Exercise 1a

$$
\begin{aligned}
\frac{\partial C}{\partial q_i} &= \frac{\partial}{\partial q_i} \sum_j p_j \log(\frac{p_j}{q_j}) \\
&= \sum_j \frac{\partial}{\partial q_i} \left(p_j \log(\frac{p_j}{q_j}) \right) \\
&= \sum_j \frac{\partial}{\partial q_i} \left(p_j \log(p_j) - p_j log(q_j) \right) \\
&= \sum_j \left(-p_j \frac{\partial}{\partial q_i} log(q_j) \right)
\end{aligned}
$$

Since

$$
\frac{\partial}{\partial q_i} log(q_j) = \begin{cases} 0 & , i \neq j \\ \frac{1}{q_i} & , i = j \end{cases},
$$

$$
\frac{\partial C}{\partial q_i} = -\frac{p_i}{q_i}.
$$

Exercise 1b

$$
\begin{aligned}
\frac{\partial C}{\partial x_i} &= \frac{\partial}{\partial x_i} \sum_j p_j \log(\frac{p_j}{q_j}) \\
&= \sum_j \frac{\partial}{\partial x_i} \left(p_j \log(p_j) - p_j log(q_j)\right) \\
&= \sum_j \left(-p_j \frac{\partial}{\partial x_i} log(q_j)\right) \\
&= \sum_j \left(-p_j \frac{\partial}{\partial x_i} log(\frac{e^{x_j}}{\sum_k e^{x_k}})\right) \\
&= \sum_j \left(-p_j \frac{\partial}{\partial x_i} (x_j - log(\sum_k e^{x_k}))\right) \\
&= \sum_j \left(-p_j \frac{\partial}{\partial x_i} x_j\right) + \sum_j \left(p_j \frac{\partial}{\partial x_i} log(\sum_k e^{x_k})\right) \\
&= \sum_j \left(-p_j \frac{\partial}{\partial x_i} x_j\right) + \sum_j \left(p_j \frac{1}{\sum_k e^{x_k}} \frac{\partial}{\partial x_i} \sum_k e^{x_k}\right) \\
&= \sum_j \left(-p_j \frac{\partial}{\partial x_i} x_j\right) + \sum_j \left(p_j \frac{e^{x_i}}{\sum_k e^{x_k}}\right) \\
&= \sum_j \left(-p_j \frac{\partial}{\partial x_i} x_j\right) + q_i \sum_j p_j \\
&= \sum_j \left(-p_j \frac{\partial}{\partial x_i} x_j\right) + q_i
\end{aligned}
$$

Since

$$
\frac{\partial}{\partial x_i} x_j = \begin{cases} 0 & , i \neq j \\ 1 & , i = j \end{cases},
$$

$$
\frac{\partial C}{\partial x_i} = -p_i + q_i
$$