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

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

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

(c) $|\vec{M}| = |\vec{p} \times \vec{E}| = \vec{p}\vec{E}\sin(\theta); \quad E_{pot} = \int_\theta^{\pi/2} |\vec{M}| \, \mathrm{d}\tilde{\theta}$

$$0 = \cos\left(\tfrac{1}{2}\delta\omega t\right)$$
$$t = \frac{2\arccos(0)}{\delta\omega} = \underline{50.29 \text{ s}}$$