Base Nationale des Sujets d'Examens de l'enseignement professionnel

Campagne 2009

CORRIGE

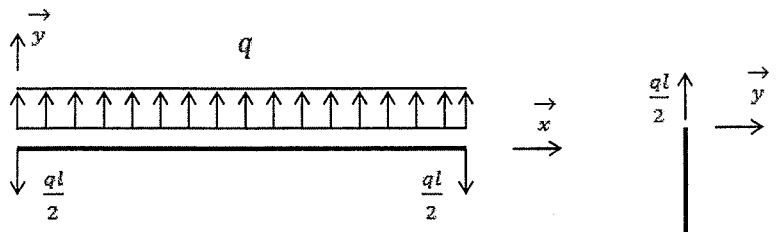
Ces éléments de correction n'ont qu'une valeur indicative. Ils ne peuvent en aucun cas engager la responsabilité des autorités académiques, chaque jury est souverain.

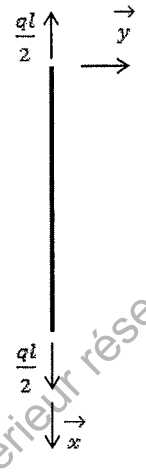
Mécanique

Eléments de correction

PARTIE 1 :

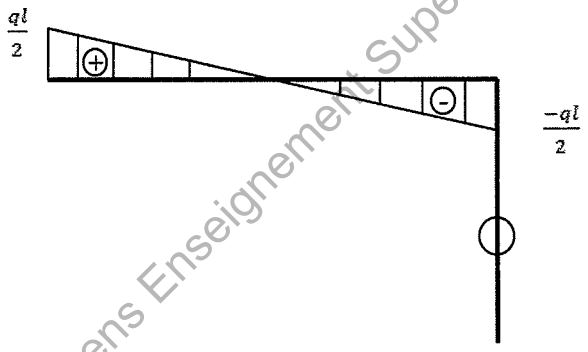
1.1





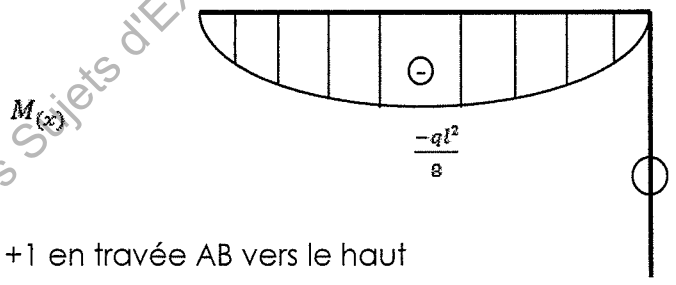
1.2 AB : $V_{(x)} = -qx + q\frac{l}{2}$

BC : $V_{(x)} = 0$

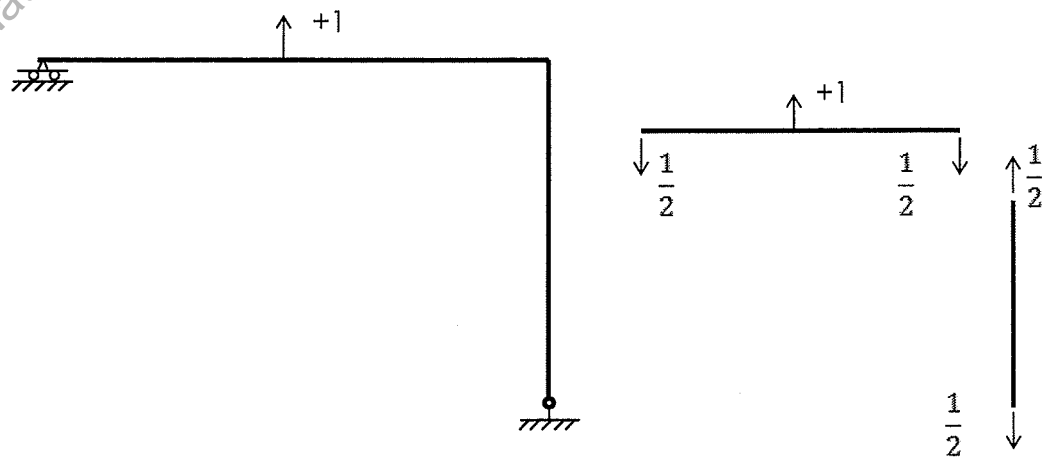


1.3 AB : $M_{(x)} = q\frac{x^2}{2} - q\frac{l}{2}x$

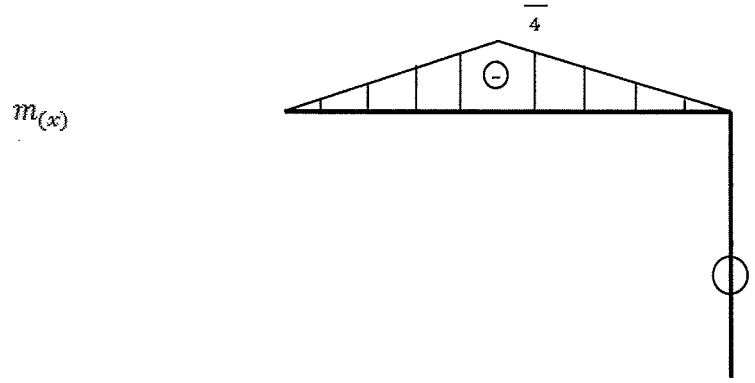
BC: $M_{(x)} = 0$



1.4 MDF charge +1 en travée AB vers le haut



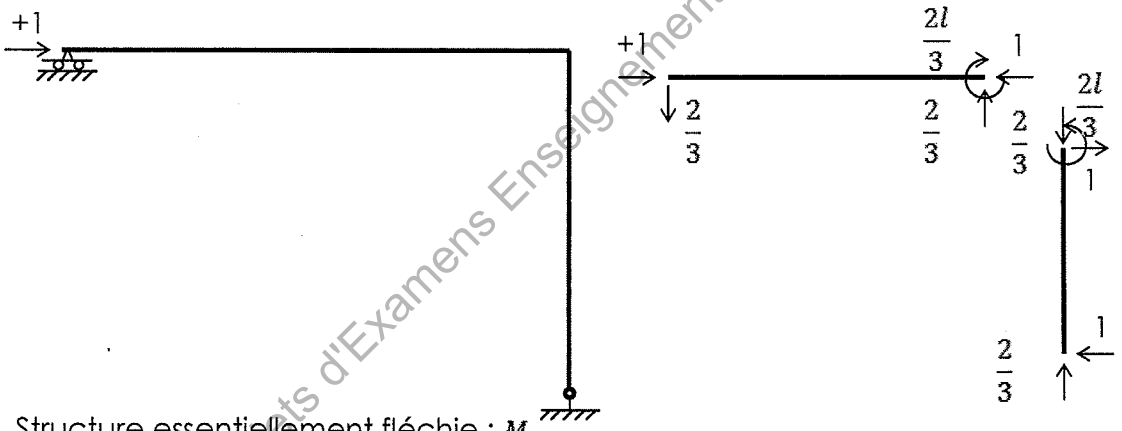
Structure essentiellement fléchie : $M_{(x)}$



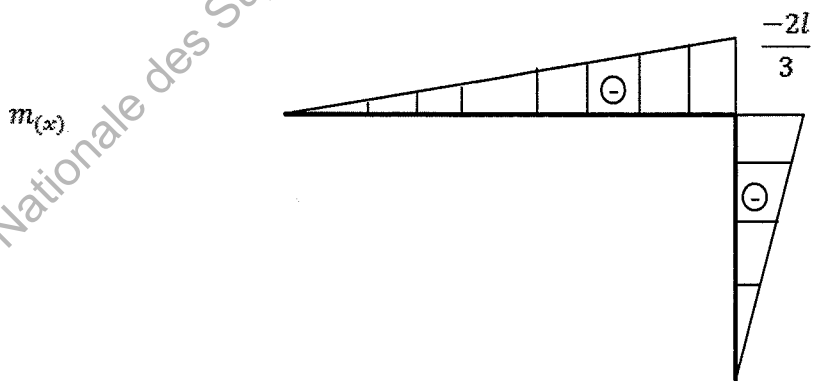
$\Delta_{T_{AB}} = \frac{l}{EI}\frac{1}{l}\int_{AB} Mmds + \frac{2l}{3EI}\frac{1}{\frac{2l}{3}}\int_{BC} Mmds = \frac{l}{EI}\left[\frac{5}{12}\left(\frac{-ql^2}{8}\right)\left(\frac{-l}{4}\right)\right] = \frac{5ql^4}{384EI}$ vers le haut (↑)

AN : $\Delta_{T_{AB}} = 62{,}8mm$

1.5 MDF charge +1 en A ou B si on néglige la compression dans (AB)



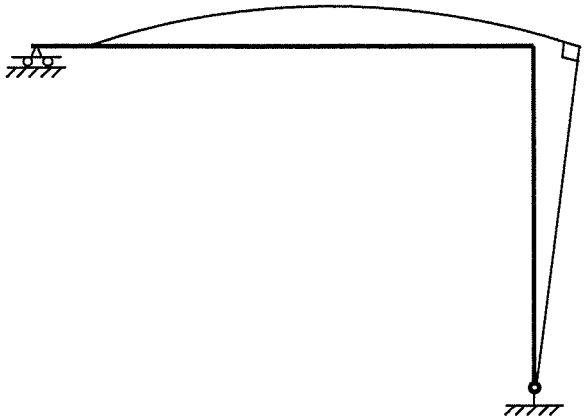
Structure essentiellement fléchie : $M_{(x)}$



$\Delta_{h\,(AB)} = \frac{l}{EI}\frac{1}{l}\int_{AB} Mmds + \frac{2l}{3EI}\frac{1}{\frac{2l}{3}}\int_{BC} Mmds = \frac{l}{EI}\left[\frac{1}{3}\left(\frac{-ql^2}{8}\right)\left(\frac{-2l}{3}\right)\right] = \frac{ql^4}{36EI}$ vers la droite (→)

AN : $\Delta_{h(AB)} = 134mm$

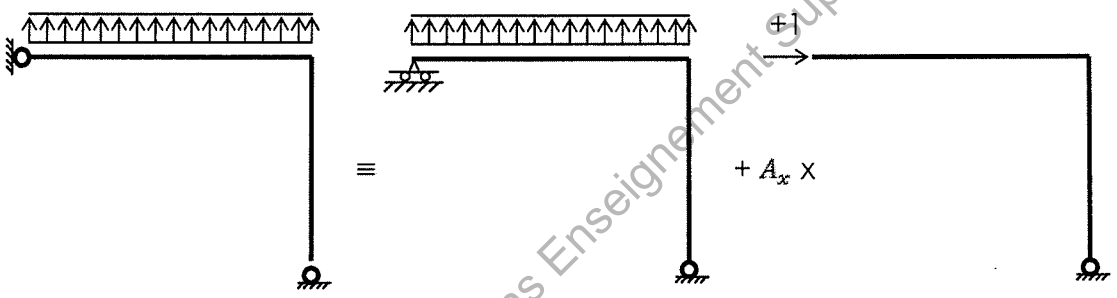
1.6



PARTIE 2 :

2.1 $1l_3 + 2l_2 + 0l_1$-3b=3+4-6=1 hyper degré 1

2.2 choix A_x car structure ISO associée de la partie 1



$\Delta_{10} + A_x\delta_{11} = 0$

S_0 étudié partie 1

S_1 étudié partie 1

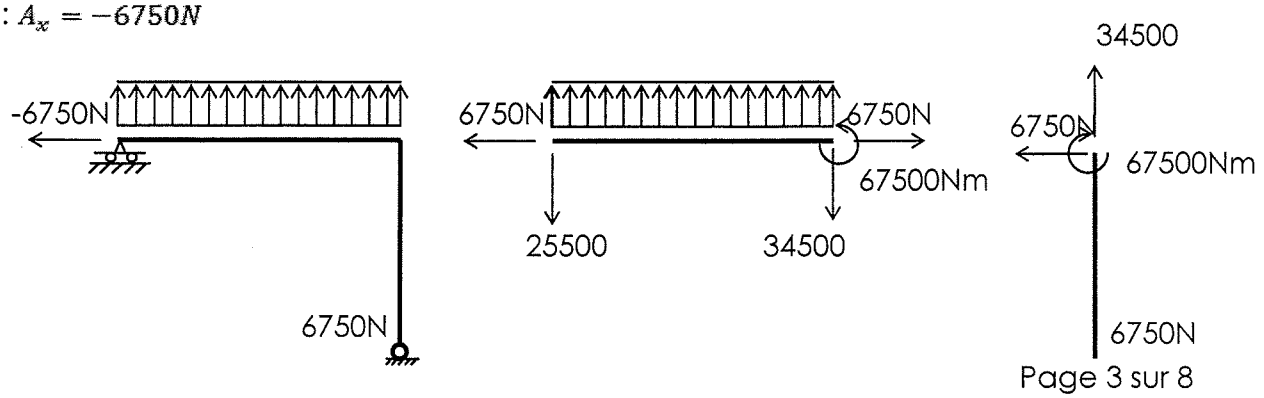
$\Delta_{10} = \frac{ql^4}{36EI}$

$\delta_{11} = \frac{l}{EI}\left[\frac{1}{3}\left(\frac{-2l}{3}\right)\left(\frac{-2l}{3}\right)\right] + \frac{2l}{3EI}\left[\frac{1}{3}\left(\frac{-2l}{3}\right)\left(\frac{-2l}{3}\right)\right] = \frac{4l^3}{27EI} + \frac{8l^3}{81EI} = \frac{20l^3}{81EI}$

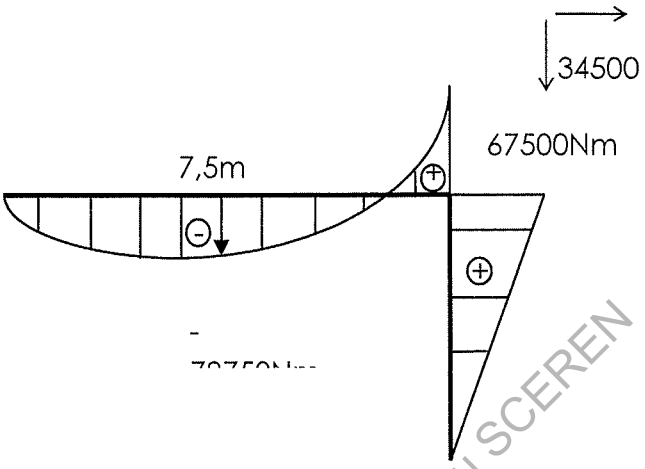
$A_x = \frac{-\Delta_{10}}{\delta_{11}} = \frac{-9ql}{80}$

AN : $A_x = -6750N$

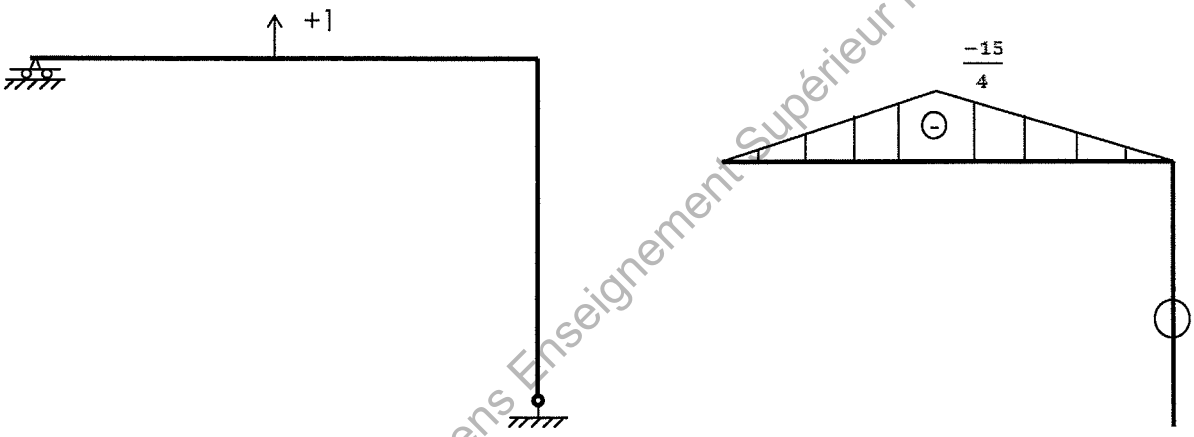
2.3



2.4 $M_{(x)} = 4000\frac{x^2}{2} - 25500x$



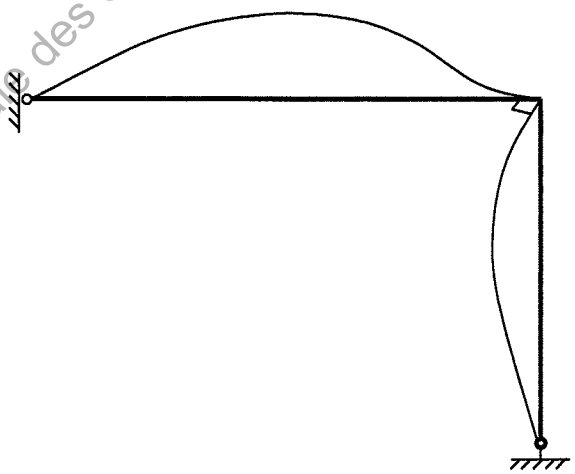
2.5 MDF charge +1milieu AB sur n'importe quelle structure ISO associée



$$\Delta = \frac{l}{EI}\left[\frac{1}{24}m(M_1 + 10M_0 + M_2)\right] = \frac{15}{EI}\left[\frac{1}{24}\left(\frac{-15}{4}\right)(0 - 787500 + 67500)\right] = 0{,}04m$$

Soit $4cm$ vers le haut (↑)

2.6



PARTIE 3 :

3.1 $2l_3 + 1l_2 + 0l_1$-3b=6+2-6=2 Hyper degré 2

3.2 MDR

- 1 inc cinématique ω_B
- Equations intrinsèques

$$AB \begin{cases} M_{AB} = 0 \\ M_{BA} = \frac{3EI}{l}(\omega_B) + \overline{M_{BA}} \end{cases} \qquad \overline{M_{BA}} = \frac{ql^2}{8}$$

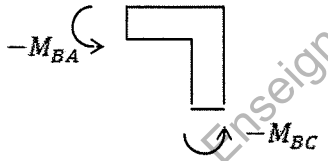
$$BC \begin{cases} M_{BC} = \frac{2EI}{\left(\frac{2l}{3}\right)}(2\omega_B + \omega_C) + M^e_{BC} \; avec \; M^e_{BC} = 0 \\ M_{CB} = \frac{2EI}{\left(\frac{2l}{3}\right)}(\omega_B + 2\omega_C) + M^e_{CB} \; avec \; M^e_{CB} = 0 \end{cases} \text{ et } \omega_C = 0$$

$Soit :$

$$AB \begin{cases} M_{AB} = 0 \\ M_{BA} = \frac{3EI}{l}(\omega_B) + \frac{ql^2}{8} \end{cases}$$

$$BC \begin{cases} M_{BC} = \frac{6EI}{l}\omega_B \\ M_{CB} = \frac{3EI}{l}\omega_B \end{cases}$$

- Equations d'équilibre

Nœud B 

$$M_{BA} + M_{BC} = 0$$

- Résolution

$$\frac{3EI}{l}\omega_B + \frac{ql^2}{8} + \frac{6EI}{l}\omega_B = 0$$

Soit $\omega_B = \frac{-ql^3}{72EI}$

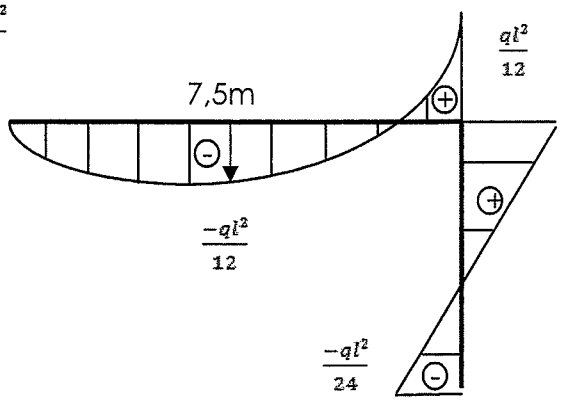
3.3 Calcul des M_{ij}

$$M_A = -M_{AB} = 0$$

$$M_{B/_{AB}} = M_{BA} = \frac{ql^2}{12}$$

$$M_{B/_{BC}} = -M_{BC} = \frac{ql^2}{12}$$

$$M_C = M_{CB} = \frac{-ql^2}{24}$$



$$M_{T_{AB}} = M_{T_{0\,AB}} + \left(\frac{M_g + M_d}{2}\right) = \frac{-ql^2}{8} + \left(\frac{0 + \frac{ql^2}{12}}{2}\right) = \frac{-ql^2}{12}$$

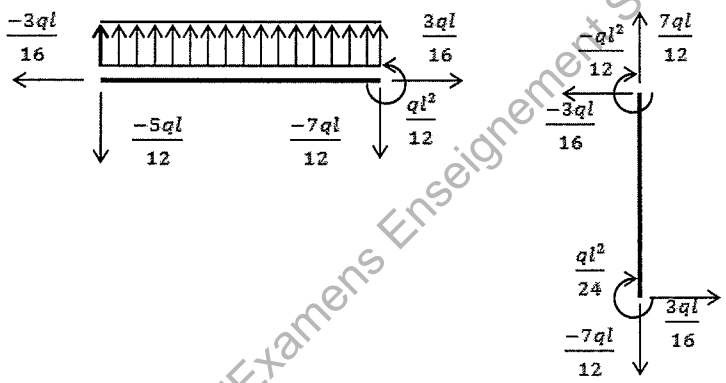
3.4 Actions aux appuis V_{ij}

$$V_{AB} = v_{AB} + \frac{M_{AB} + M_{BA}}{l} = \frac{-ql}{2} + \frac{ql}{12} = \frac{-5ql}{12}$$

$$V_{BA} = v_{BA} - \frac{M_{AB} + M_{BA}}{l} = \frac{-ql}{2} - \frac{ql}{12} = \frac{-7ql}{12}$$

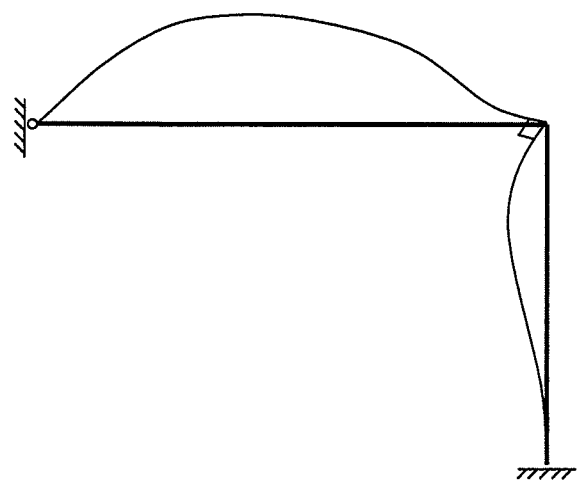
$$V_{BC} = v_{BC} + \frac{M_{BC} + M_{CBA}}{\frac{2l}{3}} = 0 + \left(\frac{\frac{-ql^2}{12} + \frac{-ql^2}{24}}{\frac{2l}{3}}\right) = \frac{-3ql}{16}$$

$$V_{CB} = v_{CB} - \frac{M_{BC} + M_{CB}}{\frac{2l}{3}} = 0 - \left(\frac{\frac{-ql^2}{12} + \frac{-ql^2}{24}}{\frac{2l}{3}}\right) = \frac{3ql}{16}$$



3.5 $\Delta_{T_{AB}} = \frac{3ql^4}{384EI} = 0{,}037m \; soit \; 37mm$

3.6



PARTIE 4 :

4.1 $X_G = 0$ pour des raisons des symétrie.

$$Y_G = \frac{95\times5380+300\times6430}{(5380+6430)} = \frac{2440100}{11810} = 206,61mm$$

4.2 $I_{GY} = 5409,7 + 1335,6 = 6745,3cm^4$

$$W_{el.Y} = \frac{I_{GY}}{v_Y} = \frac{6745,3}{10,5} = 642,4cm^3$$

$$i_Y = \sqrt{\frac{I_{GY}}{A}} = \sqrt{\frac{6745,3}{118,1}} = 7,56cm$$

4.3

$I_{GX} = (1954,5 + 64,3 \times 9,34^2)_{HEA220}+(3692,2 + 53,8 \times 11,16^2)_{HEA200}$=7563,75+10393,05

$$I_{GX} = 17956,8cm^4$$

$$W_{el.X} = \frac{I_{GX}}{v_X} = \frac{17956,8}{20,66} = 869,16cm^3$$

$$i_X = \sqrt{\frac{I_{GX}}{A}} = \sqrt{\frac{17956,8}{118,1}} = 12,33cm$$

Document réponse DR1