(r, θ, φ) Kugelkoordinaten:

$$\vec{\zeta} = \delta q \, \vec{e}_r$$

$$\ddot{\vec{x}} = (\ddot{q} - q\underbrace{\cancel{\dot{\theta}^2}}_{=0} - q \sin^2\theta \underbrace{\dot{\varphi}^2}_{=\omega^2}) \vec{e}_r + \dots \; \vec{e}_\theta + \dots \; \vec{e}_\varphi$$

dl.

D'Alembert

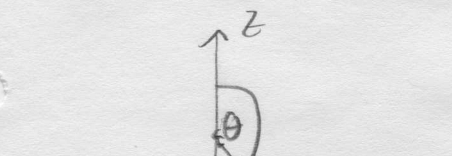
$$m\ddot{\vec{x}} \cdot \vec{\zeta} = 0;$$

$$m(\ddot{q} - q \sin^2\theta\, \omega^2) \cancel{\vec{e}_r}\, \delta q \cancel{\vec{e}_r} = 0 \quad \Leftrightarrow$$

$$\ddot{q} - q \sin^2\theta\, \omega^2 = 0; \qquad (\underline{\text{O.K.}} \quad \text{gleich})$$

Teilchen der Masse m auf einer Kugelschale (Scheck S. 68)

Check



$\vec{K} = (0, 0, -mg)$

$|\vec{r}| = R \qquad q_1 = \theta; \quad q_2 = \varphi$

$Q_1 = \vec{Q} \cdot \vec{e}_\theta = +\vec{K} \cdot \frac{\partial \vec{r}}{\partial \theta} = R\, mg \sin\theta \qquad (?)$

$Q_2 = \vec{Q}\, \vec{e}_\varphi = 0;$

$\mathcal{L} = \frac{1}{2} m R^2 \left[\dot{q}_1^2 + \dot{q}_2^2 \sin^2 q_1 \right] - \underbrace{mgR(1 + \cos q_1)}_{U(q_1)}$

$\frac{\partial U}{\partial q_1} = Q_1;$

$\frac{\partial \mathcal{L}(q_1, q_2)}{\partial q_1} - \frac{d}{dt} \frac{\partial \mathcal{L}}{\partial \dot{q}_1} = 0; \qquad mgR \sin q_1 + mR^2 \dot{q}_2^2 \sin q_1 \cos q_1 - mR^2 \ddot{q}_1 = 0;$

$\frac{\partial \mathcal{L}}{\partial q_2} - \frac{d}{dt} \frac{\partial \mathcal{L}}{\partial \dot{q}_2} = 0; \qquad - mR^2 \sin^2 q_1\, \ddot{q}_2 = 0;$