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

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

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

3) $(\partial_t + 2\,t)\,G = \delta(t-a)\;\;,\;\; G_{\text{hom}} = e^{-t^2}\;\;,\;\; G = e^{-t^2}u\;\;,\;\; u' = e^{t^2}\delta(t-a) = e^{a^2}\delta(t-a)\;\;,\;\; u =$
$C + e^{a^2}\theta(t-a) \;\;\curvearrowright\;\; G = C\,e^{-t^2} + e^{a^2}e^{-t^2}\theta(t-a)$ (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) $V_{\text{eff}} = \alpha\,r^2 + \frac{L^2}{2mr^2}\;\;,\;\; V'_{\text{eff}} = 2\alpha r - \frac{L^2}{mr^3} \overset{!}{=} 0\;\;,\;\; r_0^4 = \frac{L^2}{2\alpha m}\;\;,\;\; m\ddot{\vec{r}} = -V'_{\text{eff}} = -2\alpha(r_0 + \eta) + \frac{L^2}{m(r_0+\eta)^3}$
$m\ddot{\vec{r}} = -2\alpha r_0 - 2\alpha\eta + \frac{L^2}{mr_0^3}\Big(1 - 3\frac{\eta}{r_0}\Big) + \mathcal{O}(\eta^2) = -\Big(2\alpha + \frac{3\,L^2}{mr_0^4}\Big)\,\eta + \mathcal{O} = -8\,\alpha\,\eta + \mathcal{O}\;\;,\;\; \omega^2 = 8\,\alpha/m\;.$

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) $\rho = \frac{Q}{4\pi R^2}\,\delta(r-R)\;\;,\;\; \vec{v} = \omega\,\vec{e}_3\times\vec{r}\;\;,\;\; \vec{\jmath} = \vec{v}\,\rho\;\;,\;\; \frac{1}{\varepsilon_0 c^2\,4\pi}\,\frac{\omega\,Q}{4\pi R^2} =: \gamma\;\;,\;\; \vec{J} = \gamma\int d^3r'\,\frac{\vec{r}\,'\;\delta(r'-R)}{|\vec{r} - \vec{r}\,'|}$
$f(r) = \frac{\gamma}{r^2}\int d^3r'\;\frac{\vec{r}\,\vec{r}\,'\;\delta(r'-R)}{\sqrt{r^2 + r'^{\,2} - 2\vec{r}\,\vec{r}\,'}}\;\;,\;\; \cos(\vartheta) = u\;\;,\;\; f(r) = \frac{\gamma}{r^2}\,2\pi\,R^2\int_{-1}^1 du\;\frac{rR\,u}{\sqrt{r^2 + R^2 - 2rR\,u}}\;\;.$

9) $T(\vec{0},0) = T_0\;\;,\;\; T(\vec{r},0) = \frac{T_0}{2\,\kappa}\,\frac{\text{sh}(2\kappa r)}{r}\;\;,\;\; \Delta\,\frac{\text{sh}(2\kappa r)}{r} = \frac{1}{r}\partial_r^2 r\,\frac{\text{sh}(2\kappa r)}{r} = (2\kappa)^2\,\frac{\text{sh}(2\kappa r)}{r}$ (was man auch im Kopf schnallen durfte) $,\;\; T(\vec{r},t) = \frac{T_0}{2\,\kappa}\,e^{tD\,4\kappa^2}\,\frac{\text{sh}(2\kappa r)}{r}\;\;,\;\; T(\vec{0},t) = T_0\,e^{tD\,4\kappa^2} \overset{!}{=} 2\,T_0\;\;,\;\; t_1 = \frac{\ln(2)}{D\,4\kappa^2}\;.$

10) $\rho = \varepsilon_0\,\nabla\vec{E} = \varepsilon_0 2\,\alpha\,z\;\;,\;\; \nabla\times\vec{E} = 3\alpha\,(\,-y\,,\,x\,,\,0\,) \overset{!}{=} -\partial_t\vec{B}\;\;,\;\; \vec{B} = -\,3\,\alpha\,t\,(\,-y\,,\,x\,,\,0\,)$. Daß
$\nabla\vec{B} = 0$ ist, sieht man im Kopf. Bleibt $\vec{\jmath} = \varepsilon_0 c^2\,\nabla\times\vec{B} = -\,\varepsilon_0 c^2\,3\,\alpha\,t\,(\,0\,,\,0\,,\,2\,) = -\,6\,\varepsilon_0 c^2\,\alpha\,t\,\vec{e}_3\;.$

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

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

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

13) $\widetilde{T}(\,\vec{k}\,) = \int d^3r\;e^{-\mathrm{i}\,\vec{k}\,\vec{r}}\;T(r) = 2\pi\int_R^\infty dr\;r^2\,\frac{T_0}{\alpha\,r}e^{-\alpha r}\int_{-1}^1 du\;e^{-\mathrm{i}kru}\;\;,\;\; u\text{–Integral} = \frac{2\,\sin(kr)}{k\,r}\;\;,$
$\widetilde{T}(\,\vec{k}\,) = \frac{4\pi\,T_0}{\alpha\,k}\int_R^\infty dr\;\sin(kr)\,e^{-\alpha r} = \frac{2\pi\,T_0}{\alpha\,k\,\mathrm{i}}\int_R^\infty dr\;e^{\mathrm{i}kr - \alpha r} + \text{dito}_{-k} = \frac{2\pi\,T_0\,e^{-\alpha R}}{\alpha\,k\,\mathrm{i}}\,\Big(\frac{e^{\mathrm{i}kR}}{\alpha - \mathrm{i}k} - \frac{e^{-\mathrm{i}kR}}{\alpha + \mathrm{i}k}\Big)$
$\Big(\quad\Big) = \frac{(c + \mathrm{i}s)(\alpha + \mathrm{i}k) - (c - \mathrm{i}s)(\alpha - \mathrm{i}k) = 2\,\mathrm{i}\,(\dots)}{\alpha^2 + k^2}\;\;,\;\; \widetilde{T}(\,\vec{k}\,) = \frac{4\pi\,T_0\;e^{-\alpha R}}{\alpha\,k}\;\frac{\alpha\,\sin(kR) + k\,\cos(kR)}{\alpha^2 + k^2}\;\;.$