2.3.1 Electric potential

The fact that $\vec{\nabla}\times\vec{E}=\vec{0}$ places a limit on the types of functions which can be used for E. Your author for example states that $\vec{E}=y\hat{x}$ is not an electrostatic field that can be represented by any charge distribution because:

$$\vec{\nabla}\times\vec{E}=\begin{bmatrix}\hat{x} & \hat{y} & \hat{z}\\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z}\\ y & 0 & 0\end{bmatrix}=0\hat{x}+\hat{y}\frac{\partial y}{\partial z}+\hat{z}\frac{-\partial y}{\partial y}=-\hat{z}\neq\vec{0}$$

But for those electric fields that can be represented by a charge distribution, since the curl of those fields is zero, there exists a potential such that:

$$-\vec{\nabla}V=\vec{E}$$

We can define the potential function by:

$$V(r_p)=-\int_{\text{some reference point}}^{r_p}\vec{E}\cdot d\vec{l}$$

Assignment: Do problem 2.20 (a) and (b)