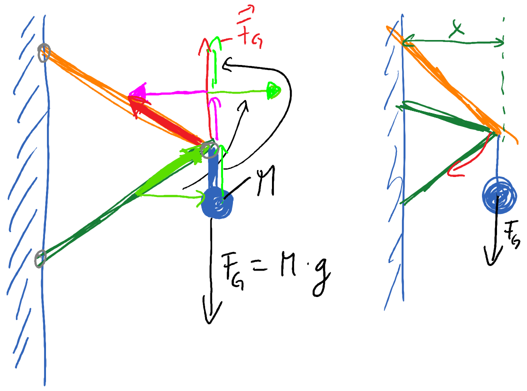
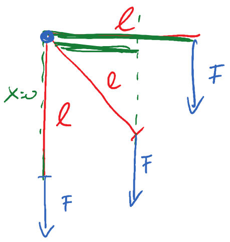
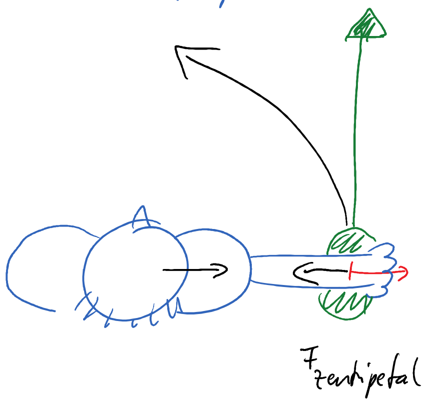
Achtung: Korrektur zur konservativen Kraft, s.u.

3/1: Wirtshausschild





Rotation: Zentripetal vs. -fugalkraft



Zentrifugalkraft im mitrotierenden System

$\cancel{-\frac{dE_{pot}}{dx}}$! **Korrektur!!**

Hier hatte ich was falsch verstanden!

Eine konservative Kraft ist tatsächlich so def., dass wenn $\frac{dE_{pot}}{}$ …

Ohne konservative Kräfte ist tatsächlich so def.,

dass wenn $F_{ges} = -\frac{dE_{pot}}{dx}$ dann ist F_{ges} = konservativ

wenn $F_{ges} = F + F_{Reibung}$, dann ist $F_{ges} \cdot dx \neq -dE_{pot}$

d.h. es wird Energie in Reibungswärme verwandelt

Thermodynamik

10/12 He Ballon

N_2

He

$\varnothing 10m$

$V = 524 m^2 = \frac{4}{3}\pi r^3$

$p_0 = 1 bar = 1013 kPa$

$15K = 288.15K$

$pV = NkT$

He Atome $N_0 = \frac{p_0 V}{kT} = 1.33 \cdot 10^{28}$

$M_{He} = m_{He} \cdot N_0 = 86 kg$ $m_{He} = 4$ amu

N_2 Moleküle : $N_{N_2} = N_{He} = 1.33 \cdot 10^{28} = N_0$

$\Delta M = N_0 (m_{N_2} - m_{He}) = 620kg - 86kg$

$M_{N_2} = 620kg$

$F = g \cdot \Delta M = 5239N$

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b) Steighöhe

$M_{He} = \text{const} = 86\,kg$

im Ballon (= geschlossen) $p_{He} = 1\,bar$

= dehnt sich nicht aus $V_{He} = 524\,m^3$

bei welcher Dichte hat die Menge des verdrängten N_2 eine Masse $M_{N_2}(h) = 86\,kg$

barometrische Höhenformel $p(h) = e^{-\alpha h} \approx 1 - \alpha x$

$$\rho_{N_2}(H) = \frac{86\,kg}{620\,kg} \cdot \rho_{N_2}(h=0)$$

$$p(h) = p_0 e^{-\frac{h-h_0}{h_s}}$$

h_s ↖ 8.2 km

$$g \cdot M_{He} = \underbrace{F_A(h)}_{\text{besser } F_G^{N_2}} = g \cdot m_{N_2} \cdot N(h) = g\, m_{N_2} \frac{p(h)\, V}{k_B \cdot T} = \overset{g \cdot m_{N_2}}{\downarrow} \underbrace{N_0}_{\frac{p_0 V_0}{k_B T_0}} \cdot e^{-\frac{h-h_0}{h_s}}$$

$$M_{He} = M_{N_2} \cdot e^{-\frac{h-h_0}{h_s}}$$

$$\frac{M_{He}}{M_{N_2}} = e^{-\frac{h-h_0}{h_s}}$$

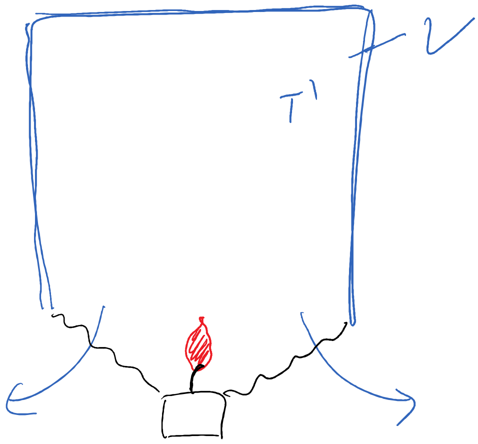
$$\ln \frac{M_{He}}{M_{N_2}} = -\frac{h-h_0}{h_s}$$

$$\ln \frac{M_{N_2}}{M_{He}} = +\frac{h-h_0}{h_s}$$

$$\Delta h = h - h_0 = h_s \cdot \ln \frac{M_{N_2}}{M_{He}} = 8.2\,km \cdot \ln \frac{620\,kg}{86\,kg}$$

$$= \underline{\underline{16\,km}}$$

$$h - h_0 = h_s \cdot \ln \frac{M_{N_2}}{M_{He}}$$



$m_{ges} = 15g = \underline{0{,}015kg}$

$$\frac{p_0 \cdot V}{k_B T_0} = N$$ Anz. der verdrängten Luftteilchen

$N \cdot m_{N_2}$ = verdrängte Masse bei $T = T_0$

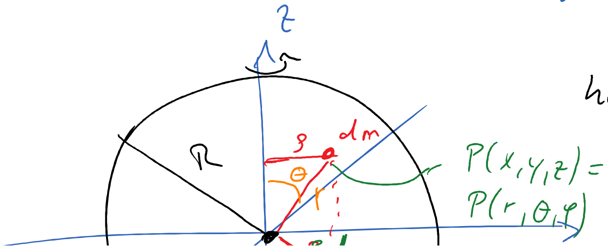
N' bei Temperatur T', so daß $\Delta N \cdot m_{N_2} = 15g$

$$(N - N') \cdot m_{N_2} = 15g$$

$$N' = \frac{p_0 \cdot V}{k_B \cdot T'}$$ = Anz. der heißen ($T = T'$) Luftmoleküle

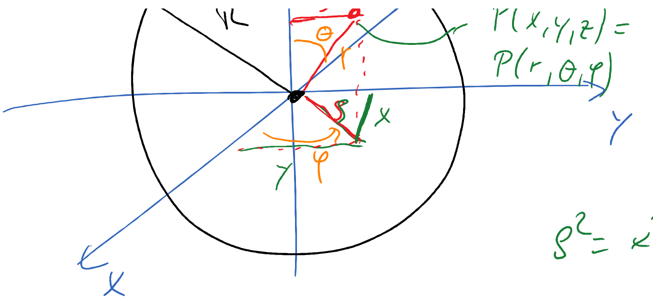
$$\left(\frac{p_0 \cdot V}{k_B T_0} - \frac{p_0 V}{k_B T'} \right) \cdot m_{N_2} \geq 15g$$

Trägheitsmoment einer Kugel in Kugelkoord.



homogene Kugel R

$$\boxed{dI = \rho^2 \, dm}$$



$$\boxed{dI = \rho^2\, dm}$$

$$\rho^2 = x^2 + y^2$$

Kugel Koord.

$$x = r \cdot \sin\theta \cos\varphi$$
$$y = r \cdot \sin\theta \sin\varphi$$
$$z = r \cdot \cos\theta$$

$$dx\,dy\,dz = \underline{r^2 \sin\theta}\, dr\, d\theta\, d\varphi$$

$$I = \iiint \rho^2\, dm = \frac{M}{\frac{4}{3}\pi R^3} \iiint \underbrace{(x^2+y^2)}_{=\rho^2}\, dx\,dy\,dz$$

$$I = \frac{M}{\frac{4}{3}\pi R^3} \int_{r=0}^{R}\int_{\varphi=0}^{2\pi}\int_{\theta=0}^{\pi} \underbrace{\Big(\underbrace{r^2\sin^2\theta\cos^2\varphi}_{x^2} + \underbrace{r^2\sin^2\theta\sin^2\varphi}_{y^2}\Big)\, r^2\sin\theta}_{\displaystyle \int_0^R dr \int_0^\pi d\theta \int_0^{2\pi} d\varphi\; f}\, dr\,d\varphi\,d\theta$$

$$= \frac{M}{\frac{4}{3}\pi R^3} \iiint r^2\sin^2\theta \cdot r^2 \sin\theta\; dr\,d\varphi\,d\theta$$

$\downarrow$

weil $\cos^2\varphi + \sin^2\varphi = 1$

$$= \frac{M}{\frac{4}{3}\pi R^3} \int_0^R\int_0^{2\pi}\int_0^{\pi} r^4 \sin^3\theta\; dr\,d\varphi\,d\theta$$

$$= \frac{M}{\frac{4}{3}\pi R^3}\, \frac{R^5}{5} \cdot 2\pi \int_0^{\pi} \sin^3\theta\, d\theta$$

$$= \frac{M}{\frac{4}{3}\pi R^3} \underset{\underset{dr}{\uparrow}}{\frac{R^5}{5}} \cdot \underset{\underset{\varphi}{\uparrow}}{2\pi} \underbrace{\int_0^\pi \sin^3\theta \, d\theta}_{\left[\frac{1}{3}\cos^3 - \cos\right]_0^\pi}$$

$$\downarrow$$

$$\left(-\frac{1}{3} + 1 - \frac{1}{3} \cdot 1 + 1\right) =$$

$$= \frac{2}{3} + \frac{2}{3} = \frac{4}{3}$$

$$= \frac{\cancel{3}M}{\cancel{4}\cancel{\pi}R^{\cancel{3}}} \cdot \frac{R^{\cancel{5}}}{\cancel{5}} \cdot 2\cancel{\pi} \cdot \frac{\cancel{4}}{\cancel{3}} = \boxed{\frac{2}{5} M R^2}$$

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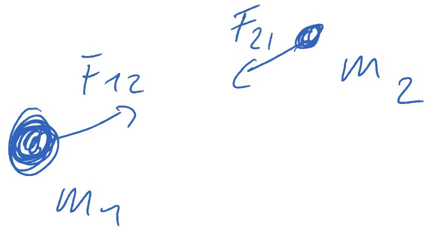
reduzierte Masse

2Körper-Problem



$$F = m \cdot a = m \cdot \dot{v} = m \frac{dv}{dt}$$

$$\text{I} \quad \frac{dv_1}{dt} = \frac{F_{12}}{m_1} \qquad \text{II} \quad \frac{dv_2}{dt} = \frac{F_{21}}{m_2}$$

$$F_{12} = - F_{21}$$

$$F_{12} = -F_{21}$$

4.1.2

$$\mathrm{I} - \mathrm{II}: \quad \frac{d}{dt}(v_1 - v_2) = \left(\frac{1}{m_1} + \frac{1}{m_2}\right) \cdot F_{12}$$

$v_{12} = v_1 - v_2$ Relativgeschwindigkeit

$$\frac{d v_{12}}{dt} = \underbrace{\left(\frac{1}{m_1} + \frac{1}{m_2}\right)} \cdot F_{12}$$

$$\frac{1}{m_{red}} = \frac{1}{m_1} + \frac{1}{m_2} \hat{=} \boxed{m_{red} = \frac{m_1 \cdot m_2}{m_1 + m_2}}$$

$$\boxed{F_{12} = m_{red} \cdot \frac{d v_{12}}{dt}}$$

BWGl. für 1 Körper in einem Kraftfeld