Exercice 29 p 90 :

a) Expressions des concentrations effectives :

$$NaCl_{(s)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$$

n_1	0	0
$n_1 - x_{max}$	x_{max}	x_{max}

$\Rightarrow x_{max} = n_1 \Rightarrow n_{Na^+} = n_{Cl^-} = n_1$

$$Na_2SO_{4(s)} \longrightarrow 2Na^+_{(aq)} + SO_4^{2-}{}_{(aq)}$$

n_2	0	0
$n_2 - x_{max}$	$2x_{max}$	x_{max}

$\Rightarrow x_{max} = n_2 \Rightarrow n_{Na^+} = 2n_{SO_4^{2-}} = 2n_2$

Soit au final : $n_{Na^+} = n_1 + 2n_2$

$n_{SO_4^{2-}} = n_2$

$n_{Cl^-} = n_1$

Soit

$$\boxed{\begin{aligned} [Na^+] &= \frac{n_1 + 2n_2}{V_{solution}} = \frac{m_1}{M_{NaCl} \times V_{solution}} + \frac{2m_2}{M_{Na_2SO_4} \times V_{solution}} \\ [Cl^-] &= \frac{m_1}{M_{NaCl} \times V_{solution}} \\ [SO_4^{2-}] &= \frac{m_2}{M_{Na_2SO_4} \times V_{solution}} \end{aligned}}$$

b) Calcul de m_2 :

$$\sigma = [Na^+]\lambda_{Na^+} + [SO_4^{2-}]\lambda_{SO_4^{2-}} + [Cl^-]\lambda_{Cl^-}$$

$$\sigma = \left(\frac{m_1}{M_{NaCl} \times V_{solution}} + \frac{2m_2}{M_{Na_2SO_4} \times V_{solution}}\right)\lambda_{Na^+} + \frac{m_1}{M_{NaCl} \times V_{solution}} \times \lambda_{Cl^-} + \frac{m_2}{M_{Na_2SO_4} \times V_{solution}} \lambda_{SO_4^{2-}}$$

On factorise cette expression

Soit $\sigma = \dfrac{m_1}{M_{NaCl} \times V}(\lambda_{Na^+} + \lambda_{Cl^-}) + \dfrac{m_2}{M_{Na_2SO_4} \times V}(2\lambda_{Na^+} + \lambda_{SO_4^{2-}})$

$\Rightarrow \dfrac{m_2}{M_{Na_2SO_4} \times V}(2\lambda_{Na^+} + \lambda_{SO_4^{2-}}) = \sigma - \dfrac{m_1}{M_{NaCl} \times V}(\lambda_{Na^+} + \lambda_{Cl^-})$

$g.\cancel{mol}$ m^3 $S.m^{-1}$ $\cancel{g}$

$\Rightarrow \boxed{m_2 = \dfrac{M_{Na_2SO_4} \times V}{2\lambda_{Na^+} + \lambda_{SO_4^{2-}}}\left(\sigma - \dfrac{m_1}{M_{NaCl} \times V}(\lambda_{Na^+} + \lambda_{Cl^-})\right)}$

$\cancel{S\,m^2\,mol^{-1}}$ $\cancel{g.mol^{-1}}$ m^3 $\cancel{S\,m^2\,mol^{-1}}$

AN: $M_{Na_2SO_4} = 2 \times 23{,}0 + 32{,}1 + 4 \times 16{,}0 = 142\ g.mol^{-1}$

$M_{NaCl} = 23{,}0 + 35{,}5 = 58{,}5\ g.mol^{-1}$

$\sigma = 40\ mS.m^{-1} = 40.10^{-3}\ S.m^{-1}$

$\lambda_{Na^+} = 5{,}008.10^{-3}\ S\,m^2\,mol^{-1}$ $m_1 = 200.10^{-3}\ g.$

$\lambda_{Cl^-} = 7{,}631 \times 10^{-3}\ S\,m^2\,mol^{-1}$

$\lambda_{SO_4^{2-}} = 16{,}0 \times 10^{-3}\ S\,m^2\,mol^{-1}$

$V = 2{,}0\,L = 2{,}0.10^{-3}\ m^3$

$$m_2 = \frac{142 \times 2{,}0.10^{-3}}{2 \times 5{,}008.10^{-3} + 16{,}0.10^{-3}}\left(40.10^{-3} - \frac{200.10^{-3}}{58{,}5 \times 2{,}0.10^{-3}}(5{,}008.10^{-3} + 7{,}631 \times 10^{-3})\right)$$

$\boxed{m_2 = 2{,}0.10^{-1}\ g}$

c) Diminution de volume :

On a $\sigma = \dfrac{m_1}{M_{NaCl} \times V}(\lambda_{Na^+} + \lambda_{Cl^-}) + \dfrac{m_2}{M_{Na_2SO_4} \times V}(2\lambda_{Na^+} + \lambda_{SO_4^{2-}})$

On constate donc que σ est proportionnel à $\dfrac{1}{V}$

Donc si V diminue de 20%, alors σ augmente de 20%.

Soit $\sigma' = \sigma + \dfrac{\sigma \times 20}{100} = \underline{\underline{48\ mS.m^{-1}.}}$