1) $A = mgh\,.\;\; \vec{r} = (\,v_0 t\,,\, h - \frac{1}{2} g t^2\,)\;,\;\; \vec{v} = (\,v_0\,,\,-gt\,)\;,\;\; t_1 = 0\;,\;\; z(t_2) \stackrel{!}{=} 0 \;\curvearrowright\; t_2 = \sqrt{2h/g}$

$A = \int_0^{t_2} dt\;(v_0, -gt)\cdot(0,-mg) = mg^2 \int_0^{t_2} dt\; t = m\,g^2\,\frac{1}{2}\,t_2^2 = m\,g\,h\;\;.$

2) $I_{\rm mant} = \int_{\rm Mantel\,(R)} df\;\vec{e}_\rho \cdot \alpha\,(-z\,\vec{r}\,) = \int_{\dots} df\;(-\alpha z \rho)\Big|_{\rho=R} = -\alpha\,R\,2\pi R \int_0^h dz\; z = -\alpha\,\pi R^2 h^2\;\;,\;\; I_{\rm deck} =$

$\int_{\rm Deckel} df\;\vec{e}_3 \cdot \alpha\,(2r^2 \vec{e}_3 - z\,\vec{r}\,)\Big|_{z=h} = 2\alpha \int_{\dots} df\;\rho^2 + \alpha\,h^2\,\pi R^2 = 2\,\alpha\,2\pi \int_0^R d\rho\,\rho^3 + \dots = \alpha\,\pi R^2 (R^2 + h^2)\;.$

3) $(\partial_t + 2\,t)\,G = \delta(t-a)\;,\;\; G_{\rm hom} = e^{-t^2}\;\;,\;\; G = e^{-t^2} u\;,\;\; u' = e^{t^2}\delta(t-a) = e^{a^2}\delta(t-a)\;,\;\; u =$

$C + e^{a^2}\theta(t-a) \;\curvearrowright\; G = C\,e^{-t^2} + e^{a^2} e^{-t^2}\theta(t-a)$ (Mit PQ–Formel ging es auch sehr gut.)

4) $E = \frac{M}{2}(R\dot\varphi)^2 + \frac{I}{2}\dot\varphi^2 + \frac{\kappa}{2}(\,2\,R\varphi)^2\;,\;\; 0 = (MR^2 + I)\dot\varphi\ddot\varphi + 4\kappa R^2 \varphi\dot\varphi\;,\;\; \ddot\varphi = -\frac{4\kappa R^2}{(\dots)}\,\varphi\;,\;\; \omega = \sqrt{\frac{4\kappa R^2}{MR^2 + I}}\;\;.$

5) $V_{\rm eff} = \alpha\,r^2 + \frac{L^2}{2mr^2}\;,\;\; V'_{\rm eff} = 2\alpha r - \frac{L^2}{mr^3} \stackrel{!}{=} 0\;,\;\; r_0^4 = \frac{L^2}{2\alpha m}\;\;,\;\; m\ddot{\vec{r}} = -V'_{\rm eff} = -2\alpha(r_0+\eta) + \frac{L^2}{m(r_0+\eta)^3}$

$m\ddot{\vec{r}} = -2\alpha r_0 - 2\alpha\eta + \frac{L^2}{mr_0^3}\Big(1 - 3\frac{\eta}{r_0}\Big) + \mathcal{O}(\eta^2) = -\Big(2\alpha + \frac{3\,L^2}{mr_0^4}\Big)\,\eta + \mathcal{O} = -8\,\alpha\,\eta + \mathcal{O}\;\;,\;\; \omega^2 = 8\,\alpha/m\;.$

6) $\frac{m}{2}v^2 = \frac{m}{2}u^2 + U\;,\;\; v_2 = u_2 \;\curvearrowright\; \frac{m}{2}v_1^2 = \frac{m}{2}u_1^2 + U\;,$ und bei $v_1 < \sqrt{\frac{2}{m}U}$ gibt es kein u_1 mehr.

7) $\nabla\vec{B} = \vec{e}_3 \nabla 2r^2 - \vec{e}_3\,\vec{r} - z\nabla\vec{r} = 0\;,\;\; (\vec{r}\nabla)\vec{B} = \vec{e}_3(\vec{r}\nabla)2r^2 - \vec{r}\,(\vec{r}\nabla)z - z(\vec{r}\nabla)\vec{r} = 2\,\vec{B}\;\curvearrowright$ Bruch $= \frac{1}{4}$

$\vec{A} = \frac{1}{4}\vec{B}\times\vec{r}\;\;,\;\; 4\,\nabla\times\vec{A} = \nabla\times(\vec{B}\times\vec{r}) = \vec{B}(\nabla\vec{r}) + (\vec{r}\nabla)\vec{B} - \vec{r}(\nabla\vec{B}) - (\vec{B}\nabla)\vec{r}\;\;,\;\; 3+2-0-1 = 4\;.$

8) $\rho = \frac{Q}{4\pi R^2}\,\delta(r-R)\;,\;\; \vec{v} = \omega\vec{e}_3 \times \vec{r}\;\;,\;\; \vec{j} = \vec{v}\rho\;,\;\; \frac{1}{\varepsilon_0 c^2\,4\pi}\,\frac{\omega\,Q}{4\pi R^2} =: \gamma\;\;,\;\; \vec{J} = \gamma \int d^3r' \frac{\vec{r}\,'\,\delta(r'-R)}{|\vec{r} - \vec{r}\,'|}$

$f(r) = \frac{\gamma}{r^2}\int d^3r'\;\frac{\vec{r}\,\vec{r}\,'\;\delta(r'-R)}{\sqrt{r^2 + r'^2 - 2\vec{r}\,\vec{r}\,'}}\;\;,\;\; \cos(\vartheta) = u\;\;,\;\; f(r) = \frac{\gamma}{r^2}\,2\pi\,R^2 \int_{-1}^1 du\;\frac{rR\,u}{\sqrt{r^2 + R^2 - 2rR\,u}}\;\;.$

9) $T(\vec{0}, 0) = T_0\;\;,\;\; T(\vec{r}, 0) = \frac{T_0}{2\,\kappa}\,\frac{\sh(2\kappa r)}{r}\;\;,\;\; \Delta\,\frac{\sh(2\kappa r)}{r} = \frac{1}{r}\partial_r^2 r\,\frac{\sh(2\kappa r)}{r} = (2\kappa)^2\,\frac{\sh(2\kappa r)}{r}$ (was man auch im Kopf schnallen durfte)

$\;,\;\; T(\vec{r}, t) = \frac{T_0}{2\,\kappa}\,e^{tD\,4\kappa^2}\,\frac{\sh(2\kappa r)}{r}\;\;,\;\; T(\vec{0}, t) = T_0\,e^{tD\,4\kappa^2} \stackrel{!}{=} 2\,T_0\;\;,\;\; t_1 = \frac{\ln(2)}{D\,4\kappa^2}\;.$

10) $\rho = \varepsilon_0\,\nabla\vec{E} = \varepsilon_0 2\,\alpha\,z\;\;,\;\; \nabla\times\vec{E} = 3\alpha\,(\,-y\,,\,x\,,\,0\,) \stackrel{!}{=} -\,\partial_t\vec{B}\;\;,\;\; \vec{B} = -\,3\,\alpha\,t\,(\,-y\,,\,x\,,\,0\,)\,.$ Daß

$\nabla\vec{B} = 0$ ist, sieht man im Kopf. Bleibt $\vec{j} = \varepsilon_0 c^2\,\nabla\times\vec{B} = -\,\varepsilon_0 c^2\,3\,\alpha\,t\,(\,0\,,\,0\,,\,2\,) = -\,6\,\varepsilon_0 c^2\,\alpha\,t\,\vec{e}_3\;.$

11) $\nabla\cos(\,\vec{k}\,\vec{r} - ck\,t)\times\vec{E}_0 = -\,\vec{k}\,\sin(\dots)\times\vec{E}_0 \;\stackrel{?}{=}\; -\,\partial_t\,\frac{1}{c}\,\frac{\vec{k}}{k}\times\vec{E}_0\cos(\dots) = -\,\vec{k}\times\vec{E}_0\sin(\dots)\;,$ ja.

12) $c_n = \frac{1}{L}\int_0^L dx\;\alpha\,\delta\Big(x - \frac{L}{2}\Big)\,e^{{\rm i}n\frac{2\pi}{L}x} = \frac{\alpha}{L}\,(-1)^n\;\;,\;\; T(x,t) = \frac{\alpha}{L}\sum_n (-1)^n\,e^{-tD\,(n\frac{2\pi}{L})^2}\,e^{{\rm i}n\frac{2\pi}{L}x}$

$T\Big(\frac{L}{2}, t\Big) = \frac{\alpha}{L}\sum_n\,e^{-tD\,(\frac{2\pi}{L})^2\,n^2} \;\to\; \frac{\alpha}{L}\int dn\;\,e^{-tD\,(\frac{2\pi}{L})^2\,n^2} = \frac{\alpha}{L}\sqrt{\frac{L^2}{(2\pi)^2\,t\,D}}\int dn\,e^{-n^2} = \frac{\alpha}{\sqrt{4\pi\,t\,D}}\;.$

13) $\widetilde{T}(\,\vec{k}\,) = \int d^3r\;e^{-{\rm i}\vec{k}\,\vec{r}}\,T(r) = 2\pi\int_R^\infty dr\;r^2\,\frac{T_0}{\alpha\,r}e^{-\alpha r}\int_{-1}^1 du\;e^{-{\rm i}kru}\;\;,\;\; u\text{–Integral} = \frac{2\,\sin(kr)}{k\,r}\;\;,$

$\widetilde{T}(\,\vec{k}\,) = \frac{4\pi\,T_0}{\alpha\,k}\int_R^\infty dr\;\sin(kr)\,e^{-\alpha r} = \frac{2\pi\,T_0}{\alpha\,k\,{\rm i}}\int_R^\infty dr\;e^{{\rm i}kr - \alpha r} + \text{dito}_{-k} = \frac{2\pi\,T_0\,e^{-\alpha R}}{\alpha\,k\,{\rm i}}\Big(\frac{e^{{\rm i}kR}}{\alpha - {\rm i}k} - \frac{e^{-{\rm i}kR}}{\alpha + {\rm i}k}\Big)$

$\Big(\quad\Big) = \frac{(c + {\rm i}s)(\alpha + {\rm i}k) - (c - {\rm i}s)(\alpha - {\rm i}k) = 2\,{\rm i}\,(\dots)}{\alpha^2 + k^2}\;\;,\;\; \widetilde{T}(\,\vec{k}\,) = \frac{4\pi\,T_0\,e^{-\alpha R}}{\alpha\,k}\;\frac{\alpha\,\sin(kR) + k\,\cos(kR)}{\alpha^2 + k^2}\;.$