Q_1 a. $mAh = 3600\ s \times 10^{-3}\ A = 3.6\ A \times sec = 3.6\ C.$

b. $100\ mAh = 360\ C$

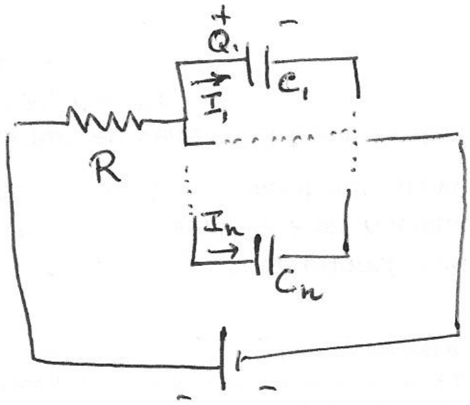
c. $Q = CV = 1\,mF \times 3.6\ V \times n = n \times 3.6\ 10^{-3} = 360\ C$

$\rightarrow n = \frac{360}{3.6\ 10^{-3}} = 100 \times 10^{3} = 10^{5}$!

d. ils ne pourraient décharger la pile car tous porteraient la même charge de $3.6\ 10^{-3}\ C$ délivrée par la pile.

e. $\tau = nRC = 10^{5} \times 100 \times 1\,mF = 10^{5} \times 10^{2} \times 10^{-3}$
$= 10^{4}$ sec.

Démi



$C_1 = \dots = C_n$

$$\frac{dQ_1}{dt} = I_1 = \frac{I}{n} \qquad Q_1 = C_1 V_1 \qquad V_1 + IR = V$$

$$\rightarrow I = \frac{V - V_1}{R}$$

$$\rightarrow \frac{dQ_1}{dt} = \frac{1}{n}\frac{V - V_1}{R} \rightarrow \frac{dQ_1}{dt} = \frac{V - Q_1/C_1}{nR}$$

$$\frac{dQ_1}{dt} = \frac{VC_1 - Q_1}{nRC_1} \qquad \frac{dQ_1}{C_1V - Q_1} = \frac{dt}{nRC_1}$$

$$\ln K(Q_1 - C_1V) = -\frac{t}{nRC_1} \rightarrow Q_1 = C_1V + K\exp\left(-\frac{t}{nRC_1}\right)$$

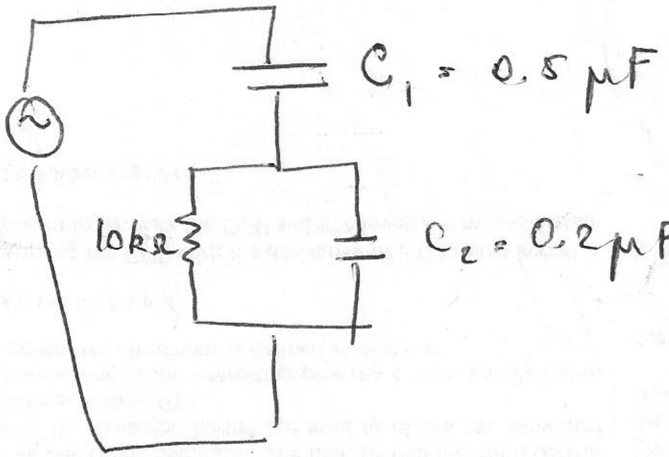
$t \to \infty$: $\exp(-\infty) \to 0$: $Q_1 \to C_1V$

$t \to 0$: $Q_1(0) = C_1V + K$. or $Q_1(0) = 0 \rightarrow K = -C_1V$

$$\rightarrow Q_1(t) = C_1V\left(1 - \exp(-t/nRC_1)\right)$$

Q2

1.



2.
$$\frac{1}{Z_{11}} = \frac{1}{Z_R} + \frac{1}{Z_{C_2}} = \frac{1}{R} + \omega C j$$

$$= \frac{1}{10^4} + 2\pi \times f \times 0.2\ 10^{-6} j$$

$$= 10^{-4} + \pi \times 2f \times 2\,10^{-7} j$$

$$= 10^{-4} + 314 \times 2\,10^{-7} j = 10^{-4}(1 + 314 \times 2 \times 10^{-3} j)$$

$$= 10^{-4}(1 + 0.628 j)$$

$$Z_{11} = \frac{1}{10^{-4}(1 + 0.628 j)} = 10^{4}\,\frac{1 - 0.628 j}{1^2 + (0.628)^2}$$

$$= (7170 - 4500 j)\ \Omega$$

$$Z_{tot} = Z_{C_1} + Z_{//}$$

$$= -\frac{j}{\omega C} + Z_{//} = \frac{-j}{314 \times 0.5\,10^{-6}} + (7170 - 4500\,j)$$

$$= -6370\,j + 7170 - 4500\,j$$

$$= (7170 - 10870\,j)\ \Omega$$

3. $\hat{V} = 120\,V$, $\hat{i} = ?$ $\qquad \hat{i} = \frac{\hat{V}}{Z} = \frac{120 \times \sqrt{2}}{7170 - 10870\,j}$

$\times\sqrt{2}$

$$= \frac{120 \times \sqrt{2}}{7170^2 + 10870^2} \times (7170 + 10870\,j)$$

$$= (5.08 + 7.69\,j)\,10^{-3} \times \sqrt{2}\,A.$$

4. $$i_{eff} = \frac{V_{eff}}{|Z|} = (5.08^2 + 7.69^2)^{1/2} \times 10^{-3} \times \frac{\sqrt{2}}{\sqrt{2}}$$

$$= 9.2\,10^{-3}\,A.$$

5. $$\varphi = \operatorname{arctg} \frac{7.69}{5.08} = 0.987\ \text{rad}$$

6. $$\langle P \rangle = V_{eff}\, i_{eff} \cos\varphi = 120 \times 9.2\,10^{-3} \times \cos 0.987$$

$$= 0.61\ W.$$

7. Cette puissance est dissipée dans la résistance.

8. $$\hat{V}_{tot} = 120 = \hat{V}_{c_1} + \hat{V}_{//}$$

$$= Z_{c_1} \hat{I}_1 + \hat{V}_{//}$$

$$\longrightarrow \hat{V}_{//} = 120 - Z_{c_1} \hat{I}_1$$

$$= 120 + \frac{j}{314 \times 0.5\ 10^{-6}} \times (5.08 + 7.69 j)\, 10^{-3}$$

$$= 120 + j \times 63\cancel{70} \times (5.08 + 7.69 j)\, 10^{-3}$$

$$= 120 + 32.36 j - 49$$

$$= 71 + 32{,}36 j$$

9. $$P = \frac{V_{//}^2}{R} = \frac{71^2 + 32{,}4^2}{10^4} = 0.61\ W$$

10. Idem

11. Oui elle fondra !

Q3

a. $\frac{1}{2} m v^2 = mgh \rightarrow v^2 = 2gh \rightarrow v = (2 \times 10 \times 100)^{1/2}$

$= \sqrt{2000} = 44.7 \text{ m/s}.$

b. $E_{\text{transféré}} = E_c(\text{avant}) - E_c(\text{après})$

$= \frac{1}{2} m v^2 - \frac{1}{2} m (0.2\, v)^2$

$= \frac{1}{2} m\, 0.96\, v^2 = 0.96 \frac{1}{2} m v^2$

$= 0.96\ E_c(\text{avant}) = 0.96\ E_{\text{pot}}(\text{sommet})$

mais 15% de cette énergie est perdue en chaleur :

$E_{\text{électrique}} = 0.85\ E_{\text{transféré}}$

$= 0.85 \times 0.96\ E_c(\text{avant}) = 0.85 \times 0.96 \times \frac{1}{2} m \times 2000 \text{ J}$

$= 816 \times m \text{ J}$

Or débit de 600 kg s^{-1} :

$\frac{\Delta K}{\Delta t} = 816 \times 600 \text{ J s}^{-1} = 489.6 \text{ kW}.$

c. Les pals de la turbine font tourner un alternateur qui alimente une ligne à haute tension efficace de 100 kV à 50 Hz

$\frac{\Delta K}{\Delta t} = 489.6 \text{ kW} = 100 \text{ kV} \times I_{eff} \times \cos 10°$

$\rightarrow I_{eff} = \frac{489.6\ 10^3}{10^5 \times \cos 10°} = 4.97 \text{ A}$

d. $R = \rho \frac{l}{A} = 1.7\ 10^{-8}\ \frac{100 \times 10^3}{\pi \left(\frac{10^{-1}}{2}\right)^2} = 0.216\ \Omega$

$$P_J = I_{eff}^2 \times R = (4.97)^2 \times 0.216 = 5.34 \text{ W}$$

$$f = \frac{P_J}{P_{transp.}} = \frac{5.34}{489.6 \; 10^3} = 1.09 \; 10^{-5}$$

e. circuit RL série : $Z_{tot} = Z_R + Z_L$

$$= R + j\omega L$$

$$\operatorname{tg} \varphi = \frac{\omega L}{R} = \operatorname{tg} 10^\circ$$

$$\rightarrow \frac{\omega L}{R} = \operatorname{tg} 10^\circ$$

$$\rightarrow L = \frac{R}{\omega} \operatorname{tg} 10^\circ$$

$$= \frac{0.054}{50 \times 2 \times \pi} \times \operatorname{tg} 10$$

$$= \frac{0.054}{314} \operatorname{tg} 10^\circ$$

$$\rightarrow L = 3.03 \, 10^{-5} \text{ H.}$$