1. Superpositionsprinzip

$$q = -1.0 * 10^{-9}\ \text{C}; \quad Q = 8.0 * 10^{-6}\ \text{C}; \quad k = \frac{1}{4\pi\epsilon_0}; \quad \vec{F} = k\,\frac{q_1 q_2}{r^2}\,\vec{r}$$

(a) $d = 0.01\ \text{m}; \quad r = \frac{d}{2}; \quad Q_1 = Q; \quad Q_2 = -Q$

$$\vec{F}_1 = k\,\frac{qQ_1}{r^2}\begin{pmatrix}-1\\0\end{pmatrix}$$

$$\vec{F}_2 = k\,\frac{qQ_2}{r^2}\begin{pmatrix}1\\0\end{pmatrix}$$

$$\vec{F}_{ges} = \vec{F}_1 + \vec{F}_2 = \underline{\underline{\begin{pmatrix}-5.75\\0\end{pmatrix}\ \text{N}}}$$

(b) $d = 0.07\ \text{m}; \quad r = \frac{d}{2}; \quad h = \sqrt{3}r; \quad Q_1 = Q_3 = Q; \quad Q_2 = -Q$

$$\vec{F}_1 = k\,\frac{qQ_1}{r^2}\begin{pmatrix}-1\\0\end{pmatrix}$$

$$\vec{F}_2 = k\,\frac{qQ_2}{r^2}\begin{pmatrix}1\\0\end{pmatrix}$$

$$\vec{F}_3 = k\,\frac{qQ_3}{h^2}\begin{pmatrix}0\\-1\end{pmatrix}$$

$$\vec{F}_{ges} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = \underline{\underline{\begin{pmatrix}-0.12\\0.020\end{pmatrix}\ \text{N}}}$$

(c) $d = 0.03\ \text{m}; \quad r = \frac{d}{2}; \quad s = \sqrt{5}r; \quad Q_1 = Q_3 = Q; \quad Q_2 = Q_4 = -Q$

$$\vec{F}_1 = k\,\frac{qQ_1}{s^2}\begin{pmatrix}d\\r\end{pmatrix}\frac{1}{s}$$

$$\vec{F}_2 = k\,\frac{qQ_2}{r^2}\begin{pmatrix}0\\1\end{pmatrix}$$

$$\vec{F}_3 = k\,\frac{qQ_3}{r^2}\begin{pmatrix}0\\-1\end{pmatrix}$$

$$\vec{F}_4 = k\,\frac{qQ_4}{s^2}\begin{pmatrix}d\\-r\end{pmatrix}\frac{1}{s}$$

$$\vec{F}_{ges} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = \underline{\underline{\begin{pmatrix}0\\0.58\end{pmatrix}\ \text{N}}}$$

2. Sonnenwind und Ladungsneutralität

$$q = -1.0 * 10^{-9}\ \mathrm{C}; \quad Q = 8.0 * 10^{-6}\ \mathrm{C}; \quad k = \frac{1}{4\pi\epsilon_0}; \quad \vec{F} = k\,\frac{q_1 q_2}{r^2}\,\vec{r}$$

(a) $d = 0.01\ \mathrm{m}; \quad r = \frac{d}{2}; \quad Q_1 = Q; \quad Q_2 = -Q$

$$\vec{F}_1 = k\,\frac{qQ_1}{r^2}\begin{pmatrix}-1\\0\end{pmatrix}$$

$$\vec{F}_2 = k\,\frac{qQ_2}{r^2}\begin{pmatrix}1\\0\end{pmatrix}$$

$$\vec{F}_{ges} = \vec{F}_1 + \vec{F}_2 = \underline{\underline{\begin{pmatrix}-5.75\\0\end{pmatrix}\ \mathrm{N}}}$$

(b) $d = 0.07\ \mathrm{m}; \quad r = \frac{d}{2}; \quad h = \sqrt{3}r; \quad Q_1 = Q_3 = Q; \quad Q_2 = -Q$

$$\vec{F}_1 = k\,\frac{qQ_1}{r^2}\begin{pmatrix}-1\\0\end{pmatrix}$$

$$\vec{F}_2 = k\,\frac{qQ_2}{r^2}\begin{pmatrix}1\\0\end{pmatrix}$$

$$\vec{F}_3 = k\,\frac{qQ_3}{h^2}\begin{pmatrix}0\\-1\end{pmatrix}$$

$$\vec{F}_{ges} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = \underline{\underline{\begin{pmatrix}-0.12\\0.020\end{pmatrix}\ \mathrm{N}}}$$

(c) $d = 0.03\ \mathrm{m}; \quad r = \frac{d}{2}; \quad s = \sqrt{5}r; \quad Q_1 = Q_3 = Q; \quad Q_2 = Q_4 = -Q$

$$\vec{F}_1 = k\,\frac{qQ_1}{s^2}\begin{pmatrix}d\\r\end{pmatrix}\frac{1}{s}$$

$$\vec{F}_2 = k\,\frac{qQ_2}{r^2}\begin{pmatrix}0\\1\end{pmatrix}$$

$$\vec{F}_3 = k\,\frac{qQ_3}{r^2}\begin{pmatrix}0\\-1\end{pmatrix}$$

$$\vec{F}_4 = k\,\frac{qQ_4}{s^2}\begin{pmatrix}d\\-r\end{pmatrix}\frac{1}{s}$$

$$\vec{F}_{ges} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = \underline{\underline{\begin{pmatrix}0\\0.58\end{pmatrix}\ \mathrm{N}}}$$