22. Schulübung

2.108a) $F(x) = -100x$

$$W(-0{,}1;0) = \int_{-0{,}1}^{0} -100x\,dx = -100\int_{-0{,}1}^{0} x\,dx = -50x^2\Big|_{-0{,}1}^{0} =$$

$$= \underline{\underline{0{,}5\ J}}$$

2.110) $F = -kx$

$$W(0,-a) = \int_{0}^{-a} -kx\,dx = -\frac{kx^2}{2}\Big|_{0}^{-a} = -\frac{ka^2}{2}$$

$k \to 2k$

$$W(0,-a) = \int_{0}^{-a} -2kx\,dx = -\frac{2kx^2}{2}\Big|_{0}^{-a} = -ka^2$$

doppelt

$$W(0,-2a) = \int_{0}^{-2a} -kx\,dx = -\frac{kx^2}{2}\Big|_{0}^{-2a} = -\frac{4ka^2}{2} = -2ka^2$$

vierfach

Doppelte Federkonstante → doppelte Arbeit

Doppelter Weg → vierfache Kraft

2.111) $F(x) = -kx - ax^2$

$$W(0,A) = \int_{0}^{A} -kx - ax^2\,dx = -\frac{kx^2}{2} - \frac{ax^3}{3}\Big|_{0}^{A} = \underline{\underline{-\frac{kA^2}{2} - \frac{aA^3}{3}}}$$

2.112) $F(r) = 6{,}67\cdot10^{-11}\cdot\frac{5{,}97\cdot10^{24}\cdot m}{r^2} = 6{,}67\cdot5{,}97\cdot10^{-11}\cdot10^{24}\cdot m\cdot r^{-2} =$

$$= 39{,}8199\cdot10^{13}\,mr^{-2} = 3{,}98199\cdot10^{14}\,mr^{-2}$$

(1) $$W(r_1,r_2) = \int_{r_1}^{r_2} 3{,}98199\cdot10^{14}\,mr^{-2}\,dr = 3{,}98199\cdot10^{14}\,m\,\frac{r^{-1}}{-1}\Big|_{r_1}^{r_2} =$$

$$= -\frac{3{,}98199\cdot10^{14}\,m}{r}\Big|_{r_1}^{r_2} = \underline{\underline{-3{,}98199\cdot10^{14}\cdot m\left(\frac{1}{r_2} - \frac{1}{r_1}\right)}}$$

(2) $m = 1000\,kg \quad r_1 = 6\,378\,000 \quad r_2 = 6\,678\,000$

$$W = -3{,}98199\cdot10^{14}\cdot1000\cdot\left(\frac{1}{6\,678\,000} - \frac{1}{6\,378\,000}\right) = \underline{\underline{2\,804\,726\,321\ J}}$$