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Blatt 9

PS Physik
5. Januar 2022

132. Freier Fall einer rotierenden Hantel

$$m_1 = 1\ \text{kg}; \qquad \vec{v}_1 = (4,0,0)\ \text{m/s}; \qquad \vec{r}_1 = (0,0,2.5)\ \text{m}$$
$$m_2 = 0.5\ \text{kg}; \qquad \vec{v}_2 = (1,0,0)\ \text{m/s}; \qquad \vec{r}_2 = (0,0,2.2)\ \text{m}$$

$$\vec{r}_{sp} = \frac{m_1 r_1 + m_2 r_2}{m_1 + m_2} = \begin{pmatrix} 0 \\ 0 \\ 2.4\ \text{m} \end{pmatrix}$$

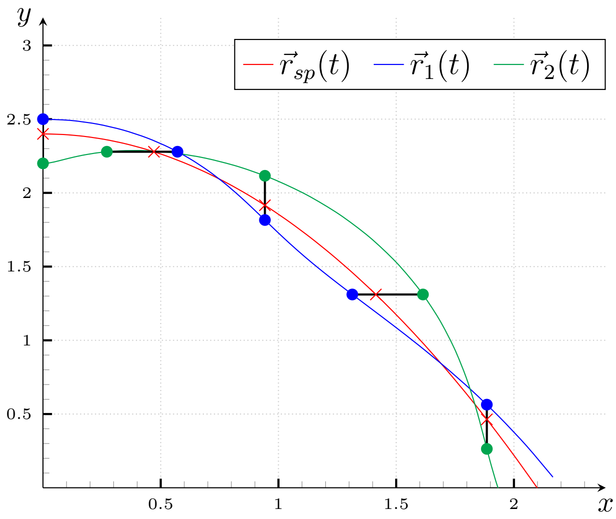
a) Im bewegten Bezugssystem, das sich mit 3 m/s mitbewegt reine Rotation

$$\Rightarrow \vec{r}_{sp}(t) = \underline{\underline{\begin{pmatrix} 0 \\ 0 \\ 2.4\ \text{m} \end{pmatrix} + \begin{pmatrix} 3\ \text{m/s} \\ 0 \\ 0 \end{pmatrix} t + \frac{1}{2} \begin{pmatrix} 0 \\ 0 \\ -9.81\ \text{m/s}^2 \end{pmatrix} t^2}}$$

b) Im bewegten Bezugssystem: $\vec{v}_1 = (1,0,0)\ \text{m/s}$; $\vec{v}_1 = (-2,0,0)\ \text{m/s}$

$$\omega = \frac{|v_1|}{r_1} = \underline{\underline{10\ \text{s}^{-1}}}$$
$$T = \frac{2\pi}{\omega} = \frac{\pi}{5} = \underline{\underline{0.63\ \text{s}}}$$

c)



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d) Im Schwerpunktsystem:

$$\vec{r}_{1,sp}(t) = 0.1 \begin{pmatrix} \sin(\omega t) \\ 0 \\ \cos(\omega t) \end{pmatrix}\ \text{m}$$

$$\vec{r}_{2,sp}(t) = -0.2 \begin{pmatrix} \sin(\omega t) \\ 0 \\ \cos(\omega t) \end{pmatrix}\ \text{m}$$

Im Laborsystem:

$$\vec{r}_1(t) = \vec{r}_{sp}(t) + \vec{r}_{1,sp}(t)$$

$$= \underline{\underline{\begin{pmatrix} 0.1\sin(\omega t)\ \mathrm{m} \\ 0 \\ 0.1\cos(\omega t)\ \mathrm{m} + 2.4\ \mathrm{m} \end{pmatrix} + \begin{pmatrix} 3\ \mathrm{m/s} \\ 0 \\ 0 \end{pmatrix} t + \frac{1}{2}\begin{pmatrix} 0 \\ 0 \\ -9.81\ \mathrm{m/s^2} \end{pmatrix} t^2}}$$

$$\vec{r}_2(t) = \vec{r}_{sp}(t) + \vec{r}_{2,sp}(t)$$

$$= \underline{\underline{\begin{pmatrix} -0.2\sin(\omega t)\ \mathrm{m} \\ 0 \\ -0.2\cos(\omega t)\ \mathrm{m} + 2.4\ \mathrm{m} \end{pmatrix} + \begin{pmatrix} 3\ \mathrm{m/s} \\ 0 \\ 0 \end{pmatrix} t + \frac{1}{2}\begin{pmatrix} 0 \\ 0 \\ -9.81\ \mathrm{m/s^2} \end{pmatrix} t^2}}$$

140. International Space Station

$$R_E = 6.37 * 10^6\ \mathrm{m}; \quad m = 4.55 * 10^5\ \mathrm{kg}; \quad h = 3.3 * 10^5\ \mathrm{m}$$

a) $h = 0$ m

$$F_G = mg\frac{1}{\left(1+\frac{h}{R_E}\right)^2}$$

$$= 4.55 * 10^5\ \mathrm{kg} * 9.81\ \mathrm{m/s^2}$$

$$F_G = \underline{\underline{4.46 * 10^6\ \mathrm{kg\,m/s^2}}}$$

b) $h = 3.3 * 10^5$ m

$$F_G = mg\frac{1}{\left(1+\frac{h}{R_E}\right)^2}$$

$$= 4.55 * 10^5\ \mathrm{kg} * 9.81\ \mathrm{m/s^2}\frac{1}{\left(1 + \frac{3*10^5\ \mathrm{m}}{6.37*10^6\ \mathrm{m}}\right)}$$

$$F_G = \underline{\underline{4.03 * 10^6\ \mathrm{kg\,m/s^2}}}$$

$$g(h) = \frac{g}{\left(1+\frac{h}{R_E}\right)^2}$$

$$g(3.3 * 10^5) = \underline{\underline{8.87\ \mathrm{m/s^2}}}$$

$$v = r\omega; \quad a = \frac{v^2}{r} = r\omega^2; \quad r = R_E + h$$

c)

$$\omega = \sqrt{\frac{g(h)}{r}}$$
$$= \underline{\underline{1.2 * 10^{-3}\ \mathrm{s}^{-1}}}$$

d)

$$T = \frac{2\pi}{\omega}$$
$$= \underline{\underline{5461.58\ \mathrm{s}}}$$

e)

$$v = r\omega$$
$$= \underline{\underline{7707.91\ \mathrm{m/s}}}$$

152. Komprimierter Metallblock

$$a = h = 0.2\ \mathrm{m} \qquad \Delta h = 1.3 * 10^{-6}\ \mathrm{m} \qquad m = 500\ \mathrm{kg}$$
$$V = 8 * 10^{-3}\ \mathrm{m}^3 \qquad \Delta V = 3 * 10^{-7}\ \mathrm{m}^3 \qquad p = 2 * 10^6\ \mathrm{kg/m\,s^2}$$

a) $p = K\,\frac{\Delta V}{V}; \quad \frac{F}{A} = E\,\frac{\Delta h}{a}$

fyi: Einheit der verschiedenen Module wird meist in N/m^2 angegeben.

$$K = p\,\frac{V}{\Delta V}$$
$$= \underline{\underline{\frac{16}{3} * 10^{10}\ \mathrm{kg/m\,s^2}}}$$

$$E = \frac{mga}{a^2 \Delta h}$$
$$= \underline{\underline{1.89 * 10^{10}\ \mathrm{kg/m\,s^2}}}$$

b) $\Delta a = \mu \Delta h; \quad K = \frac{E}{3(1-2\mu)}$

$$K = \frac{E}{3(1-2\mu)}$$
$$\frac{3K}{E} = \frac{1}{1-2\mu}$$
$$\mu = \frac{1}{2} - \frac{E}{6K}$$
$$= \underline{\underline{0.44}}$$

$$\Delta a = \mu \Delta h$$
$$= \underline{\underline{5.73 * 10^{-7}\ \mathrm{m}}}$$

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