

1. Der Dipol

$$k = \frac{1}{4\pi\epsilon_0}; \quad x_1 = -\frac{d}{2}; \quad x_2 = \frac{d}{2}$$

(a)

$$V_{ges} = V_+ + V_- = kq \left(\frac{1}{r_+} - \frac{1}{r_-} \right)$$

(b) $d \ll r; \quad \vec{p} := q\vec{d}$

$$kq \left(\frac{1}{r_+} - \frac{1}{r_-} \right) = kq \left(\frac{r_- - r_+}{r_+ r_-} \right) \\ \approx kq \frac{d \cos(\theta)}{r^2}$$

$$\begin{aligned} r_- - r_+ &\approx d \cos(\theta) \\ r_+ r_- \pm l &\approx r^2 \end{aligned}$$

(c) $\delta\omega = \omega_b - \omega_a$

$$0 = \cos\left(\frac{1}{2}\delta\omega t\right)$$

$$t = \frac{2 \arccos(0)}{\delta\omega} = \underline{\underline{50.29 \text{ s}}}$$