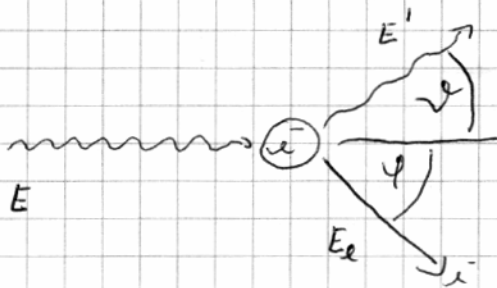


36)

Blatt # 11



$$E - E' = E_e \quad \text{Energieerh.} \quad (1)$$

$$\frac{E}{c} - \frac{E'}{c} \cos \vartheta = p_e \cos \varphi \quad \text{Impulserh. } \parallel \quad (2)$$

$$\frac{E'}{c} \sin \vartheta = p_e \sin \varphi \quad \text{Impulserh. } \perp \quad (3)$$

$$p_e^2 = \frac{1}{c^2} (E_e^2 + 2 m_0 c^2 E_e) \quad (4)$$

$$((2)^2 + (3)^2) \cdot c^2 :$$

$$\begin{aligned} E^2 - 2EE' \cos \vartheta + E'^2 \cos^2 \vartheta + E'^2 \sin^2 \vartheta &= c^2 p_e^2 \\ &= E_e^2 + 2 m_0 c^2 E_e \\ &= E^2 - 2EE' + E'^2 + 2 m_0 c^2 (E - E') \end{aligned}$$

$$2EE'(1 - \cos \vartheta) = 2 m_0 c^2 (E - E')$$

$$E' = \frac{E}{1 + \frac{E}{m_0 c^2} (1 - \cos \vartheta)} = 9,9037 \text{ keV}$$

a)

$$\Delta E = E - E' = 96,9 \text{ eV}$$

$$\Delta \nu = \frac{\Delta E}{h} = 2,34 \cdot 10^{16} \frac{1}{s}$$

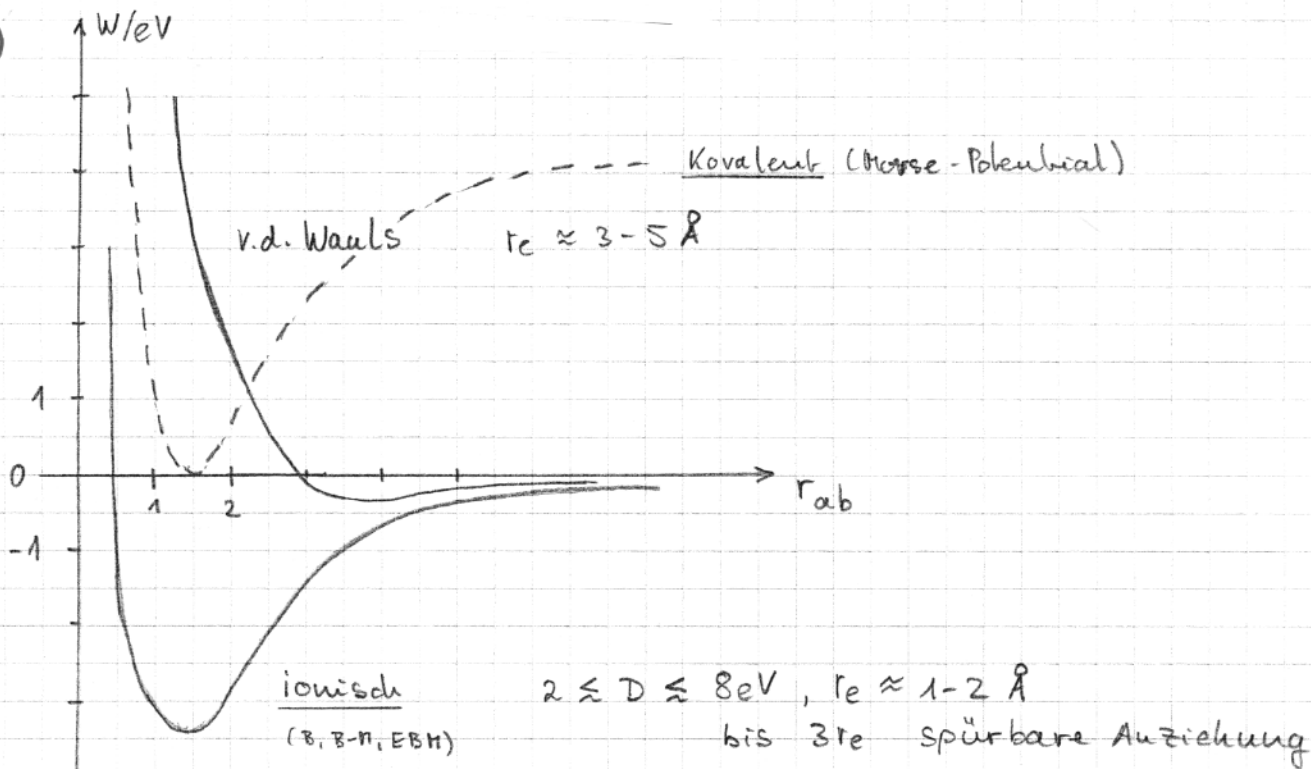
$$\Delta \lambda = \lambda_c (1 - \cos \vartheta) = \frac{h}{m_0 c^2} (1 - \cos \vartheta) = 1,21 \cdot 10^{-12} \text{ m}$$

b) $\Delta E = E - E' = E_e = 96,9 \text{ eV}$

$$p_e = \frac{1}{c} \sqrt{E_e^2 + 2m_0 c^2 E_e} = 5,31 \cdot 10^{-24} \text{ kg } \frac{\text{m}}{\text{s}}$$

$$\sin \Theta = \frac{E'}{E} \sin \alpha \approx \frac{1}{p_e} \quad \leadsto \quad \Theta = 59,47^\circ$$

37)



33)

erweitertes Born-Hayer-Potential

$$W(r) = -\frac{e^2 z^2}{4\pi\epsilon_0 r} + \beta_1 e^{-r/s_1} - \frac{d}{r^6} \quad (z=1)$$

 $\beta_1, s_1, d \rightarrow 3 \text{ Konstanten}$

$$a) \quad \frac{dW}{dr} = +\frac{e^2}{4\pi\epsilon_0 r^2} - \frac{\beta_1}{s_1} e^{-r/s_1} + \frac{6d}{r^7}$$

$$\frac{d^2W}{dr^2} = -\frac{2e^2}{4\pi\epsilon_0 r^3} + \frac{\beta_1}{s_1^2} e^{-r/s_1} - \frac{42d}{r^8}$$

gleichgewichtsabstand: $\frac{dW}{dr} \stackrel{!}{=} 0$ für r_e

$$\Rightarrow \frac{e^2}{4\pi\epsilon_0 r_e^2} - \frac{\beta_1}{s_1} e^{-r_e/s_1} + \frac{6d}{r_e^7} = 0$$

Dissoziationsenergie:

$$D_e = W(r \rightarrow \infty) - W(r_e) = +\frac{e^2}{4\pi\epsilon_0 r_e} - \beta_1 e^{-r_e/s_1} + \frac{d}{r_e^6}$$

Federkonstante:

$$k_e = \left(\frac{d^2W}{dr^2} \right)_{r=r_e} = -\frac{2e^2}{4\pi\epsilon_0 r_e^3} + \frac{\beta_1}{s_1^2} e^{-r_e/s_1} - \frac{42d}{r_e^8}$$

$$b) \quad r \rightarrow 0 \leadsto W(r) \rightarrow -\infty$$

$$r \rightarrow \infty \leadsto W(r) \rightarrow 0$$

$$c) \quad \text{LiF: } d = 2.68 \text{ eV} \cdot \text{\AA}^6, s_1 = 0.308 \text{ \AA}; \beta_1 = 895 \text{ eV}$$

$$W(r) = -\frac{14.40 \text{ eV} \cdot \text{\AA}}{r} + 895 \text{ eV} e^{-r/0.308 \text{ \AA}} - \frac{2.68 \text{ eV} \cdot \text{\AA}^6}{r^6}$$

 $r_e = ?$

$$\frac{14.40 \text{ eV} \cdot \text{\AA}}{r_e^2} - \frac{895 \text{ eV}}{0.308 \text{ \AA}} e^{-r_e/0.308 \text{ \AA}} + \frac{6 \cdot 2.68 \text{ eV} \cdot \text{\AA}^6}{r_e^7} = 0$$

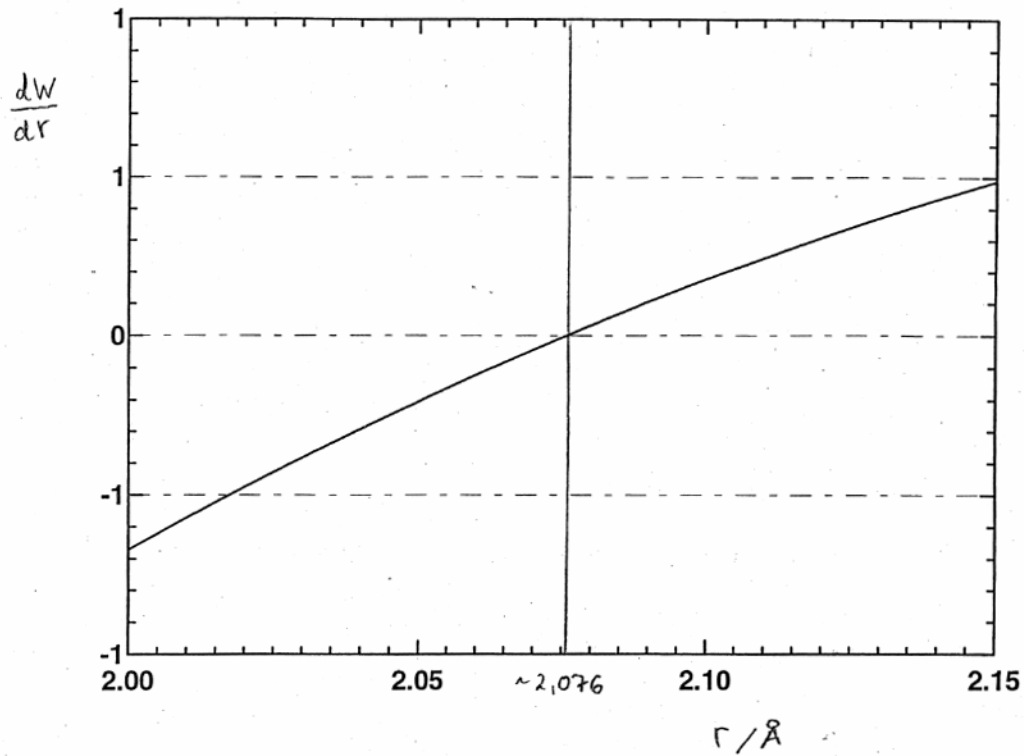
$$\frac{14.40}{r_e^2} - 2905.8 e^{-r_e/0.308} + \frac{16.08}{r_e^7} \stackrel{!}{=} 0$$

graphische Lösung: $r_e = 2.076 \text{ \AA}$

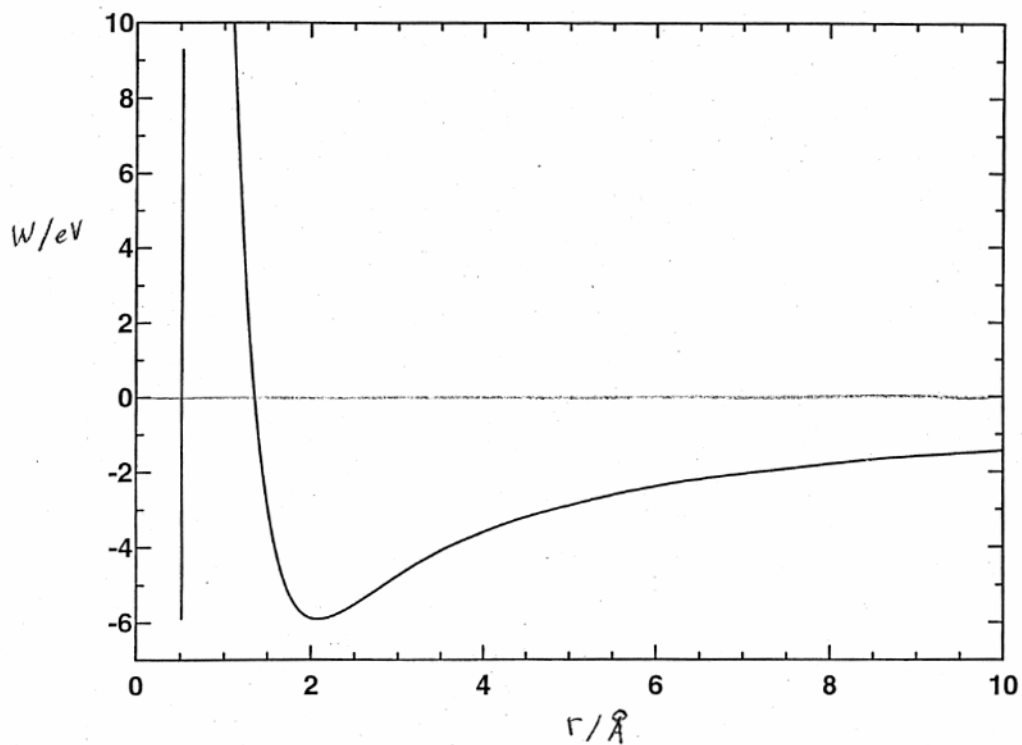
damit: $D_e = 5,91 \text{ eV}$

$r_e = 7,61 \frac{\text{eV}}{\text{\AA}} = 121,9 \frac{\text{N}}{\text{m}}$

Skizze zur Bestimmung von r_e :

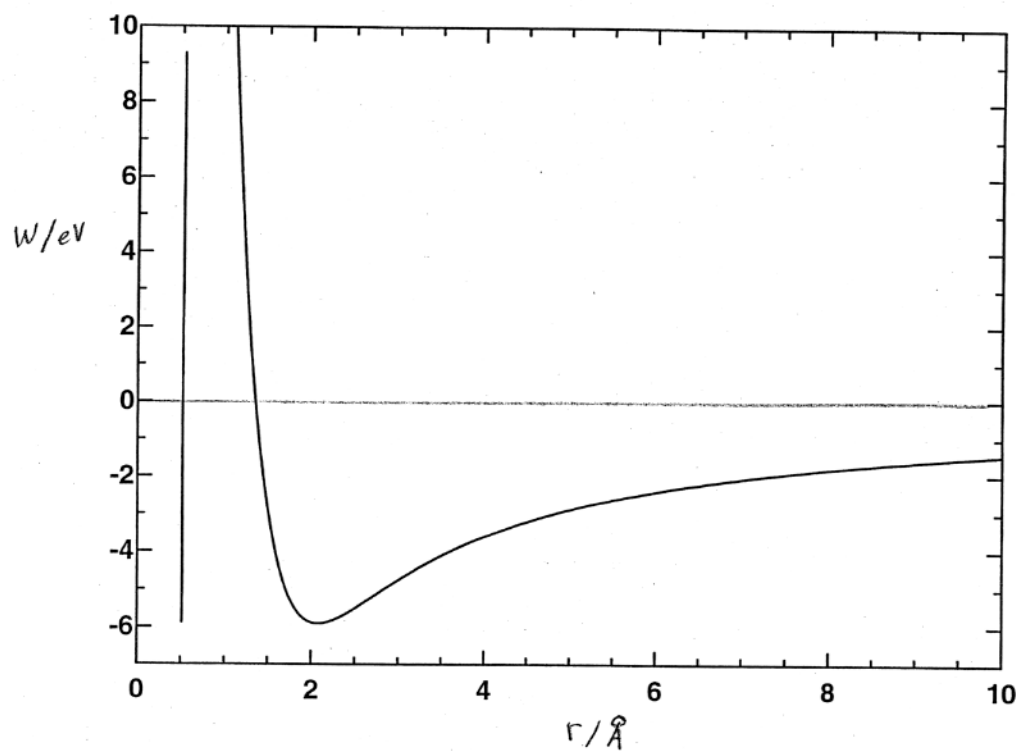
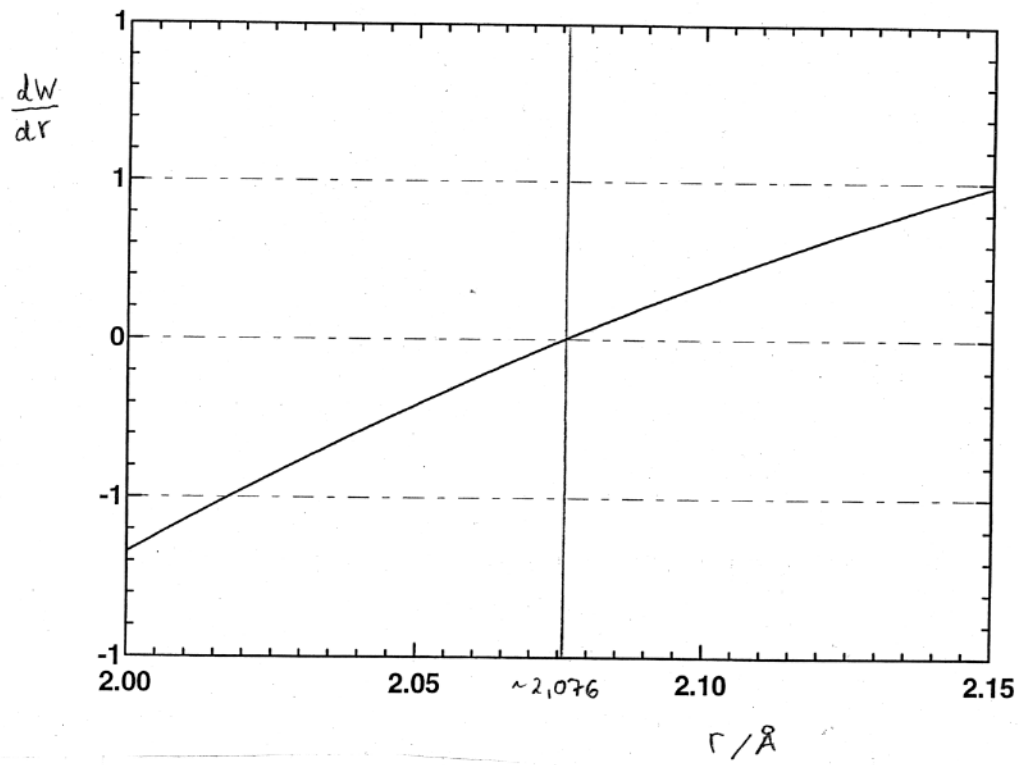


Skizze des erw. B-M-Potentials:



damit: $D_e = 5,91 \text{ eV}$

$R_e = 7,61 \frac{\text{eV}}{\text{\AA}} = 121,9 \frac{\text{N}}{\text{m}}$



39)

Morse potential : $W = D (1 - e^{-a(r-r_0)})^2$

$$r_e : \left. \frac{dW}{dr} \right|_{r=r_e} \stackrel{!}{=} 0$$

$$\frac{dW}{dr} = 2D (1 - e^{-a(r-r_0)}) e^{-a(r-r_0)} a \stackrel{!}{=} 0$$

$$\Rightarrow e^{-a(r-r_0)} \stackrel{!}{=} 1 \Rightarrow r_e = r_0$$

allgemein: $\omega_0 = \sqrt{\frac{\kappa}{m}}$

$$\kappa = \left. \frac{d^2 W}{dr^2} \right|_{r=r_e} \quad \text{aus Aufg. 43}$$

$$\begin{aligned} \frac{d^2 W}{dr^2} &= 2D (a e^{-a(r-r_0)}) a e^{-a(r-r_0)} \\ &\quad - 2D (1 - e^{-a(r-r_0)}) a^2 e^{-a(r-r_0)} \end{aligned}$$

$$\kappa \stackrel{r_e=r_0}{=} 2D a^2 - 2D (1-1) a^2 = 2D a^2$$

$$\Rightarrow \omega^2 = \frac{2D a^2}{\mu}$$

m.L. effective Mass $\mu = \frac{m_1 \cdot m_2}{m_1 + m_2}$