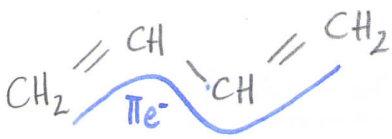
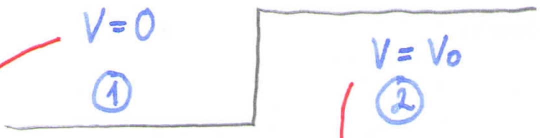
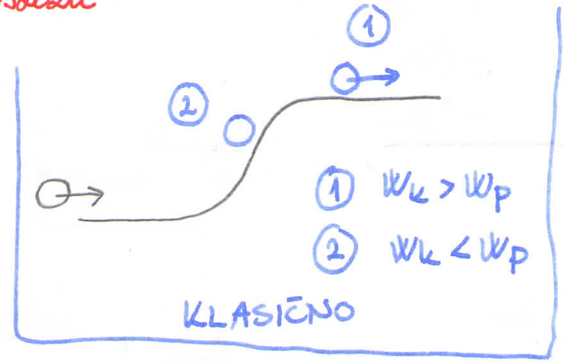



$\pi e^-$ v BUTADIENU se obnašajo kot delci v neskončni potencialni jami

## Delec na potencialnem skoku




1

$$\hat{H}\psi = E\psi$$

$$\hat{H} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2} + \cancel{V}$$

$$-\frac{\hbar}{2m}\frac{\partial^2\psi}{\partial x^2} = E\psi$$

$$\psi = Ae^{ikx} + Be^{-ikx}$$

$\boxed{\frac{2mE}{\hbar^2} \quad k^2}$ glej nazaj

2

$$\hat{H} = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2} + V_0$$

$$-\frac{\hbar^2}{2m}\frac{\partial^2\psi}{\partial x^2} + V_0\psi = E\psi$$

$$-\frac{\hbar^2}{2m}\frac{\partial^2\psi}{\partial x^2} + V_0\psi - E\psi = 0$$

a) $\boxed{E > V_0}$

$$-\frac{\hbar^2}{2m}\frac{\partial^2\psi}{\partial x^2} - (E - V_0)\psi = 0 \quad / \cdot -\frac{2m}{\hbar^2}$$

$$\frac{\partial^2\psi}{\partial x^2} + \underbrace{\frac{2m}{\hbar^2}(E - V_0)}_{q^2}\psi = 0$$

$$\frac{\partial^2\psi}{\partial x^2} + q^2\psi = 0$$

$$\psi = Ce^{iqx} + De^{-iqx}$$

$\rho_1(0) = \rho_2(0) \Rightarrow$

$$\psi_1(0) = \psi_2(0)$$

$$\boxed{A + B = C + D}$$

$$j_1(0) = j_2(0) \Rightarrow \frac{\partial\psi_1}{\partial x}(0) = \frac{\partial\psi_2}{\partial x}(0)$$

$$\psi_1' = Aike^{ikx} - Bike^{-ikx} \qquad \psi_2' = Ciqe^{iqx} - Diqe^{-iqx}$$

$\boxed{Aik - Bik = Ciq - Diq}$ za $x = 0$

$\boxed{D=0}$ ; pri $V=V_0$ nimamo delcev v smeri


sledi:

$$\boxed{A+B=C} \quad \cdot k$$

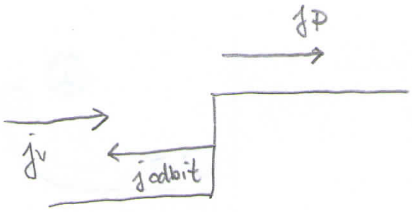
$$\boxed{Ak - Bk = Cg} \quad \Big| \text{ seštejemo}$$

$$2Ak = C(k+g)$$

$$C = \frac{2Ak}{k+g}$$

$$B = C - A = \frac{2Ak}{k+g} - A = \frac{2Ak - kA - Ag}{k+g} =$$

$$B = \frac{A(k-g)}{k+g}$$




$$\psi = Ae^{ikx}$$

$$j = \frac{\hbar k}{2m}|A|^2$$

$$\eta_{odb.} = \frac{j_{odb.}}{j_v} =$$

$$j_v = \frac{\hbar k}{2m}|A|^2$$

$$j_{odb.} = \frac{\hbar k}{2m}|B|^2$$

$$\boxed{\eta_{odb.} = \frac{|B|^2}{|A|^2}}$$

$$\boxed{k = \sqrt{\frac{2mE}{\hbar^2}} \qquad g = \sqrt{\frac{2m(E-V_0)}{\hbar^2}}}$$

DELEŽ ODBITIH DELCEV

$$\eta_{odb.} = \frac{B^*B}{|A|^2} = \frac{A^*\frac{k-g}{k+g}\cdot A\frac{k-g}{k+g}}{\cancel{|A|^2}} =$$

$$\eta_{odb.} = \frac{(k-g)^2}{(k+g)^2} \Rightarrow$$

$$\eta_{odb.} = \frac{(k-g)^2}{(k+g)^2} = \frac{\left(\sqrt{\frac{\cancel{2m}E}{\cancel{\hbar^2}}} - \sqrt{\frac{\cancel{2m}(E-V_0)}{\cancel{\hbar^2}}}\right)^2}{\left(\sqrt{\frac{\cancel{2m}E}{\cancel{\hbar^2}}} + \sqrt{\frac{\cancel{2m}(E-V_0)}{\cancel{\hbar^2}}}\right)^2}$$

$$\boxed{\eta_{odb.} = \left(\frac{\sqrt{E} - \sqrt{E-V_0}}{\sqrt{E} + \sqrt{E-V_0}}\right)^2}$$

kv. delci se obnašajo kot valovanje

DELEŽ PREPUŠČENIH DELCEV

$$\eta_{prepuščenih} = \frac{j_P}{j_V} = \frac{\frac{\hbar g}{2m}|C|^2}{\frac{\hbar k}{2m}|A|^2} =$$

$$= \frac{\frac{\cancel{\hbar} g}{\cancel{2m}}\frac{(2k)^2}{(k+g)^2}\cancel{|A|^2}}{\frac{\cancel{\hbar} k}{\cancel{2m}}\cancel{|A|^2}} =$$

$$\eta_{p.} = \frac{4kg}{(k+g)^2} \ldots$$

→ izračunali smo, da je

$$\boxed{\boxed{\eta_{p.} + \eta_{odb.} = 1}}$$

(b) $\boxed{E < V_0}$

$$-\frac{\hbar^2}{2m}\frac{\partial^2\psi}{\partial x^2} + (V_0 - E)\psi = 0 \quad \Big| \cdot \frac{-2m}{\hbar^2}$$

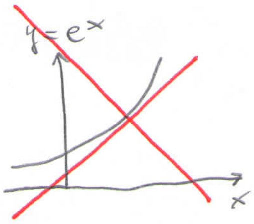
$$\frac{\partial^2\psi}{\partial x^2} - \frac{2m(V_0-E)}{\hbar^2}\psi = 0 \qquad \boxed{\chi^2 = \frac{2m(V_0-E)}{\hbar^2}}$$

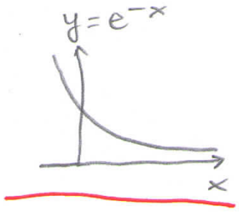
$$\frac{\partial^2\psi}{\partial x^2} - \chi^2\psi = 0$$

$$\psi = Ce^{\chi x} + De^{-\chi x} \quad \boxed{*}$$

$\psi_1(0) = \psi_2(0) \Rightarrow \boxed{A + B = C + D}$

$\psi_1'(0) = \psi_2'(0) \Rightarrow \boxed{ikA - ikB = \chi C - \chi D}$




$\boxed{C = 0}$

$\boxed{A + B = D} \quad ik$

$\boxed{ikA - ikB = -\chi D}$ | seštejemo

$$2Aik = Dik - \chi D$$

$$D = \frac{2ikA}{ik - \chi}$$

$$B = D - A =$$

$$B = \frac{2ikA - (ik+\chi)A}{ik - \chi} = \frac{(ik+\chi)A}{(ik-\chi)}$$

$$\boxed{\eta_{odb.} = \frac{|B|^2}{|A|^2}}$$

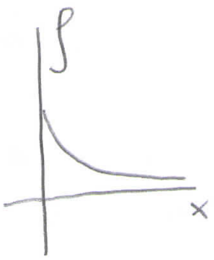
$$B^* = \frac{(-ik+\chi)A^*}{(-ik-\chi)}$$

$$\eta_{odb.} = \frac{B^*B}{|A|^2} = \frac{(-ik+\chi)\cancel{A^*}(ik+\chi)\cancel{A}}{(-ik-\chi)(ik-\chi)\cancel{|A|^2}} = \boxed{\frac{\chi^2+k^2}{\chi^2+k^2} = 1}$$

vsi delci se odbijejo, VENDAR... $\boxed{*}$

$$\psi_2 = De^{-\chi x}$$

$$\rho_2 = |D|^2 e^{-2\chi x}$$




Heisenbergova enakost delcem omogoča, da gredo tja, kjer nimajo dovolj E →
E si „IZPOSODIJO" OD OKOLICE

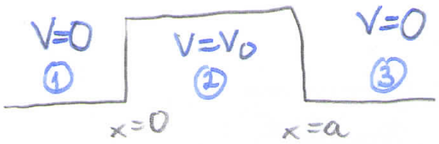
$\Delta E \Delta t \geq \hbar$

V neskončni pot. jami delci ne morejo priti v področje $V = \infty$; vendar, če je $V < \infty$; tu je možno, da so.

ZEVRAZO

GOVORIMO O KV. DELCIH

# Delci na potencialni plasti




$\boxed{E > V_0}$

$$\boxed{\begin{aligned} &① \; \psi = Ae^{ikx} + Be^{-ikx} \\ &② \; \psi = Ce^{iqx} + De^{-iqx} \\ &③ \; \psi = Ee^{ikx} + \cancel{F}e^{-ikx} \end{aligned}}$$

$$\psi_1(0) = \psi_2(0) \Rightarrow A + B = C + D$$

$$\psi_1'(0) = \psi_2'(0) \qquad ikA - ikB = iqC - iqD$$

$$\psi_2(a) = \psi_3(a) \Rightarrow Ee^{ika} + Fe^{-ika} = Ce^{iqa} + De^{-iqa}$$

$$\psi_2'(a) = \psi_3'(a) \Rightarrow ikEe^{ika} - ikFe^{-ika} = iqCe^{iqa} - iqDe^{-iqa}$$

$$\Rightarrow \boxed{F = 0}$$

$$\left.\begin{aligned} &A + B - C - D = 0 \\ &ikA - ikB - iqC + iqD = 0 \end{aligned}\right\} \text{ GAUSSOVA ELIMINACIJA } \Rightarrow$$

REŠITVE:

$$B = \frac{(k^2 - q^2)(e^{2iqa} - 1)}{(e^{2iqa} - 1)(k^2 + q^2) - 2kq(e^{2iqa} + 1)}$$

$$\eta_{odb.} = \frac{j_{odb.}}{j_v} = \frac{|B|^2}{|A|^2} = \frac{(k^2 - q^2)^2 \sin^2 qa}{(k^2 + q^2)\sin^2 qa + 4k^2q^2\cos^2 qa}$$ DELEŽ ODBITIH KV. DELCEV

$$\eta_{prepuščenih} = \frac{4k^2q^2}{(k^2 - q^2)^2 \sin^2 qa + 4k^2q^2}$$

za $qa = n\pi \Rightarrow$

$\sin qa = 0 \Rightarrow \boxed{\eta_{prep.} = 1}$

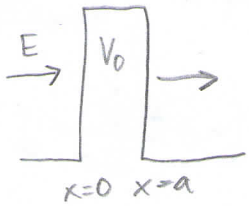
$\boxed{E < V_0}$

$$\boxed{\begin{aligned} &(1)\ \psi = Ae^{ikx} + Be^{-ikx} \\ &(2)\ \psi = Ce^{\chi x} + De^{-\chi x} \\ &(3)\ \psi = Ee^{ikx} + \cancel{F}e^{-ikx} \end{aligned}}$$

$\Rightarrow$

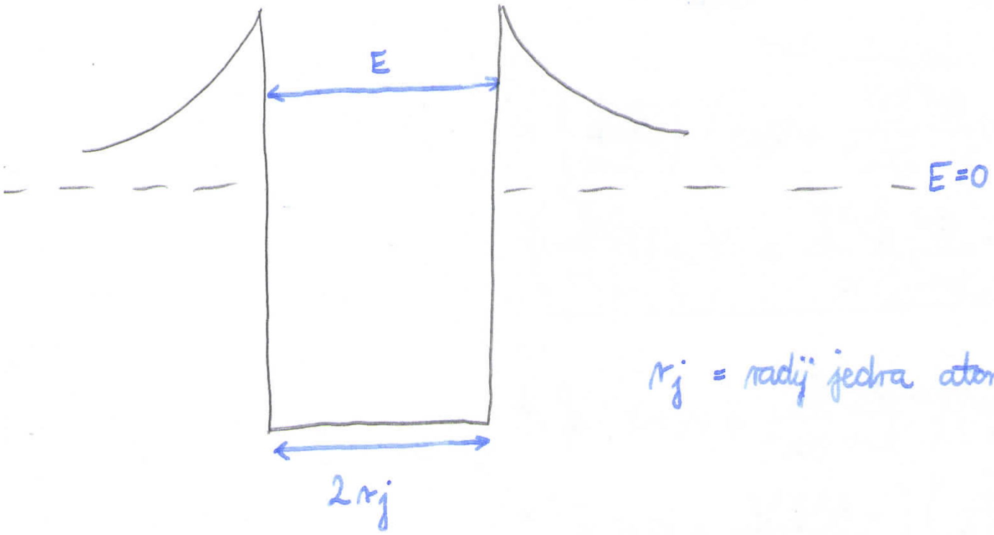
$$E = \frac{-2ik\chi e^{-ika}}{i(k^2-\chi^2)\,\mathrm{sh}(\chi a) - 2ik\chi\,\mathrm{ch}(\chi a)}$$

$$\eta_{prepuščenih} = \frac{4k^2\chi^2}{(\chi^2+k^2)^2\,\mathrm{sh}^2(\chi a) + 4k^2\chi^2}$$




**TUNELSKI EFEKT**

- razpad jedra na $\alpha$-delce $\boxed{{}^4_2He}$
- v DNK: mutacije zaradi tun. efekta H-jev
- molekule: $NH_3$




$r_j$ = radij jedra atoma