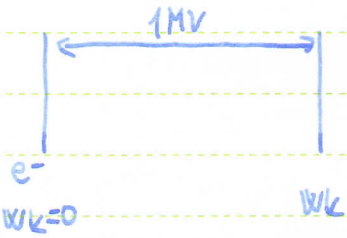
9. 10. 13

SEMINAR 2

Elektron preleti napetost 1 MV. S kakšno hitrostjo se giblje, kakšna je njegova gib. količina ?



$A = \Delta W$

$e \cdot U = W_k$

$m_e = 9{,}1 \cdot 10^{-31}\ kg$

$e_0 = 1{,}6 \cdot 10^{-19}\ As$

$W_k = U \cdot e = 1 \cdot 10^6\ V \cdot 1{,}6 \cdot 10^{-19}\ As = \underline{1{,}6 \cdot 10^{-13}\ J}$

$W_k = \frac{1}{2} m v^2$

$v = \sqrt{\frac{2 W_k}{m}} = \sqrt{\frac{2 \cdot 1{,}6 \cdot 10^{-13}\ J}{9{,}1 \cdot 10^{-31}\ kg}} = \underline{5{,}93 \cdot 10^8\ m/s}$

Nerv. M ne velja

$$\frac{J}{kg} = \frac{N \cdot m}{kg} = \frac{kg\, m^2}{s^2\, kg} = \frac{m^2}{s^2} \Rightarrow \sqrt{\frac{m^2}{s^2}} = \frac{m}{s}$$

$W_k = mc^2(\gamma - 1)$

$\gamma - 1 = \frac{W_k}{mc^2}$

$\gamma = \frac{W_k}{mc^2} + 1 = \frac{1\ MeV}{0{,}511\ MeV} + 1 = \underline{2{,}96}$

$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$

$\sqrt{1 - \frac{v^2}{c^2}} = \frac{1}{\gamma}$

$1 - \frac{v^2}{c^2} = \frac{1}{\gamma^2}$

$\frac{v^2}{c^2} = 1 - \frac{1}{\gamma^2}$

$v = c \cdot \sqrt{1 - \frac{1}{\gamma^2}}$

$v^2 = c^2\left(1 - \frac{1}{\gamma^2}\right)$

$v = \sqrt{c^2\left(1 - \frac{1}{\gamma^2}\right)} =$

$= \sqrt{(3 \cdot 10^8)^2 \frac{m^2}{s^2}\left(1 - \frac{1}{2{,}96^2}\right)} =$

$= \underline{2{,}82 \cdot 10^8\ m/s}$

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Mioni so osnovni delci z nabojem $-e_0$ in z energijo 105,7 MeV. Razpolovni čas je $2{,}197 \cdot 10^{-6}$ s. Mioni razpadejo na elektron, mionski nevtrino in el. antinevtrino. Kolikšna je masa miona v kg? S kolikšno hitrostjo se morajo mioni gibati, da je razpadni čas $5 \cdot 10^{-6}$ s?

$E_0 = 105{,}7$ MeV

1) $E = mc^2$

$m = \frac{E}{c^2} = \frac{105{,}7 \cdot 10^6 \text{ eV}\, s^2}{(3 \cdot 10^8)^2 m^2} =$

$= \frac{105{,}7 \cdot 10^6 \cdot 1{,}6 \cdot 10^{-19} \text{ J}\, s^2}{9 \cdot 10^{16} m^2} =$

$= \frac{105{,}7 \cdot 1{,}6 \cdot 10^{-13} \text{ kg}\, m^2 s^2}{9 \cdot 10^{16} s^2 m^2} =$

$= 1{,}88 \cdot 10^{-28}$ kg

2) $N = N_0 \cdot e^{-\frac{t}{\tau}} = N_0 \cdot 2^{-\frac{t}{t_{1/2}}}$

$t_{1/2} = 2{,}197 \cdot 10^{-6}$ s

$t'_{1/2} = 5 \cdot 10^{-6}$ s

$t'_{1/2} = \gamma \cdot t_{1/2} \Rightarrow \gamma = \frac{t'_{1/2}}{t_{1/2}} = \frac{5 \cdot 10^{-6} \text{ s}}{2{,}197 \cdot 10^{-6} \text{ s}} = 2{,}276$

$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$

$1 - \frac{v^2}{c^2} = \frac{1}{\gamma^2}$

$v^2 = \left(1 - \frac{1}{\gamma^2}\right) c^2$

$v = c\sqrt{\left(1 - \frac{1}{\gamma^2}\right)} =$

$= c \cdot \sqrt{1 - \frac{1}{2{,}276^2}} =$

$= 0{,}898\, c = 2{,}69 \cdot 10^8$ m/s

Kolikšna je vezavna energija devterija, če je njegova masa 2,0141078 u, kjer je u atomska enota mase z vrednostjo $1\,u = 1{,}660538782 \cdot 10^{-27}$ kg, m protona je 1,0072764667 u ter m nevtrona 1,0086649156 u?

$E_{vezavna} < 0$ $\qquad p + n \longrightarrow {}^{2}_{1}H$

$$E_v = (m_{{}^{2}_{1}H} - m_p - m_n)\,c^2$$

Δm

$$E_v = (2{,}0141078\,u - 1{,}660538782\,1{,}0072764667\,u - 1{,}0086649156\,u)\,(c \cdot 10^8)^{\frac{m^2}{s^2}}$$

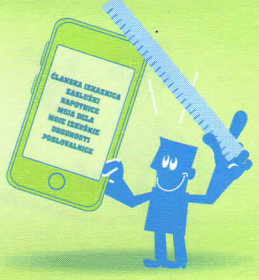
$$= 1{,}660538782 \cdot 10^{-27}\,kg \cdot 9 \cdot 10^{16}\,\frac{m^2}{s^2} \cdot (2{,}0141078 - 1{,}0072764667 - 1{,}0086649156) =$$

$$E_v = 2{,}75 \cdot 10^{-13}\,J =$$

$$= 1{,}706\ MeV$$

$E = -13{,}6\ eV \Rightarrow \Delta m = \frac{E}{c^2} = \frac{-13{,}6\,eV \cdot 1{,}6 \cdot 10^{-19}\,kg\,\frac{m^2}{s^2}}{(3 \cdot 10^8)^2\,\frac{m^2}{s^2}} = -2{,}4 \cdot 10^{-35}\,kg$

$\frac{\Delta m}{1\,u} = \frac{2{,}4 \cdot 10^{-35}\,kg}{1{,}660538782 \cdot 10^{-27}\,kg} = 1{,}45 \cdot 10^{-8}\,u \Rightarrow$ nedoločljivost na 8. decimalko



Izstopno delo za Pt je 6,35 eV. Izračunajte mejno frekvenco in val. dolžino pri fotoefektu? Kolikšna je zaporna napetost na fotodiodi, če Pt osvetlimo s svetlobo val. dolžine 147 nm?

$A_i = 6,35\,eV$

$W_f = A_i = h\nu$

W_f mejna frekvenca

$$\nu = \frac{W_f}{h} = \frac{6,35 \cdot 1,6 \cdot 10^{-19}\,J}{6,62 \cdot 10^{-34}\,Js} = 1,53 \cdot 10^{15}\,Hz$$

$$= 1,53 \cdot 10^{6}\,GHz$$

$c = \nu\lambda$

$$\lambda = \frac{c}{\nu} = \frac{3 \cdot 10^{8}\,m/s}{1,53 \cdot 10^{15}} = 195,5\,nm$$

UV sv.

$E_f = A_i + W_k$

$W_k = W_f - A_i$

$W_k = h\nu - A_i$

$$W_k = h\frac{c}{\lambda} - A_i = 6,62 \cdot 10^{-34}\,Js \cdot \frac{3 \cdot 10^{8}\,m\,s^{-1}}{147 \cdot 10^{-9}\,m} - 6,35 \cdot 1,6 \cdot 10^{-19}\,J =$$

$$= 7,16 \cdot 10^{-19}\,J = \frac{6,62 \cdot 10^{-34}\,Js \cdot 3 \cdot 10^{8}\,m\,s^{-1}}{1,6 \cdot 10^{-19}\,J\,eV^{-1} \cdot 147 \cdot 10^{-9}\,m} - 6,35\,eV =$$

$W_k = eU_z$

$$U_z = \frac{W_k}{e} = \frac{7,16 \cdot 10^{-19}\,J}{1,6 \cdot 10^{-19}\,As} = 2,09\,eV$$

$\Delta W_k = 2,09\,eV = eU_z$ $\quad U_z = 2,09\,V$