

**177. Stabpendel mit Kugeln**

$$L = 0.3 \text{ m}; \quad r_1 = 0.02 \text{ m}; \quad r_2 = 0.03 \text{ m}$$

$$m_0 = 0.1 \text{ kg}; \quad m_1 = 0.1 \text{ kg}; \quad m_2 = 0.3 \text{ kg}$$

$$\text{a) } I_{ges} = I_{Stab} + I_{Kugel_1} + I_{Kugel_2}$$

$$I_{Stab} = \frac{1}{12} m_0 L^2 = 7.5 \cdot 10^{-4} \text{ kg m}^2$$

$$I_{Kugel_1} = \frac{2}{5} m_1 r_1^2 + m_1 \left( \frac{L}{2} + r_1 \right)^2 = 2.9 \cdot 10^{-3} \text{ kg m}^2$$

$$I_{Kugel_2} = \frac{2}{5} m_2 r_2^2 + m_2 \left( \frac{L}{2} + r_2 \right)^2 = 9.8 \cdot 10^{-3} \text{ kg m}^2$$

$$\Rightarrow I_{ges} = \underline{\underline{1.3 \cdot 10^{-2} \text{ kg m}^2}}$$

b)

$$x_{Stab_{sp}} = 0 \text{ m}$$

$$x_{Kugeln_{sp}} = \frac{m_1 \left( -\frac{2r_1+L}{2} \right) + m_2 \left( \frac{2r_2+L}{2} \right)}{m_1+m_2} = 0.0925 \text{ m}$$

$$x_{sp} = \frac{x_{Stab_{sp}} \cdot m_0 + x_{Kugeln_{sp}} \cdot (m_1+m_2)}{m_0+m_1+m_2} = \underline{\underline{0.074 \text{ m}}}$$

$$\text{c) } T = 2\pi \sqrt{\frac{I}{Mgl}}$$

$$T = 2\pi \sqrt{\frac{I}{(m_0+m_1+m_2) g \left( \frac{2r_2+L}{2} \right)}}$$

$$= \underline{\underline{0.69 \text{ s}}}$$

**184. Resonanzverhalten einer Stimmgabel**

$$f_0 = 440 \text{ Hz}; \quad \omega_0 = 2\pi f_0; \quad x(\tau) = x_m e^{-\beta\tau/2}; \quad x(5) = \frac{1}{10} x(0)$$

a)

$$x_m e^{-\beta 5/2} = \frac{x_m}{10}$$

$$\beta = -\frac{2}{5} \ln(0.1)$$

$$\tau = \frac{1}{\beta} = \underline{\underline{1.09 \text{ s}}}$$

$$\text{b) } \omega = \sqrt{\omega_0^2 - \frac{\beta^2}{4}}$$

$$\omega = 2764.6 \text{ Hz} \quad (\omega_0 \approx \omega)$$

$$f = \frac{\omega}{2\pi} = 440 \text{ Hz} \quad (f_0 \approx f)$$

$$f\tau = \underline{\underline{477.7}}$$

c)  $Q = \frac{\omega}{\beta}$

$$Q = \underline{\underline{3001.63}}$$

## 185. Resonante Anregung eines Federpendels

$$m = 0.1 \text{ kg}; \quad k = 40 \text{ N/m}$$

a)  $\omega = \sqrt{\frac{k}{m}} = 20 \text{ rad/s}; \quad \omega_0 = \sqrt{\frac{k}{m} - \frac{\beta^2}{4m^2}}$

$$\frac{x_m}{2} = x_m * e^{-\beta t/2m}$$

$$\beta = -\frac{\ln(0.5)2m}{t} = \underline{\underline{1.4 * 10^{-2} \text{ kg/s}}}$$

$$\omega_0 = \sqrt{\frac{k}{m} - \frac{\beta^2}{4m^2}} = \underline{\underline{19.99988 \text{ rad/s}}}$$

b)

$$Q = \omega_0 \frac{m}{\beta} = \underline{\underline{144.269}}$$