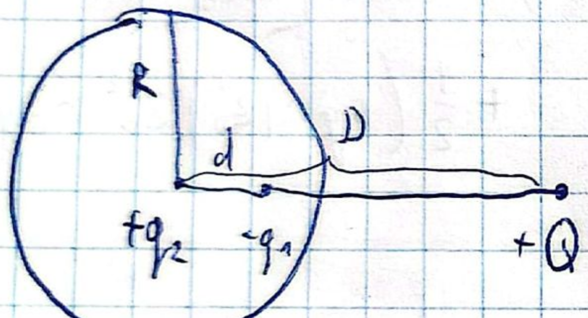
5.3



$$q_1 = -Q\frac{R}{D}, \quad d = \frac{R^2}{D}, \quad q_2 = Q_0 + Q\frac{R}{D}$$

Równowaga: $E(D) = 0$

$$E(D) = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q_0 + Q\frac{R}{D}}{D^2} - \frac{Q\frac{R}{D}}{(D-d)^2}\right) = 0$$

$$\left(Q_0 + Q\frac{R}{D}\right)\left(D - \frac{R^2}{D}\right)^2 - Q\frac{R}{D}\cdot D^2 = 0$$

$$Q_0 D^2 + Q_0 \frac{R^4}{D^2} - 2Q_0 R^2 \cancel{+ QRD} + Q\frac{R^5}{D^3} - 2Q\frac{R^3}{D} \cancel{- QRD} = 0$$

$$Q_0\left(D^2 + \frac{R^4}{D^2} - 2R^2\right) = Q\left(2\frac{R^3}{D} - \frac{R^5}{D^3}\right)$$

$$x = \frac{R}{D}$$

$$Q_0 D^2\left(1 + x^4 - 2x^2\right) = Q D^2\left(2x^3 - x^5\right)$$

$$Q = Q_0 \frac{(1-x^2)^2}{x^3(2-x^2)}$$

Dla $D = 2R$:

$$\frac{Q}{Q_0} = \frac{\left(1-\frac{1}{4}\right)^2}{\frac{1}{8}\left(2-\frac{1}{4}\right)} = \frac{\frac{9}{16}}{\frac{1}{8}\cdot\frac{7}{4}} = \frac{9}{14}$$