot ds$$

$$W = q_0 \Delta V \rightarrow \boxed{W = Q \Delta V}$$

Sabiendo que la capacitancia es $C = \frac{Q}{\Delta V}$

$$dW = \Delta V dq$$

$$dW = \frac{q}{C} dq$$

$$W = \int_0^Q \frac{q}{C} dq$$

$$\rightarrow W = \left[\frac{q^2}{2C}\right]_0^Q$$

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

ΔV

$$\therefore \boxed{W = \frac{1}{2} Q \Delta V}$$

(2) $r = 12 cm$ $E = 4,90 \cdot 10^4 \, N/C$ $d = 21 cm \rightarrow 0,21 m$

$$E = K\frac{Q}{d^2} \Rightarrow Q = \frac{d^2 E}{K}$$

$$\sigma = \frac{Q}{A} \quad A = 4\pi r^2$$

$$Q = \sigma A$$

$$Q = \sigma (4\pi r^2)$$

$$\frac{d^2 E}{K} = \sigma 4\pi r^2 \quad \varepsilon_0 = \frac{1}{4\pi K}$$

$$\sigma = \frac{d^2 E}{K 4\pi r^2} \Rightarrow \sigma = \frac{d^2 E \varepsilon_0}{r^2}$$

$$\sigma = \frac{(0,21)^2 (4,90 \cdot 10^4)(8,85 \cdot 10^{-12})}{(0,12)^2}$$

(1) $\boxed{\sigma = 1,328 \cdot 10^{-6} \, C/m^2}$

$C = \frac{Q}{\Delta V}$ $\Delta V = -\int_0^R E \cdot dr$ $C = \frac{Q}{\Delta V} \Rightarrow Q = C\Delta V$

$\Delta V = -\int_0^R K\frac{Q}{r^2}\,dr$

$\Delta V = -KQ\int_0^R \frac{1}{r^2}\,dr$

$\cancel{\Delta V} = -KC\cancel{\Delta V}\int_0^R \frac{1}{r^2} \Leftrightarrow \frac{1}{C} = -K\left[-\frac{1}{r}\right]_0^R \Rightarrow \frac{1}{C} = \frac{K}{R}$

$C = \frac{R}{K} \Rightarrow C = 4\pi\varepsilon_0 R \Rightarrow C = 4\pi(8{,}85.10^{-12})(0{,}12)$

(b) $\boxed{C = 1{,}33.10^{-11}\,F}$

(3) $A = 7{,}60\,cm^2$ $d = 1{,}8\,mm$ $\Delta V = 20\,V$

$\Delta V = Ed \Rightarrow E = \frac{\Delta V}{d} = \frac{20}{1{,}8.10^{-3}} = 11111{,}11\,V/m$

(a) $\boxed{E = 11111{,}11\,V/m}$

$E = \frac{\sigma}{\varepsilon_0} \Rightarrow \sigma = E\varepsilon_0 = (11111{,}11)(8{,}85.10^{-12})$

(b) $\boxed{\sigma = 9{,}83.10^{-8}\,C/m^2}$

$C = \frac{Q}{\Delta V}$ $\sigma = \frac{Q}{A}$

$Q = A\sigma$

(c) $\boxed{C = 3{,}73.10^{-12}\,F}$

$C = \frac{A\sigma}{\Delta V}$

$C = \frac{(7{,}60.10^{-2})(9{,}83.10^{-8})}{20}$

$C = \frac{Q}{\Delta V} \Rightarrow Q = C\Delta V$

$Q = (3{,}73.10^{-12})(20)$

$$\boxed{① \; Q = 7{,}46 \cdot 10^{-11}\,C}$$

④ $C_1 = 5{,}00\,\mu F$ $C_2 = 12{,}0\,\mu F$ $\Delta V = 9{,}00V$

$C_{eq} = C_1 + C_2$

$\Delta V_1 = \Delta V_2 = \Delta V$

$$\boxed{ⓐ \; C_{eq} = 17\,\mu F}$$

$$\boxed{ⓑ \; \Delta V_1 = \Delta V_2 = 9{,}00V}$$

$C = \frac{Q}{\Delta V} \Rightarrow Q_1 = C\Delta V$

$Q_1 = (5 \cdot 10^{-6})(9{,}00)$ $Q_2 = (12 \cdot 10^{-6})(9{,}00)$

$$ⓒ \; \boxed{Q_1 = 4{,}5 \cdot 10^{-5}\,C \qquad Q_2 = 1{,}08 \cdot 10^{-4}\,C}$$

⑤ $\leftarrow D \rightarrow$ $r < D$

$C = \frac{Q}{\Delta V}$

$C = \frac{\lambda l}{\Delta V}$

$C = \frac{\lambda l}{\frac{\lambda}{2\pi\varepsilon_0} \ln|D/r|}$

$C = \frac{\pi\varepsilon_0}{\ln|D/r|}$

$\Delta V = -\int_D^r E\,dr$

$\oint E\,ds = \frac{q_{in}}{\varepsilon_0}$

$E(2\pi r l) = \frac{\lambda l}{\varepsilon_0}$

$E = \frac{\lambda}{2\pi r\varepsilon_0}$

$\Delta V = -\int_D^r \frac{\lambda}{2\pi r\varepsilon_0}\,dr$

$= -\frac{\lambda}{2\pi\varepsilon_0}\int_D^r \frac{1}{r}\,dr$

$= -\frac{\lambda}{2\pi\varepsilon_0}\left[\ln|r|\right]_D^r$

$= \frac{\lambda}{2\pi\varepsilon_0}\left(\ln\left|\frac{D}{r}\right|\right)$

$\Delta V = \frac{\lambda}{2\pi\varepsilon_0}\ln\left|\frac{D}{r}\right|$

$2\Delta V = \frac{\lambda}{2\pi\varepsilon_0}\ln\left|\frac{D}{r}\right|$

$\Delta V = 2\Delta V$

⑥ l ; d ; $+Q$; $-Q$; K ; x ; $x >> d$

$$C = K\frac{\varepsilon_0 A}{d} \qquad C = \frac{\varepsilon_0 A}{d} \qquad C_1 = \frac{K\varepsilon_0 x l}{d}$$

$$C_1 + C_2 = C_{eq} \qquad C_2 = \frac{\varepsilon_0 (l-x) l}{d}$$

$$C_{eq} = \frac{K\varepsilon_0 x l}{d} + \frac{\varepsilon_0 (l-x) l}{d}$$

$$= \frac{\varepsilon_0}{d}\left(Kxl + (l-x)l\right)$$

$$= \frac{\varepsilon_0}{d}\left(Kxl + l^2 - xl\right)$$

a) $$\boxed{C_{eq} = \frac{\varepsilon_0}{d}\left(l^2 + xl(K-1)\right)}$$

$$U = \frac{1}{2} C \Delta V^2$$

$$C = \frac{Q}{\Delta V} \Rightarrow \Delta V = \frac{Q}{C}$$

$U =$

$$\Delta V = \frac{Qd}{\varepsilon_0 [l^2 + xl(x-1)]}$$

$$U = \frac{1}{2}\left(\frac{\varepsilon_0}{d}\left(l^2 + xl(x-1)\right)\right)\left(\frac{Qd}{\varepsilon_0 (l^2 + xl(x-1))}\right)^2$$

b) $$\boxed{U = \frac{1}{2}\frac{Q^2 d}{\varepsilon_0 (l^2 + xl(K-1))}}$$

c) $W = U$

$$U = \int F\,dx$$

$$-\frac{dU}{dx} = F$$

$$f = \frac{dU}{dx}\hat{i}$$

$$\frac{dU}{dx} = \frac{1}{2}\frac{Q^2 d}{\varepsilon_0}\left(\frac{-l(K-1)}{(l^2 + xl(K-1))^2}\right)\hat{i}$$

$$\boxed{f = -\frac{1}{2}\frac{Q^2 d}{\varepsilon_0}\left(\frac{l(K-1)}{(l^2 + xl(K-1))^2}\right)\hat{i}}$$

se mueve a la izquierda

(7) $\rho_{cu} = 8{,}95\ g/cm^3$

$\rho = \frac{m}{V} \Rightarrow V = \frac{m}{\rho} = \frac{1}{8{,}95} = 0{,}11 . 10^{-6} m^3$

$V = \pi r^2 l = A L \Rightarrow A = \frac{V}{L}$

$R = \rho \frac{L}{A} = \rho \frac{L^2}{V} \Rightarrow L = \sqrt{\frac{RV}{\rho}}$

$L = \sqrt{\frac{(0{,}5)(0{,}11 . 10^{-6})}{1{,}7 . 10^{-8}}} = 1{,}798 m$

(a) $\boxed{L = 1{,}798 m}$

$V = \pi r^2 l \Rightarrow r = \sqrt{\frac{V}{\pi L}} = \sqrt{\frac{(0{,}11 . 10^{-6})}{\pi(1{,}798)}} = 1{,}395 . 10^{-4} m$

$r = 1{,}395 . 10^{-4} m$ Diámetro $= 2r$

(b) $\boxed{\text{Diámetro} = 2{,}79 . 10^{-4} m}$

(8) $I = \frac{dq}{dt} \Rightarrow Q = \int_0^{1/240 s} I(t)$

$Q = \int_0^{1/240 s} 100 sen(120\pi t) dt$

$Q = \frac{100}{120\pi} \left[\cancel{-cos\left(120\pi\left(\frac{1}{240}\right)\right)} + cos(0) \right]$

$Q = \frac{100}{120\pi} C$

$\boxed{Q = 0{,}265 C}$

⑨

$U = 2{,}00\,MeV$ $I: 10{,}0\,\mu A$

$M = 3{,}34 \cdot 10^{-25}\,kg$ $n = \frac{2}{A \cdot L}$

$I = n\,q\,V_d\,A$

$1\,MeV = 1{,}6 \cdot 10^{-13}\,J$

$2\,MeV = 3{,}2 \cdot 10^{-13}\,J$

$I = \frac{2}{\cancel{A}L} q V_d \cancel{A} = \frac{2 V_d q}{L}$

$L = \frac{2 V_d q}{I}$

$U = \frac{1}{2} m V_d^2$ $V_d = \sqrt{\frac{2(3{,}2 \cdot 10^{-13})}{3{,}34 \cdot 10^{-25}}}$

$\sqrt{\frac{2U}{m}} = V_d$ $V_d = 1384257{,}08\ m/s$

$V_d = 1{,}38 \cdot 10^{6}\ m/s$

$L = \frac{2(1{,}38 \cdot 10^{6})(1{,}6 \cdot 10^{-19})}{1 \cdot 10^{-6}}$

$\boxed{L = 4{,}42 \cdot 10^{-7}\,m}$

⑩ $\Delta V = 120\,V$ $P = 2{,}50\,hp$ $90{,}0\%$

$1\,hp = 745{,}7\,W$

$P = I\,\Delta V$ $\frac{1864{,}2\,w}{90{,}0\%} \cdot 100\% = 2071{,}3\,w$ $2{,}50\,hp = 1864{,}2\,w$

$I = \frac{P}{\Delta V}$

$1h = 3600\,s$

$3h = 10800\,s$

$I = \frac{2071{,}3}{120} = 17{,}26\,A$

ⓐ $\boxed{I = 17{,}26\,A}$

$P = \frac{Energia}{t} \Rightarrow Energia = P\,t$

$Energia = (2071{,}3)(10800)$

ⓑ $\boxed{Energia = 22370040\,J}$

$P = (2{,}075)(3) = 6{,}213 \text{ Kwh}$ $\quad$ \$ 0,160/Kwh

$\text{Gasto} = (6{,}213)(0{,}160)$

(c) $\boxed{\text{Gasto} = \$0{,}991}$ //

(11) $R = \rho \frac{L}{A} = \rho \frac{r_a - r_b}{4\pi (r_a - r_b)^2} = \frac{\rho}{4\pi}\left(\frac{1}{r_a - r_b}\right)$

$R = \frac{\rho}{4\pi}\left(\frac{1}{r_a - r_b}\right)$

(12) $I = 1000\,A$ $\Delta V = 700\,kV$ $L = 100$ milla

$R/L = 0{,}500\ \Omega/\text{milla}$

$P = I^2 R$

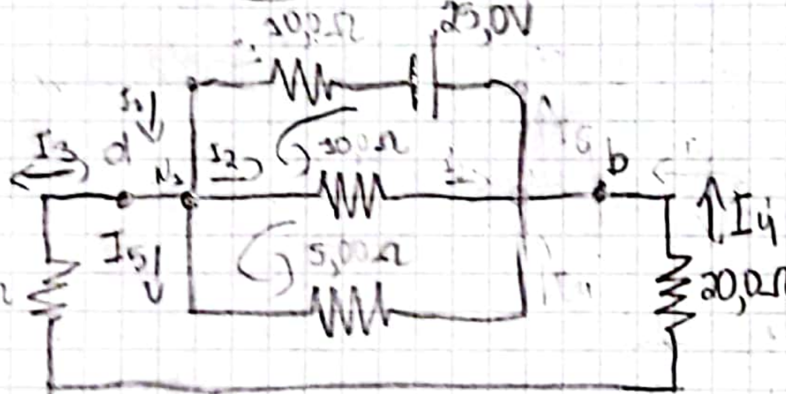
$R = (0{,}500)(100) = 50$

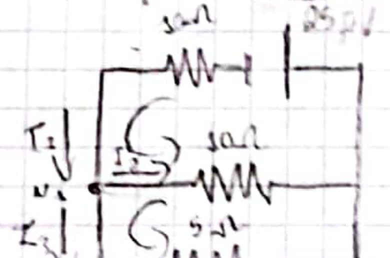
$P = (1000A)(50\Omega)$

$R = 50\,\Omega$

$\boxed{P = 50000\,W}$

(13) 227 mA 5,68 V





$R_{2345} = \left(\frac{1}{10} + \frac{1}{5} + \frac{1}{25}\right)^{-1}$

$R_{2345} = 2{,}94\,\Omega$

$R_{eq} = R_{2345} + R_1$

$R_{eq} = 12{,}94$

$I = \frac{\Delta V}{R} = \frac{25}{12{,}94}$

$I = 1{,}93\,A$

$\Delta V_{2345} = I R_{2345}$

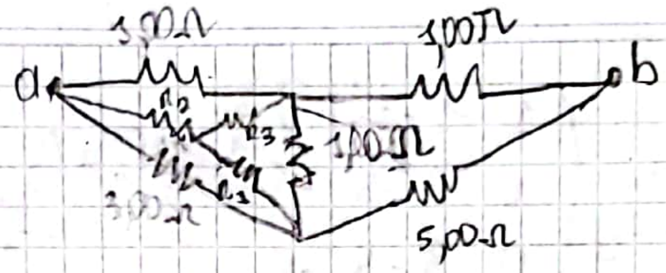
$\Delta V_{2345} = (1{,}93)(12{,}94)$

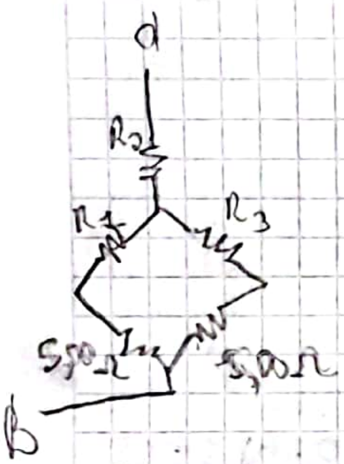
b) $\boxed{\Delta V_{2345} = 5{,}68\,V}$

$I_{234} = \frac{\Delta V}{R} = \frac{5{,}68}{25}$

a) $\boxed{I_{234} = 0{,}228\,A}$

(14)





$$R_2 = \frac{3(1)}{3+1+1} = \frac{3}{5}$$

$$R_1 = \frac{3(1)}{3+1+1} = \frac{3}{5}$$

$$R_3 = \frac{1(1)}{3+1+1} = \frac{1}{5}$$

$$R_{eq} = \left(\frac{1}{R_1+5} + \frac{1}{R_3+1}\right)^{-1} + \frac{3}{5}$$

$$\frac{3}{5} + 5 = \frac{28}{5}$$

$$\frac{1}{5} + 1 = \frac{6}{5}$$

$$= \left(\frac{1}{\frac{3}{5}+5} + \frac{1}{\frac{1}{5}+1}\right)^{-1} + \frac{3}{5}$$

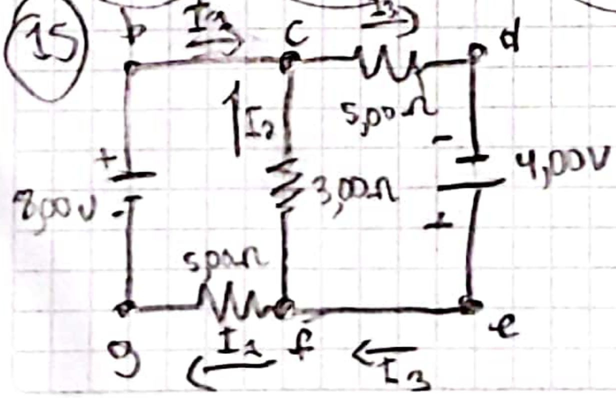
$$= \left(\frac{5}{28} + \frac{5}{6}\right)^{-1} + \frac{3}{5}$$

$$= \left(\frac{170}{168}\right)^{-1} + \frac{3}{5} \quad \frac{27}{\cancel{135}} \; \cancel{675}$$

$$= \frac{168}{170} + \frac{3}{5} = \frac{\cancel{1350}}{\cancel{850}} = \boxed{\frac{27}{17}}$$

$$\cancel{425} \; \cancel{85} \; 17$$

(15)



$$c: \; I_1 + I_2 - I_3 = 0$$

$$-5I_3 + 4 - 3I_2 = 0$$

$$-5I_1 + 8 + 3I_2$$

$$\left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 0 & -3 & -5 & -4 \\ -5 & 3 & 0 & -8 \end{array}\right) \xrightarrow{5f_1+f_3} \left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 0 & -3 & -5 & -4 \\ 0 & 8 & -5 & -8 \end{array}\right) \xrightarrow{\frac{3}{8}f_3+f_2}$$

$I_1\ I_2\ I_3$

$$\left(\begin{array}{ccc|c} 1 & 1 & -1 & 0 \\ 0 & -3 & -5 & -4 \\ 0 & 0 & -\frac{55}{8} & -7 \end{array}\right)$$

$-\frac{55}{8}I_3 = -7$

$I_3 = \frac{56}{55}$

$I_3 = 1{,}018\,A$

$-3I_2 + \left(\frac{56}{55}\right)(-5) = -4$

$-3I_2 - \frac{280}{55} = -4$

$I_2 = \left(4 - \frac{280}{55}\right)\left(\frac{1}{3}\right)$

$I_2 = -0{,}36\,A$

$I_1 = 0{,}36 + 1{,}018$

$I_1 = 1{,}38\,A$

a) $\boxed{I = 1{,}018\,A}$

b) $\boxed{I = -0{,}36\,A}$

c) $\boxed{I = 1{,}38\,A}$

D) $\boxed{I = 0}$

$C = \frac{Q}{\Delta V} \Rightarrow Q = C\Delta V$

$Q = (6\cdot 10^{-6})(3+5)$

e) $\boxed{Q = 6{,}6\cdot 10^{-5}\,C}$