1. A

$$\begin{aligned} f(\beta) &= (y - X\beta)^T W (y - X\beta) \\ &= \beta^T X^T W X \beta - 2y^T W X \beta + \cdots \\ &= \beta^T X^T W X \beta - 2y^T W^T X^T (X^T W X)^{-1} X^T W X \beta + \cdots \\ &= (\beta - (X^T W X)^{-1} X^T W y)^T X^T W X (\beta - (X^T W X)^{-1} X^T W y) + (1) \end{aligned}$$

2. A

$$\begin{aligned} l(\beta) &= -\log(\prod_i (y_i \omega_i(\beta) + (1 - y_i)(1 - \omega_i(\beta)))) \\ &= -\sum_i \log((2y_i - 1)\omega_i(\beta) + (1 - y_i)) \qquad (2) \end{aligned}$$

$$\frac{\partial \omega_i}{\partial \beta_j} = \frac{x_{ij} \exp(-x_i \beta)}{(1 + \exp(-x_i \beta))^2} = x_{ij} \omega_i (1 - \omega_i)$$

$$\frac{\partial l}{\partial \beta_j} = \sum_i \frac{x_{ij} \omega_i (1 - \omega_i)(2y_i - 1)}{(2y_i - 1)\omega_i(\beta) + (1 - y_i)}$$