1. **Assume that $\boldsymbol{\beta_0 = 1}$.**

   (a) Rewrite the regression model as

   $$y' = y - \beta_0 = \beta_1 x_1 + \beta_2 x_2 + e.$$

   $X^T X = \begin{pmatrix} \sum_{i=1}^n x_{i1}^2 & \sum_{i=1}^n x_{i1}x_{i2} \\ \sum_{i=1}^n x_{i1}x_{i2} & \sum_{i=1}^n x_{i2}^2 \end{pmatrix} = \begin{pmatrix} 1110 & 987 \\ 987 & 973 \end{pmatrix}$, thus
   $(X^T X)^{-1} = \frac{1}{(1110*973-987^2)} \begin{pmatrix} 973 & \text{-}987 \\ \text{-}987 & 1110 \end{pmatrix} = \begin{pmatrix} 0.0091913 & \text{-}0.0093235 \\ \text{-}0.0093235 & 0.0104854 \end{pmatrix}$. And
   $X^T Y' = \begin{pmatrix} \sum_{i=1}^n x_{i1}y_i - \sum_{i=1}^n x_{i1} \\ \sum_{i=1}^n x_{i2}y_i - \sum_{i=1}^n x_{i2} \end{pmatrix} = \begin{pmatrix} 2977 \\ 2832 \end{pmatrix}$.
   $\hat{\beta} = \begin{pmatrix} \hat{\beta}_1 \\ \hat{\beta}_2 \end{pmatrix} = (X^T X)^{-1} X^T Y' = \begin{pmatrix} 0.9582093 \\ 1.9385893 \end{pmatrix} \approx \begin{pmatrix} 0.958209 \\ 1.938589 \end{pmatrix}$
   Thus, the estimated regression line (or the fitted line) is given by

   $$\hat{y} = 1 + 0.958209x_1 + 1.938589x_2.$$

   (b) According to the formula on page 9 of chapter 1, we have

   $$\begin{aligned} RSS &= Y'^{\top} Y' - \hat{\beta}^{\top} X^{\top} Y' = 81.325920 \\ \hat{\sigma}^2 &= \frac{RSS}{n - p'} = \frac{81.325920}{20 - 2} = 4.518107 \end{aligned}$$

2. **Assume that $\boldsymbol{\beta_1 = 1}$.**

   (a) Rewrite the regression model as

   $$y' = y - x_1 \quad = \quad \beta_0 + \beta_2 x_2 + e,$$

   which becomes a simple linear regression. According to the formula on page 2 of chapter 1,

   $$\begin{aligned} \hat{\beta}_2 &= \frac{S_{x_2 y} - S_{x_1 x_2}}{S_{x_2 x_2}} = \frac{666.1 - 188.4}{240.95} = 1.982569 \\ \hat{\beta}_0 &= \bar{y} - \bar{x}_1 - \hat{\beta}_2 \bar{x}_2 = \frac{378}{20} - \frac{132}{20} - 1.982569 \frac{121}{20} = 0.3054576. \end{aligned}$$

   Thus, the fitted line is given by

   $$\hat{y} - x_1 \quad = \quad 0.305458 + 1.982569x_2.$$

   (b) According to the formula on page 9 of chapter 1,

   $$\begin{aligned} RSS &= S_{y'y'} - \hat{\beta}_2 S_{x_2 y'} = S_{yy} - 2S_{x_1 y} + S_{x_1 x_1} - \hat{\beta}_2 (S_{x_2 y} - S_{x_1 x_2}) \\ &= 2015.8 - 2 * 614.2 + 238.8 - 1.982569 * (666.1 - 188.4) = 79.126790 \\ \hat{\sigma^2} &= \frac{Res.SS}{n - p'} = \frac{79.126790}{20 - 2} = 4.395933. \end{aligned}$$