10. Hafta

13)BETA BOZUNMASI

β^- bozunması (eksi yüklü elektron)

β^+ bozunması(artık yüklü elektron)

e^- yakalanması

i-) ${}_0^1\eta \longrightarrow {}_1^1H + \beta^- + \overline{V}$

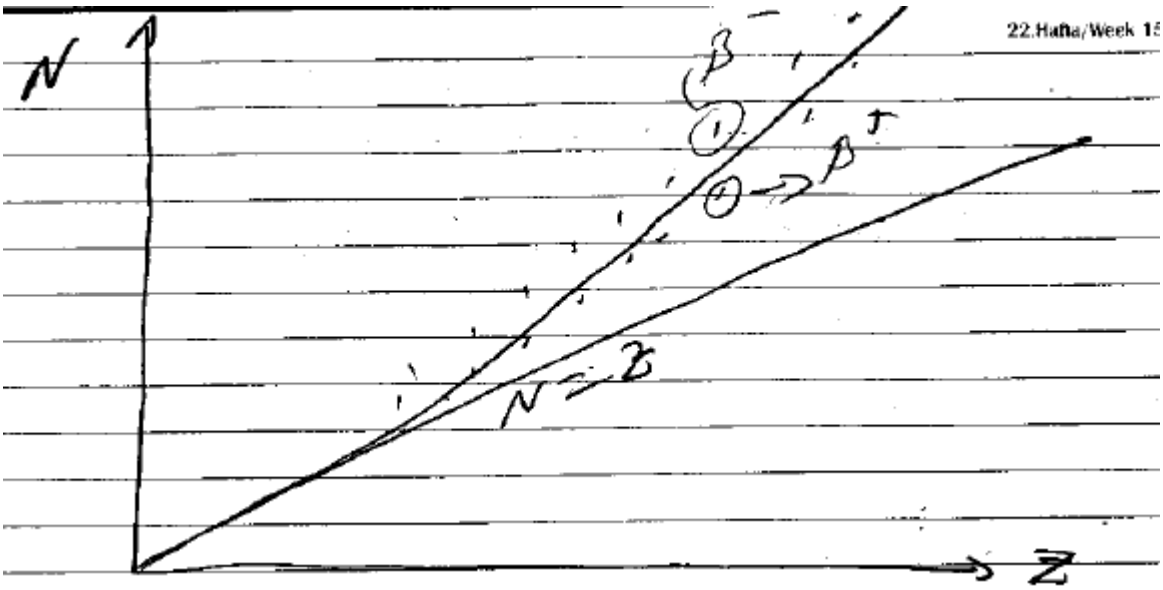
${}_Z^AX \longrightarrow {}_{Z+1}^AY + \beta^- + \overline{V}$

ii-) ${}_1^1H \longrightarrow {}_0^1\eta + \beta^+ + \nu$

${}_Z^AX \longrightarrow {}_{Z-1}^AY + \beta^+ + \nu$

iii-) ${}_1^1H + {}_{-1}^0e \longrightarrow {}_0^1\eta + \nu$

${}_Z^AX + {}_{-1}^0e \longrightarrow {}_{Z-1}^AY + \nu$



i) ${}^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \bar{\nu} + \beta^{-}$

$$E_{İ=}\, E_S$$

$$M_x^1\, c^2 + K_{x=}\, M_y^1\, c^2 + K_y + m_e^1\, c^2 + K\, e_-^0 + m_\nu c^2 + E_\nu$$

$$M_x^1 = Çekidek\ kütlesi$$

$$[M_x^1 - M_y^1 - M_{e_-^0}]c^2 = K_y + K\, e_-^0 + E_\nu$$

$$\theta = [M_x^1 - M_y^1 - M_{e_-^0}]c^2$$

$\theta = K_y + K\, e_-^0 + E_\nu$: Parçalanma enerjisi

$K_y = 0$

$\theta = K\, e_-^0 + E_\nu$

$$M_x = M_x' + ZM_e$$

$$M_x' = M_x - ZM_e$$

$M'_y = M_y - (Z+1)\,M_e$

$\theta = \left[M_x - Zm_e - M_y - (Z+1)M_e - M_e\right] c^2$

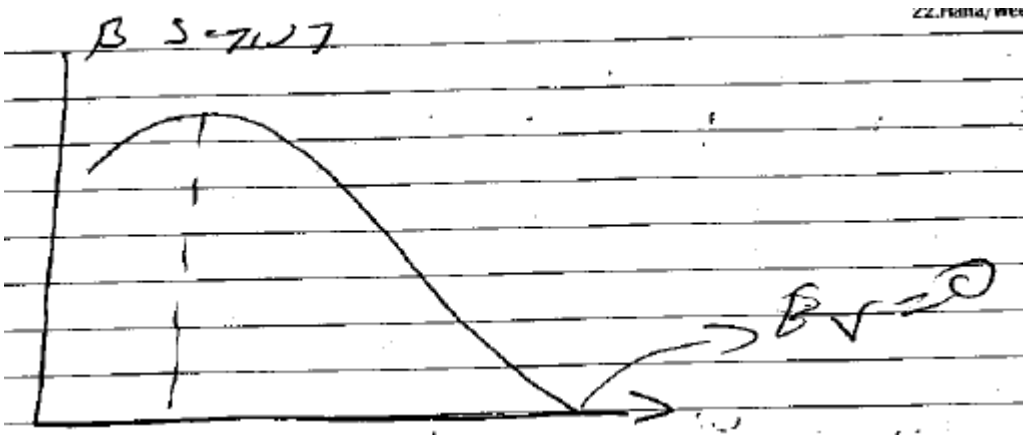
$\left[M_x - M_y - ZM_e + ZM_e + m_e - m_e\right]c^2$

$\theta = \left[M_x - M_y\right]c^2$

$\theta>0$ ise reaksiyon gerçekleşir (ekzotermik)

$[{}^A_Z M - {}^A_{Z+1}M\,]c^2>0$ *ise* β^- bozunumu gerçekleşir.

$(K_{\beta^-})_{max} = \theta = E_\nu + K\,e^0_-$



$\overline{K} = \frac{1}{3}K_{max}$

$(K_\beta)_{max} = K_e + E_\nu$

ii) ${}^A_Z X \longrightarrow e^0_- + {}^A_{Z+1}Y + \boldsymbol{\nu\beta}$

$\theta = [M'_x\text{-}M'_Y - M_e]c^2$

$\theta = K_e + E_\nu$

$\theta = [M_x - ZM_e - M_Y + (z-1)m_e - m_e]c^2$

$= [M_X - M_Y - 2m_e]\,c^2$

$\theta > 0$

$=[M_X - M_Y] > 2m_e\, c^2$

$[M_X - M_Y] > 1{,}02\ MeV$

iii) $\quad {}^{A}_{Z}X + {}^{0}_{-1}e \longrightarrow {}^{A}_{Z-1}Y + \nu$

$\theta = [M'_x + m_e - M'_Y]\, c^2$

$\theta = [M_X - Zm_e + m_e - M_Y + (Z+1)\, m_e]\, c^2$

$= [M_X - M_Y]\, c^2$

$[{}^{A}_{Z}M - {}^{A}_{Z-1}M] > 0$ *ise aktif yakalama yapar.*

Hızlı elektronların ışıma yoluyla elektron kaybı:

$\frac{dE}{dt} = \frac{2e^2a^2}{3c^3}$ $\qquad\qquad$ $f=ma$

$= \frac{2e^2f^2}{3c^3m^2}$

$\left(-\frac{dE}{dx}\right)_{top} = \left(-\frac{dE}{dx}\right)_{iyonlar} \left(+\frac{dE}{dx}\right)_{protonlar}$

$$\left(-\frac{dE}{dx}\right)_{iyonlar} = 2\pi r_0^2\, Ne\rho\, \frac{\Gamma_0}{\beta^2}\left[ln\, \frac{E^2\,(E+2\Gamma_0)}{2\Gamma_0 I^2} + \frac{(E^2/8)-(2E+\Gamma_0)\Gamma_0 ln^2}{(E+\Gamma_0)^2}\right]$$

$r_0 = 2{,}81794x10^{-15}m$

$Ne = gr$ başına elektron sayısı

$$Ne = \frac{ZN_0}{A}$$

E= Elektronun kinetik enerjisi

$\beta = V/C$

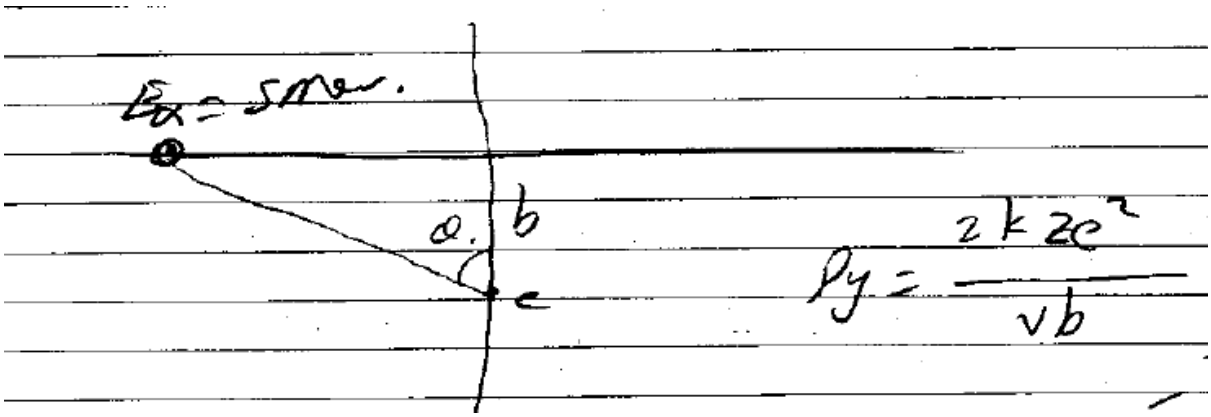
$\Gamma_0 = m_0 c^2$

$\hat{J}$= madde atomlarının ortalama iyonizasyon ve uyarma potansiyeli

$$\left(-\frac{dE}{dx}\right) = 4\rho r_0^2 \frac{NeZ}{137}\left[ln\ \frac{2(E+\Gamma_0)}{\Gamma_0} - \frac{1}{3}\right]$$

ÖRNEK:

1-Gelip gitmekte olan 5 MeV'lik bir α parçacığından bir elektron tarafından alınan enerji 32 eV'dir.Elektrona aktarılan y yanındaki momentumu hesaplayınız.



$E = \frac{P_y^2}{2M_\alpha}$, $P_y = \sqrt{2m_\alpha E} = \sqrt{2 * 1{,}166 * 10^{-24} gr * 32eV}$

$= 1{,}03 * 10^{-11} \mathrm{gr}\frac{cm}{sn}$

α'dan elektron transfer edilen enerji.

2-Aşağıdaki çekirdeklerden hangisi β^-, β^+ ve EC ile bozunacaklardır.

$Co^{60}, O^{15}, Na^{22}, P^{32}, Cu^{64}$

1-β^- bozunması

$$^{60}_{27}Co \longrightarrow {}^{60}_{28}Ni + \beta^- + \nu^-$$

$(M_{co} - M_{Ni}) * c^2$>0

(59,933806-59,930783)931,5>0

Q=2,815924 MeV β^- yapar.

2-β^+ bozunması

$$^{60}_{27}Co \longrightarrow {}^{60}_{26}Fe + \beta^+ + \nu$$

$[M_{^{60}_{27}Co} - M_{^{60}_{26}Fe}]^* c^2 > 1{,}02\ MeV$

[59,933806-59,934078]931,5>1,02 MeV

Q=-0,25337 MeV

3-U^{238}'in Th^{234}'e bozunumunda yayınlanan α parçacığının enerjisi 4196 KeV'dir.Bu bilgiden ve $U^{238'}in$ bilinen kütlesinden Th^{234} 'ün kütlesini hesaplayınız.

$$U^{238} \longrightarrow Th^{234} + {}^4_2He$$

$K_\alpha = \frac{Q}{1+\frac{m_\alpha}{M_y}}$

$Q=(M_x - M_y - m_\alpha)c^2 = K_\alpha(1 + \frac{m_\alpha}{M_y})$

$M_x c^2 - M_y c^2 - m_\alpha c^2 = K_\alpha + K_\alpha \frac{m_\alpha}{M_y}$

$M_x c^2 - m_\alpha c^2 - K_\alpha = M_y c^2 + K_\alpha \frac{m_\alpha}{M_y}$

$M_y c^2 + K_\alpha m_\alpha M_y^{-1} + K_\alpha - (M_x - m_\alpha)\, c^2 = 0$

$M_y{}^2 c^2 + [K_\alpha - (M_x - m_\alpha)c^2]M_y + K_\alpha m_\alpha = 0$

$M_y{}^2 c^2 - 218{,}012 M_y + 16{,}795 = 0$

$M_y = \frac{-b \pm \sqrt{b^2-4ac}}{2a} = \frac{218{,}012 \pm \sqrt{(218{,}012)^2 - 4*16{,}795*931{,}5}}{2*931{,}5} = \frac{218{,}012 \pm 218{,}012}{1863} = 234{,}0434984$