A sheet of charge occupies the entire $xy$ plane of three-dimensional free space, and no other charges are present. The potential within this plane is given by

$$V(x, y) = A \sin(kx),$$

where $A$ and $k$ are constants.

(a) Determine the potential $V(x, y, z)$ throughout the entire space.

(b) Determine the charge per unit area $\sigma(x, y)$ of this sheet.

(c) Replace the sheet of charge described above by a sheet with an electric dipole moment per unit area given by $p_x = B \cos(kx), p_y = 0,$ and $p_z = 0,$ where $B$ and $k$ are constants.

Determine the potential $V(x, y, z)$ throughout the entire space.