$$\phi(r) = \phi_0 \left(e^{-2(r-r_0)/\lambda} - 2e^{-(r-r_0)/\lambda} \right)$$ 1

(א
$$\frac{\partial \phi}{\partial r} = \phi_0 \left(-\frac{2}{\lambda} e^{-2(r-r_0)/\lambda} + \frac{2}{\lambda} e^{-(r-r_0)/\lambda} \right)$$

$$= \frac{2\phi_0}{\lambda} \left(e^{-(r-r_0)/\lambda} - e^{-2(r-r_0)/\lambda} \right) \overset{!}{=} 0$$

$$\Downarrow$$

$$e^{-(r-r_0)/\lambda} \left(1 - e^{-(r-r_0)/\lambda} \right) = 0$$

$$\Rightarrow \boxed{r = r_0}$$

ש״מ האטומים במרחק r_0.

(ב
$$U_{atom} = \frac{6}{2} \phi(r_0) = \boxed{-3\phi_0}$$

2

$$A_6 = \sum_{\vec{R} \neq 0} \left(\frac{1}{p(\vec{R})} \right)^6$$

(א
$$\cdots \bullet \overset{a}{\quad} \bullet \overset{a}{\quad} \bullet \cdots$$

$$A_6^1 = \left(\frac{1}{1}\right)^6 + \left(\frac{1}{1}\right)^6 = 2$$

(ב
$$A_6^2 = 1^6 + 1^6 + \frac{1}{2^6} + \frac{1}{2^6} = 2 + \frac{1}{2^5}$$

(ג
$$A_6^\infty = \sum_{\vec{R} \neq 0} \left(\frac{1}{p(\vec{R})} \right)^6 = 2 \sum_{n=1}^{\infty} \frac{1}{n^6} = \frac{2\pi^6}{945}$$

$$\approx 2.0347$$

$$\frac{A_6^1}{A_6^\infty} \approx 0.933 \qquad \frac{A_6^2}{A_6^\infty} = 0.9983$$

כלומר 2 שכנים קרובים נותנים

תיקון רק בסדר ה שלישית ביחס לפתרון המדוייק.

$$\frac{\partial u}{\partial r} = -\frac{mc}{r^{m+1}} + \frac{\alpha q^2}{r^2} = 0 \qquad (3)$$

$$\alpha q^2 r_0^{m+1} - mc\, r_0^2 = 0$$

$$r_0^2\left(\alpha q^2 r_0^{m-1} - mc\right) = 0$$

$$\alpha q^2 r_0^{m-1} = mc$$

$$\boxed{r_0 = \left(\frac{mc}{\alpha q^2}\right)^{\frac{1}{m-1}}}$$

$$B = -V \left.\frac{\partial P}{\partial V}\right|_T = -v \left.\frac{\partial p}{\partial v}\right|_T \qquad \text{(א}$$

$$P = -\frac{\partial U}{\partial V} = -\frac{\partial u}{\partial v}$$

$$\Rightarrow \quad B = v \frac{\partial}{\partial v}\frac{\partial u}{\partial v}$$

$$B = -v \frac{\partial r}{\partial v}\frac{\partial}{\partial r}\left(\frac{\partial u}{\partial r}\frac{\partial r}{\partial v}\right) \qquad \text{(ב}$$

$$\frac{\partial r}{\partial v} = \left(\frac{\partial v}{\partial r}\right)^{-1} = \frac{1}{6r^2}$$

$$= \underset{3^2}{\cancel{2r^3}\,\frac{1}{\cancel{6r^2}}}\;\frac{\partial}{\partial r}\left(\frac{1}{6r^2}\frac{\partial}{\partial r}\right)u$$

$$= \frac{1}{3} r \left(\cancel{-\frac{2}{6r^3}\frac{\partial}{\partial r}} + \frac{1}{6r^2}\frac{\partial^2}{\partial r^2}\right)u$$

בשיווי משקל $0 =$

$$\Rightarrow \boxed{\left. B = \frac{1}{8r_0} u''(r_0)\right|_{r=r_0}}$$

כי בשיווי משקל

$$U''(r_0) = \frac{m(m+1)C}{r_0^{m+2}} - \frac{2\alpha q^2}{r_0^3}$$ ג)

$$B = \frac{m(m+1)C}{18\, r_0^{m+3}} - \frac{\alpha q^2}{9 r_0^4} = \frac{m+1}{18 r_0^2}\,\frac{\alpha q^2}{r_0^2} - \frac{\alpha q^2}{9 r_0^4}$$

$$\frac{\alpha q^2}{r_0^2} = \frac{mC}{r_0^{m+1}}$$ ומהנגזרת הראשונה שווה לאפס:

$$\Rightarrow \quad B = \frac{\alpha q^2}{9 r_0^4}\underbrace{\left(\frac{1}{2}(m+1) - 1\right)}_{\frac{1}{2}m - \frac{1}{2}} = \frac{\alpha q^2}{18 r_0^4}(m-1)$$

$$\Rightarrow \quad \boxed{m = \frac{18 r_0^4 B}{\alpha q^2} + 1}$$

$$r_0 = \left(\frac{2A_{12}}{A_6}\right)^{\frac{1}{6}}\sigma$$ 4

$$U_{tot} = -\frac{\varepsilon}{2}\,\frac{A_6^2}{A_{12}}$$

△	□	⬡	
$\frac{56}{9}$	$\frac{9}{2}$	$\frac{29}{9}$	A_6
$\frac{1460}{243}$	$\frac{65}{16}$	$\frac{731}{243}$	A_{12}
1.116σ	1.1035σ	1.097σ	r_0
הכי יציב -3.222ε	-2.4923ε	-1.726ε	U_{tot}

חישובים

$$A_6 = 4\left(\frac{1}{1}\right)^6 + 4\,\frac{1}{2^3}$$

$$= 4 + \frac{1}{2} = \frac{9}{2}$$

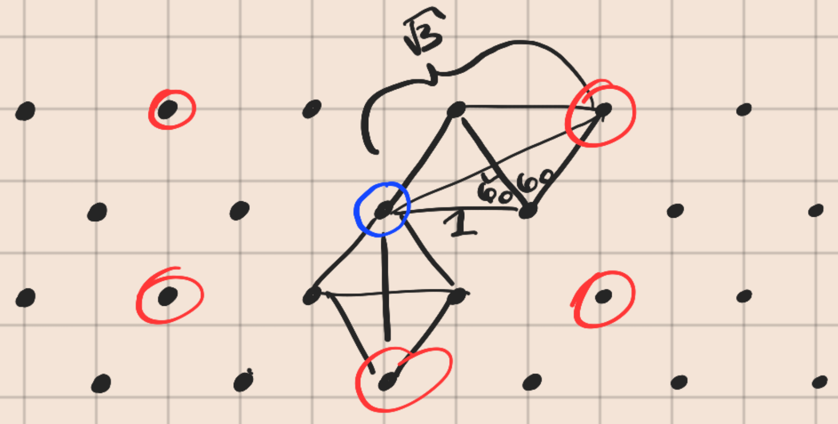
$$A_{12} = 4 + 4\,\frac{1}{2^{12/2}}$$

$$= 4 + \frac{4}{2^6} = \frac{65}{16}$$

$$\Rightarrow r_0 = \left(\frac{\cancel{2}\,\frac{65}{\cancel{16}\,8}}{\frac{9}{2}}\right)^{\frac{1}{6}}\sigma = \left(\frac{65}{36}\right)^{1/6}\sigma \simeq 1.1035\,\sigma$$

$$\frac{\cancel{2}\,65}{4\cancel{8}\cdot 9}$$

$$U = -\frac{\varepsilon}{2}\,\frac{A_6^2}{A_{12}} = -\varepsilon\,\frac{\frac{81}{4}}{\cancel{2}\,\frac{65}{\cancel{16}\,8}} = -\varepsilon\,\frac{2\cancel{8}\cdot 81}{\cancel{4}\cdot 65} \simeq -2.4923\,\varepsilon$$



$$A_6 = 6\left(\frac{1}{1}\right)^6 + 6\,\frac{1}{3^{6/2}}$$

$$= 6\left(1 + \frac{1}{3^3}\right)$$

$$= \frac{56}{9} \simeq 6.22$$

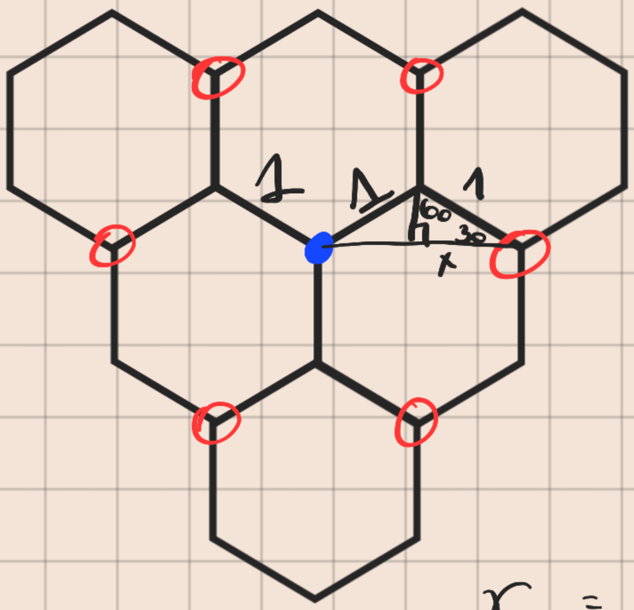
$$A_{12} = 6\,\frac{1}{1^{12}} + 6\,\frac{1}{3^6}$$

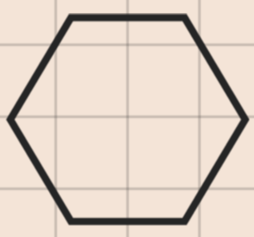
$$= \frac{1460}{243} \simeq 6$$

$$r_0 = \left(\frac{2\,\frac{1460}{243}}{\frac{56}{9}}\right)^{1/6}\sigma$$

$$\simeq 1.116\,\sigma$$

$$U = -\varepsilon\,\frac{\left(\frac{56}{9}\right)^2}{2\,\frac{1460}{243}} \simeq -3.222\,\varepsilon$$





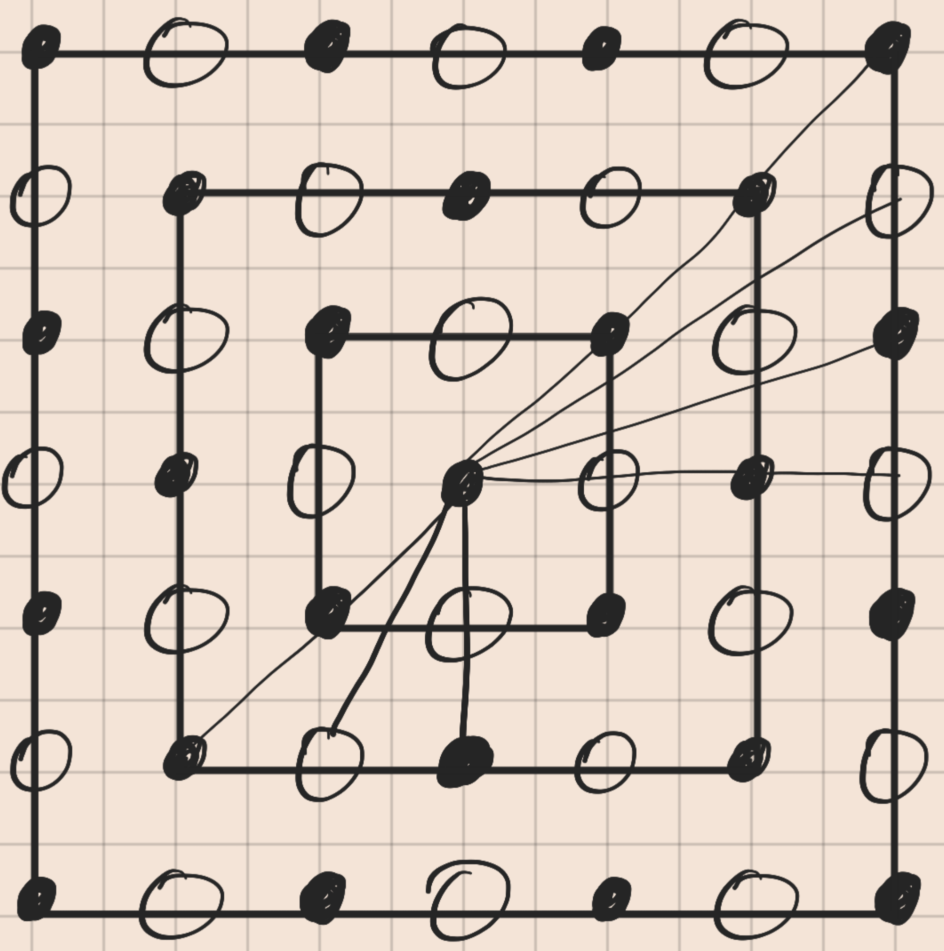
$$2\cos 30 = {}_{1/2}\,120 = \sqrt{3}$$

$$A_6 = 3 + 6\,\frac{1}{3^3} = 3\left(1 + \frac{2}{3^3}\right) = \frac{29}{9}$$

$$A_{12} = 3 + 6\,\frac{1}{3^6} = \frac{731}{243}$$

$$r_0 = \left(\frac{2\,\frac{731}{243}}{\frac{29}{9}}\right)^{1/6}\sigma \simeq 1.097\,\sigma$$

$$U = -\varepsilon \frac{\left(\frac{29}{9}\right)^2}{2\,\frac{731}{243}} \approx -1.726\,\varepsilon$$



$3^2 + 3^2 = x^2$
$\sqrt{18} = x$

$4 + 9$
$2^2 + 3^2 = x^2$
$x = \sqrt{13}$

$3^2 + 1 = x^2$
$x = \sqrt{10}$

k	N_k	$\rho(R_k)$	$\lambda(R_k)$	$\frac{1}{n}$	
1	4	1	-1	1	✓
2	4	$\sqrt{2}$	1	1	✓
3	4	2	1	1	✓
4	8	$\sqrt{5}$	-1	1	✓
5	4	$2\sqrt{2}$	1	1	✓
6	4	3	-1	$\frac{1}{2}$	✓
7	8	$\sqrt{10}$	1	$\frac{1}{2}$	✓
8	8	$\sqrt{13}$	-1	$\frac{1}{2}$	
9	4	$\sqrt{18}$	1	$\frac{1}{4}$	

$$\alpha = -4 + \cancel{\frac{4}{\sqrt{2}}}^{\,2\sqrt{2}} + \cancel{4}^{\,2}\cdot\frac{1}{\cancel{2}} - 8\frac{1}{\sqrt{5}} + \cancel{4}^{\,2}\frac{1}{\cancel{2}\sqrt{2}} - {}_{2}\cancel{4}\,\frac{1}{\cancel{2}}\,\frac{1}{3}$$

$$+ {}_{4}\cancel{8}\,\frac{1}{\sqrt{10}}\,\frac{1}{\cancel{2}} - {}_{4}\cancel{8}\,\frac{1}{\sqrt{13}}\,\frac{1}{\cancel{2}} + \cancel{4}\,\frac{1}{\sqrt{18}}\,\frac{1}{\cancel{4}}$$

$$\approx \boxed{1.6105}$$