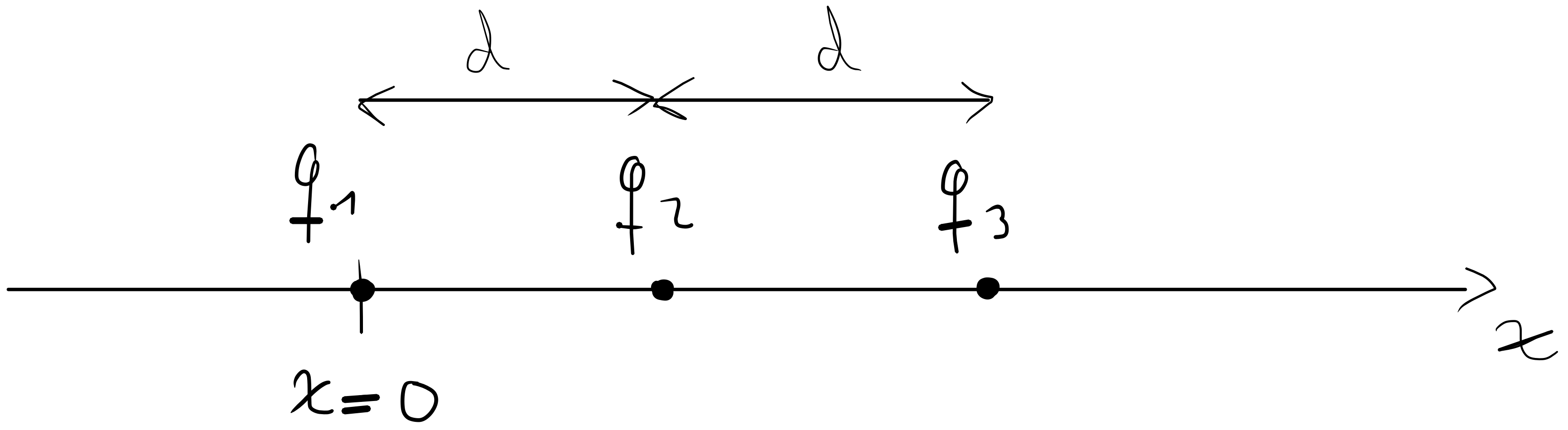
1



a) $\underline{\vec{E}_{2(x=0)}}$: $q_2 = -2\mu C$; $\vec{r}_2' = d\,\hat{\imath}$; $\vec{r} = \vec{0}$

$$\vec{E}_{2(x=0)} = k_e \frac{q_2}{\|\vec{0} - d\,\hat{\imath}\|^3}\left(\vec{0} - d\,\hat{\imath}\right) = k_e \frac{+2\mu C}{d^3}\, d\,\hat{\imath} = k_e \frac{2\mu C}{d^2}\,\hat{\imath}$$

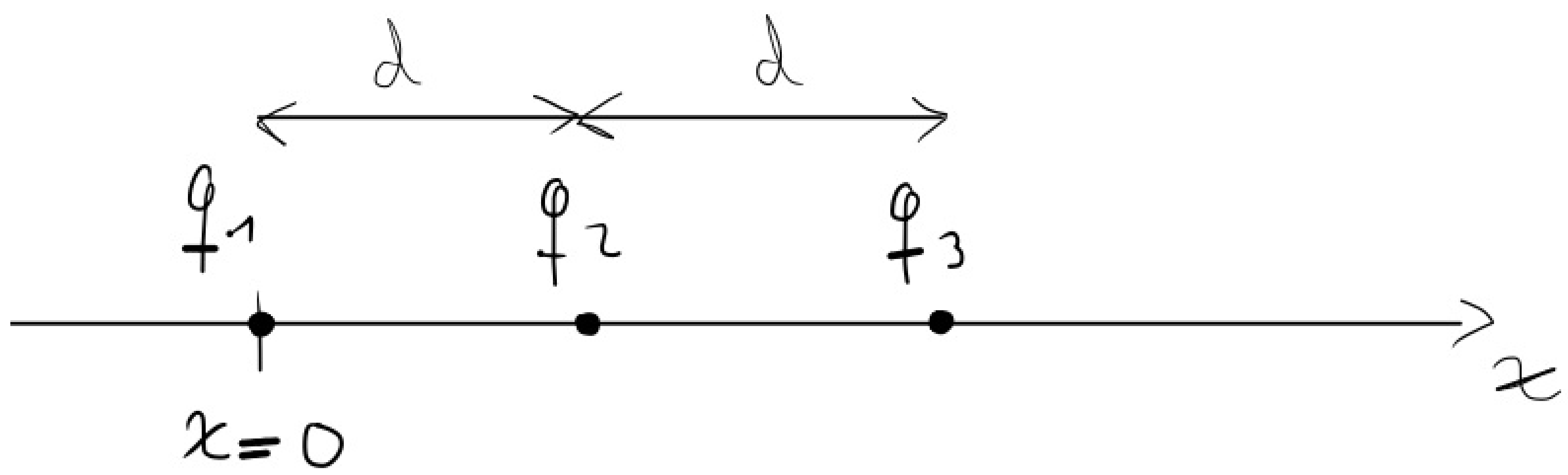
$\vec{E}_{3(x=0)}$: $q_3 = 1\mu C$; $\vec{r}_3' = 2d\hat{\imath}$; $\vec{r} = \vec{0}$

$$\vec{E}_{3(x=0)} = k_e \frac{q_3}{\|\vec{0} - 2d\hat{\imath}\|^3}(\vec{0} - 2d\hat{\imath}) = \frac{-k_e \cdot 1\mu C}{4d^2}\hat{\imath}$$

$$\vec{F} = q_1 \left[\vec{E}_{2(x=0)} + \vec{E}_{3(x=0)}\right]$$

$$= 3\mu C \left[\frac{2\mu C}{d^2} - \frac{1\mu C}{4d^2}\right] k_e \hat{\imath} = \frac{21}{4}\frac{(\mu C)^2}{d^2} k_e \hat{\imath}$$

b)



$\underline{\vec{E}_{1(x)}:}$ $\quad q_1 = 3\mu C \;;\; \vec{r}_1' = \vec{0} \;;\; \vec{r} = x\,\hat{\imath}$

$$\vec{E}_{1(x)} = k_e \frac{3\mu C}{x^2} \frac{x}{|x|}\,\hat{\imath}$$

$\underline{\vec{E}_{2(x)}:}$ $\quad q_2 = -2\mu C \; ; \; \vec{r}\,'_2 = d\,\hat{i} \; ; \; \vec{r} = x\,\hat{i}$

$$\vec{E}_{2(x)} = k_e \frac{-2\mu C}{|x-d|^2} \frac{(x-d)}{|x-d|}\,\hat{i}$$

$\underline{\vec{E}_{3(x)}:}$ $\quad q_3 = 1\mu C \; ; \; \vec{r}\,'_3 = 2d\,\hat{i} \; ; \; \vec{r} = x\,\hat{i}$

$$\vec{E}_{3(x)} = k_e \frac{1\mu C}{|x-2d|^2} \frac{(x-2d)}{|x-2d|}\,\hat{i}$$

$$
\vec{E}_{(x)}
\begin{cases}
k_e\left[\dfrac{-3\mu C}{x^2}+\dfrac{2\mu C}{(x-d)^2}-\dfrac{1\mu C}{(x-2d)^2}\right]\hat{\imath} & \text{si } x<0\\[2ex]
k_e\left[\dfrac{+3\mu C}{x^2}+\dfrac{2\mu C}{(x-d)^2}-\dfrac{1\mu C}{(x-2d)^2}\right]\hat{\imath} & \text{si } 0<x<d\\[2ex]
k_e\left[\dfrac{+3\mu C}{x^2}-\dfrac{2\mu C}{(x-d)^2}-\dfrac{1\mu C}{(x-2d)^2}\right]\hat{\imath} & \text{si } d<x<2d\\[2ex]
k_e\left[\dfrac{+3\mu C}{x^2}-\dfrac{2\mu C}{(x-d)^2}+\dfrac{1\mu C}{(x-2d)^2}\right]\hat{\imath} & \text{si } x>2d
\end{cases}
$$

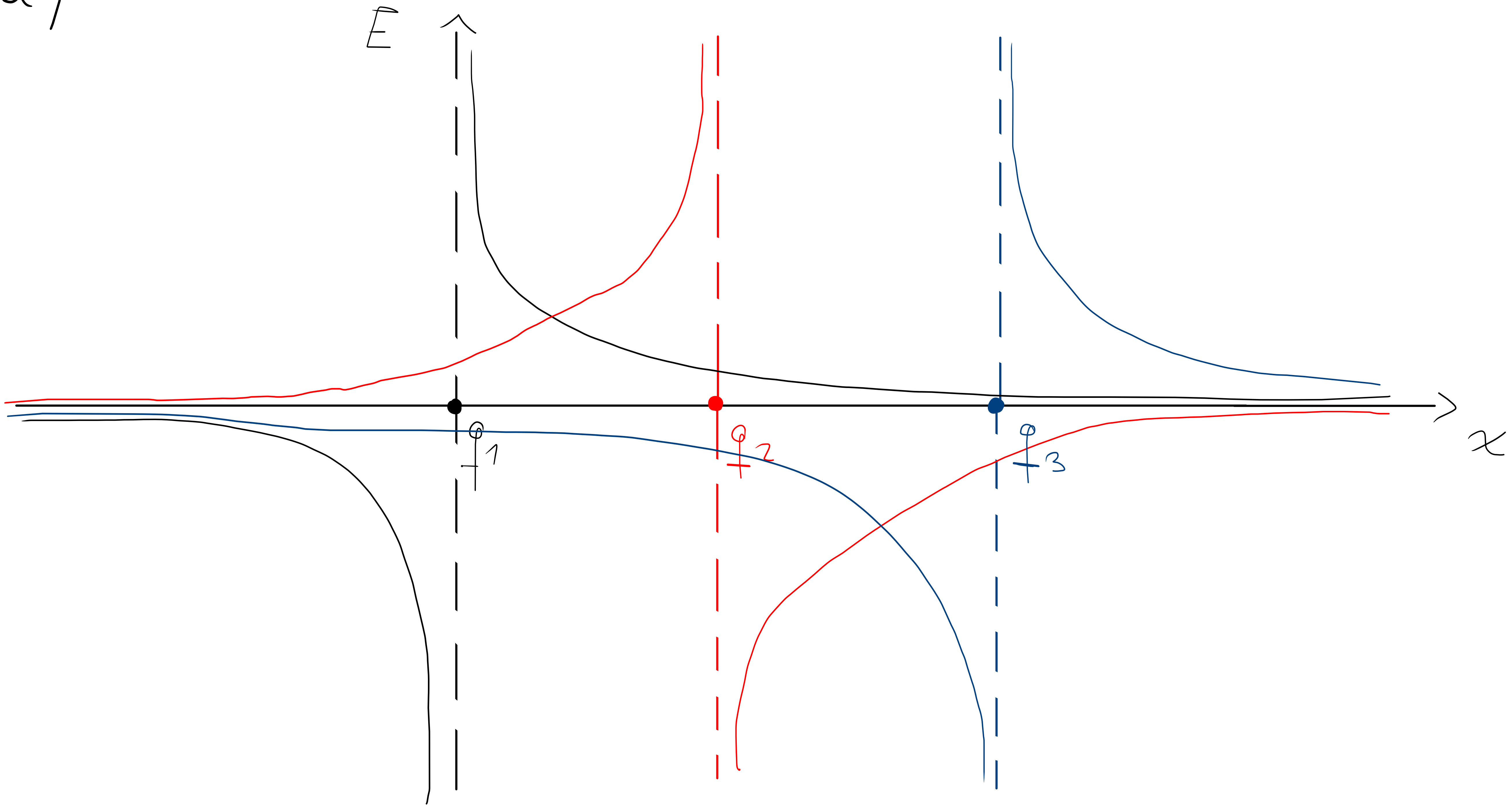
c) $V = k_e \dfrac{q}{\|\vec{r} - \vec{r}'\|}$

$V_{1(x)} = k_e \dfrac{3\mu C}{|x|}$; $V_{2(x)} = k_e \dfrac{-2\mu C}{|x-d|}$

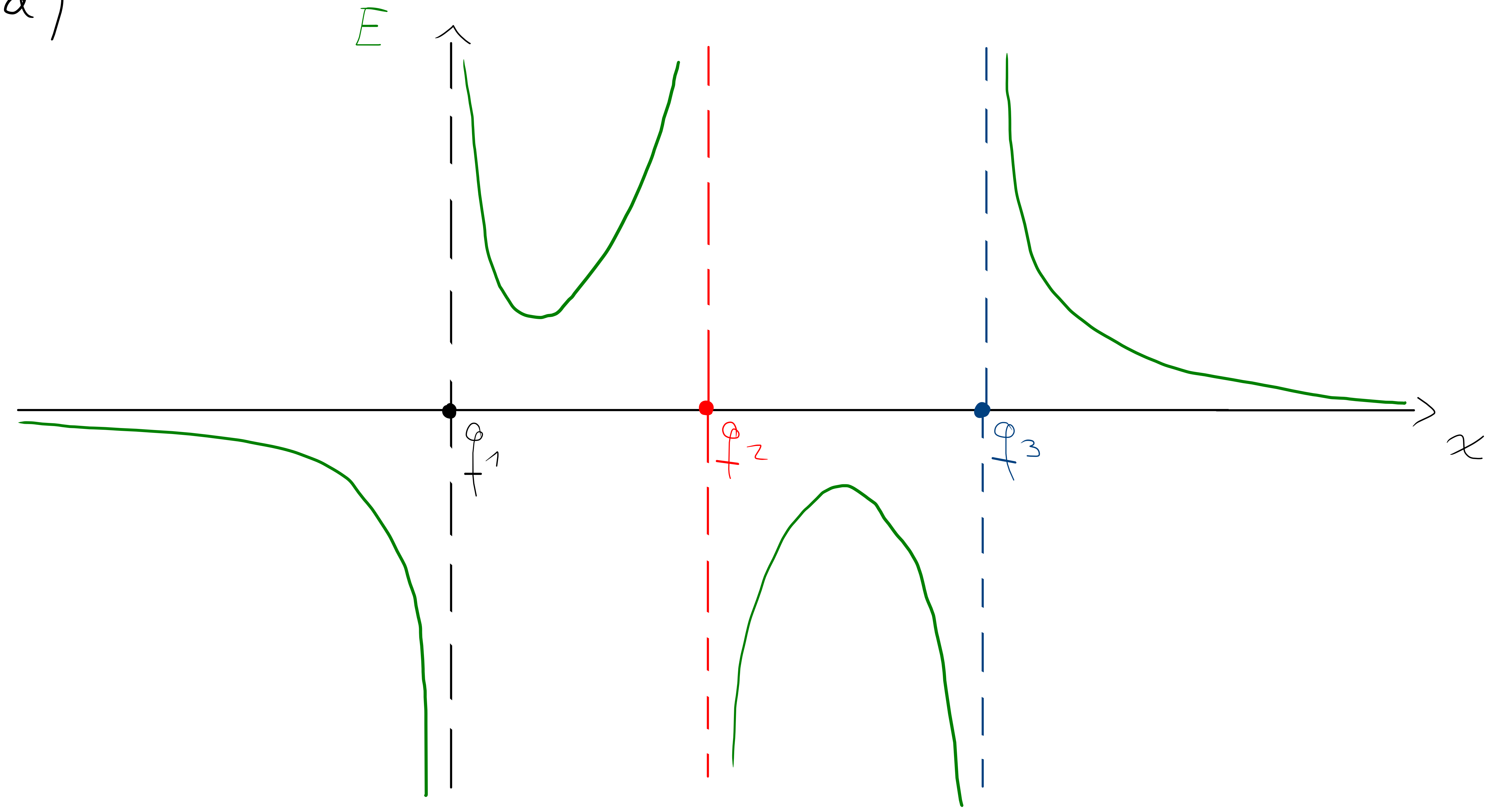
$V_{3(x)} = k_e \dfrac{1\mu C}{|x-2d|}$

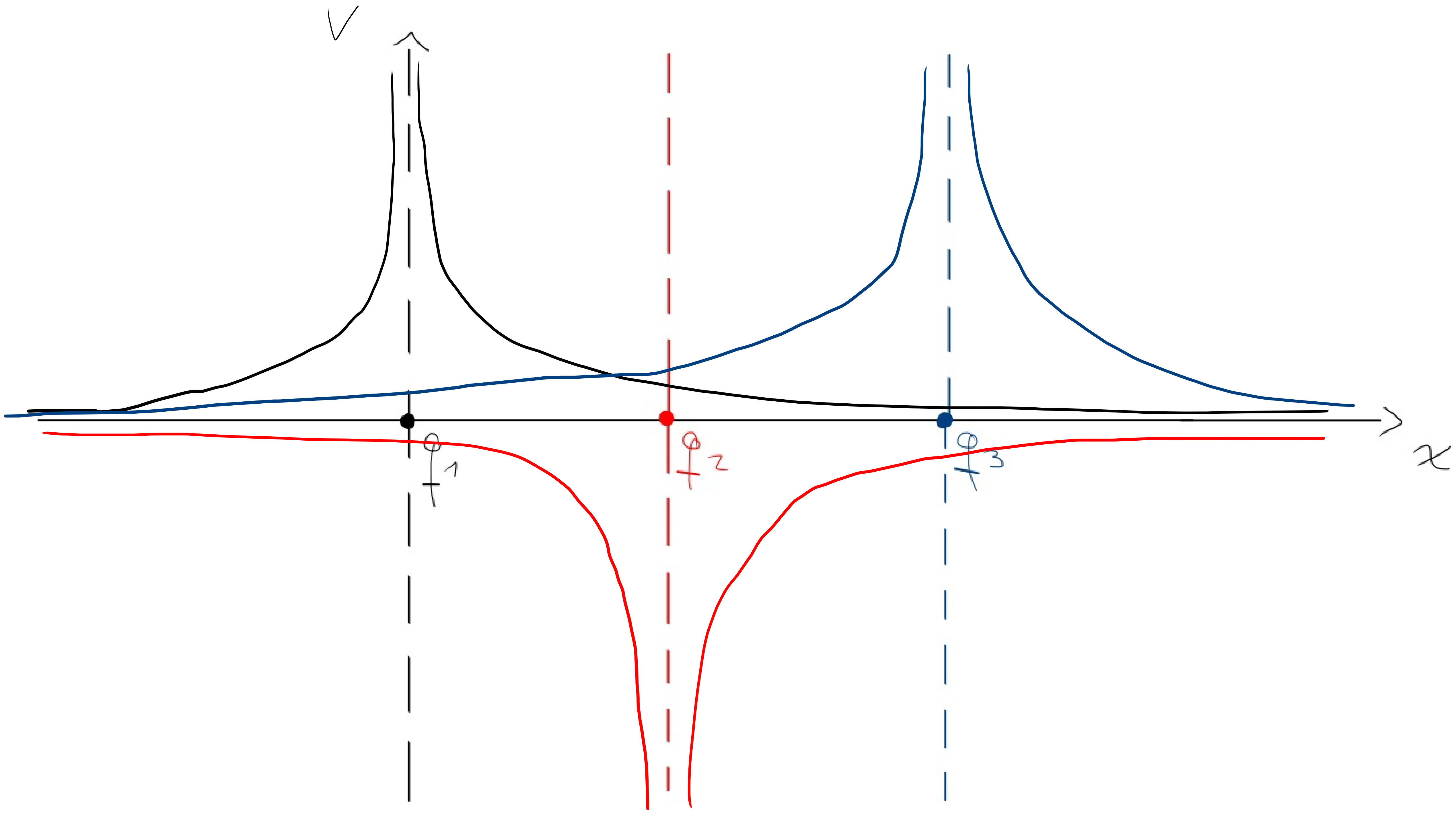
$$V_{(x)} \begin{cases} k_e \left[\dfrac{-3\mu C}{x} + \dfrac{2\mu C}{x-d} - \dfrac{1\mu C}{x-2d} \right] & \text{si } \; x < 0 \\[2ex] k_e \left[\dfrac{+3\mu C}{x} + \dfrac{2\mu C}{x-d} - \dfrac{1\mu C}{x-2d} \right] & \text{si } \; 0 < x < d \\[2ex] k_e \left[\dfrac{+3\mu C}{x} - \dfrac{2\mu C}{x-d} - \dfrac{1\mu C}{x-2d} \right] & \text{si } \; d < x < 2d \\[2ex] k_e \left[\dfrac{+3\mu C}{x} - \dfrac{2\mu C}{x-d} + \dfrac{1\mu C}{x-2d} \right] & \text{si } \; x > 2d \end{cases}$$

d)

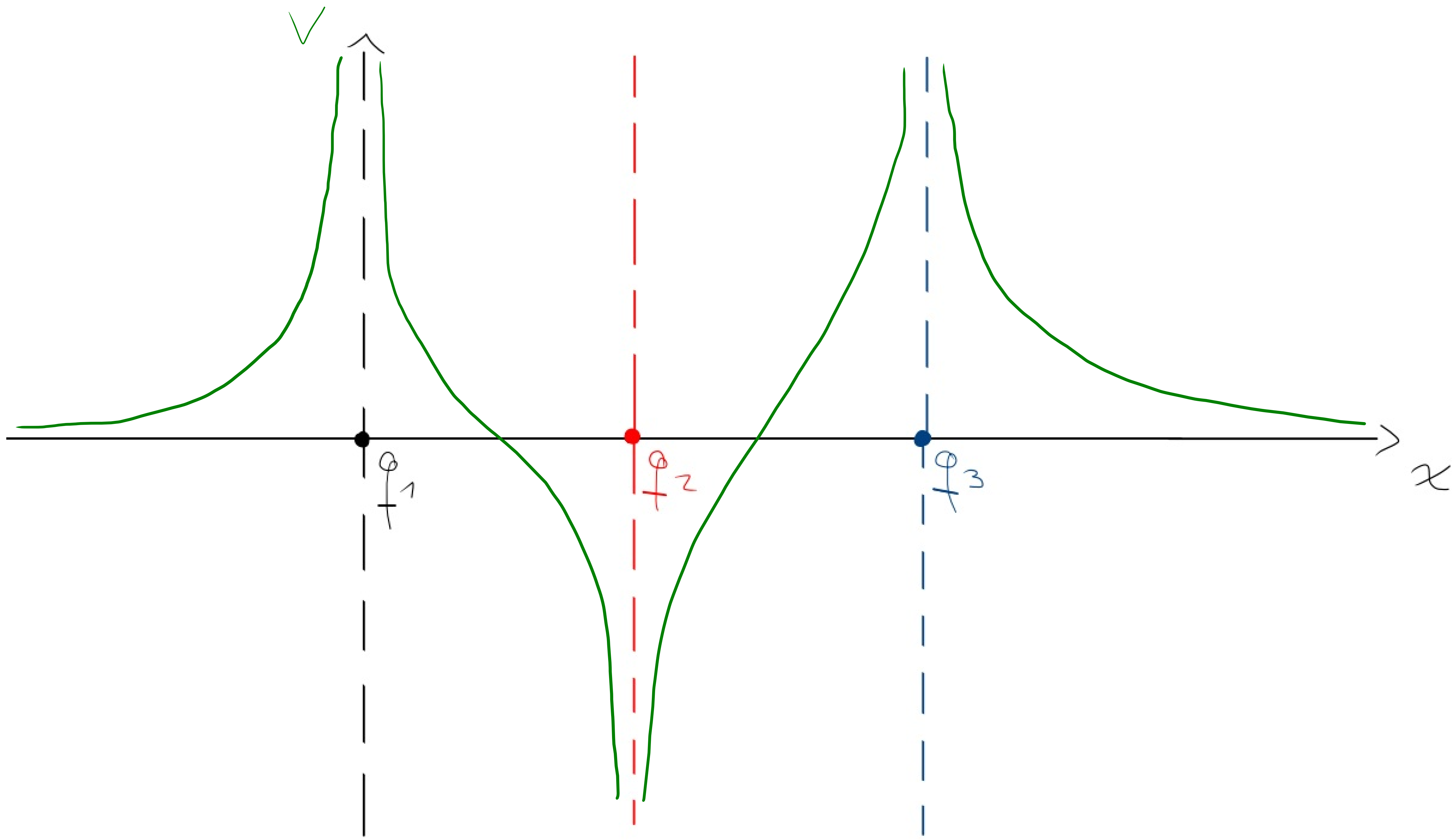


d)



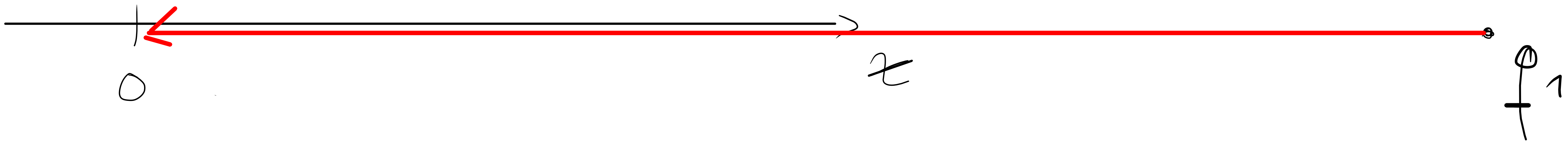


V
x
φ_1
φ_2
φ_3



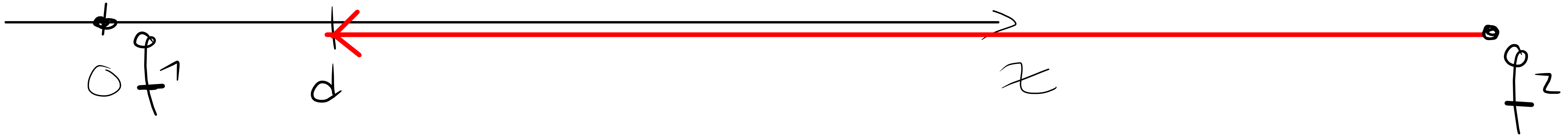
V
φ_1
φ_2
φ_3
x

e)



$W_1 \to W$ para traer a φ_1 desde ∞

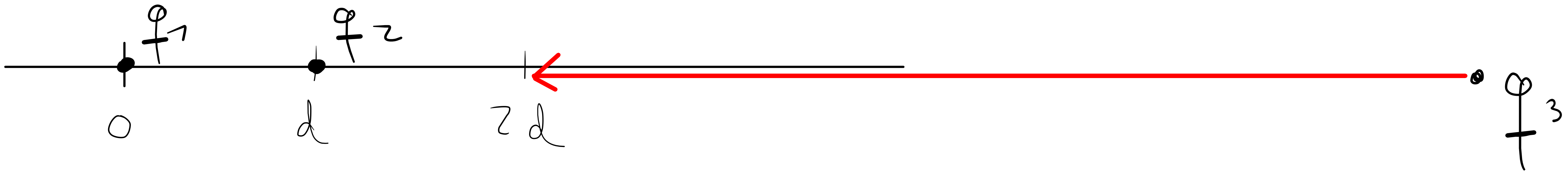
$W_1 = 0$



$W_2 \to W$ para traer a q_2 desde ∞

$$W_2 = q_2 V_1(x=d) = q_2 k_e \frac{q_1}{d}$$

$$W_2 = \frac{-6 k_e (\mu C)^2}{d}$$



$W_3 \rightarrow W$ para traer a q_3 desde ∞

$$W_3 = q_3\left[V_{1(z=2d)} + V_{2(z=2d)}\right] = q_3\left[k_e \frac{q_1}{2d} + k_e \frac{q_2}{d}\right]$$

$$= -\frac{1}{2}\frac{k_e(\mu C)^2}{d}$$

$$W = W_1 + W_2 + W_3$$

$$W = 0 - \frac{6 k_e (\mu C)^2}{d} - \frac{1}{2} \frac{k_e (\mu C)^2}{d}$$

$$W = \frac{-13}{2} \frac{k_e (\mu C)^2}{d}$$