

Footonid

Füüsika

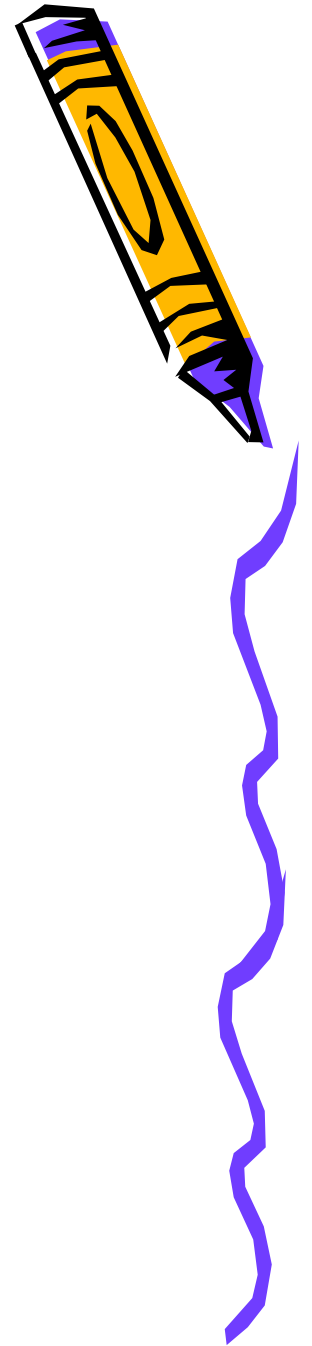
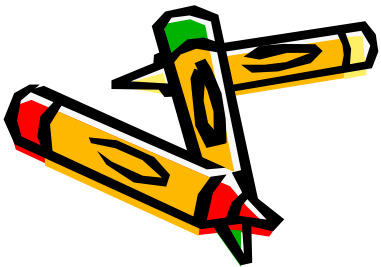
11 klass

Antsla Gümnaasium



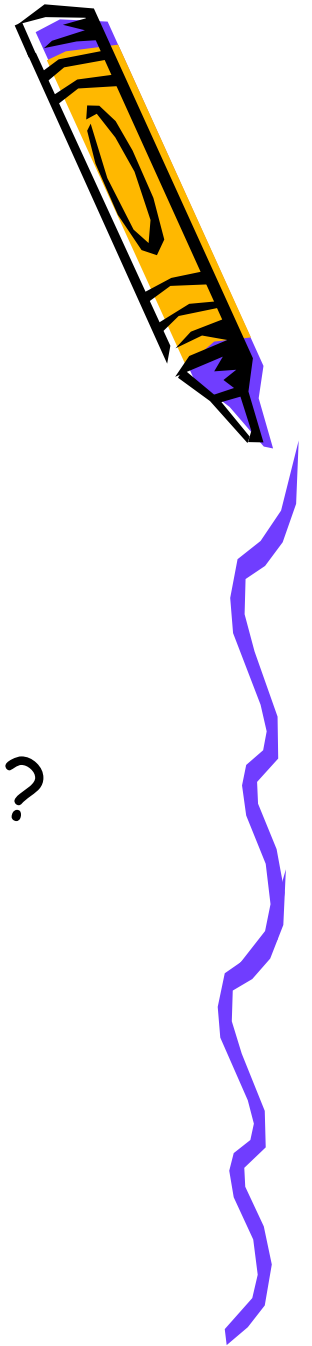
Tunnis

- Saad teada, mis footon
- Vaatleme footoni omadusi
- Uurime, kuidas arvutada footoni massi
- Uurime, kuidas arvutada footoni impulssim



Eelmine tund

- 1) Millega on määratud footoni energia?
- 2) Miks footonil pole seisumassi?
- 3) Millega on võrdne footoni impulss?



Footonid

- Footonite energia on määratud talle vastava lainepikkusega.
- Puudub seisumass, ei saa eksisteerida paigalolekus
- Iga liikuva osakese impulss= $\text{kiirus} \cdot \text{mass}$



Footoni energia

$$E = h \times f$$

$$c = f \times \lambda \Rightarrow f = \frac{c}{\lambda}$$

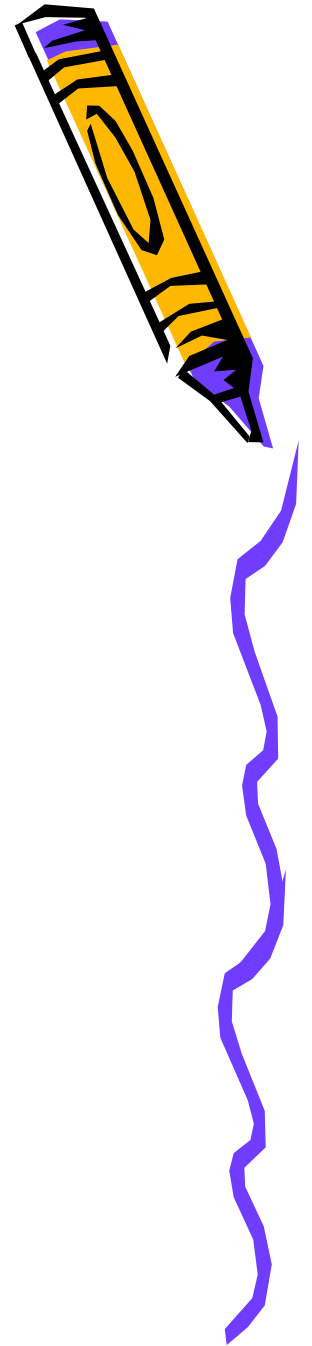
$$E = h \times \frac{c}{\lambda}, kus$$

E – kvandi energia(J)

$$h = 6,6 \times 10^{-34} J \times s$$

$$c = 3 \times 10^8 \frac{m}{s}$$

λ – lainepikkus(nm, m)

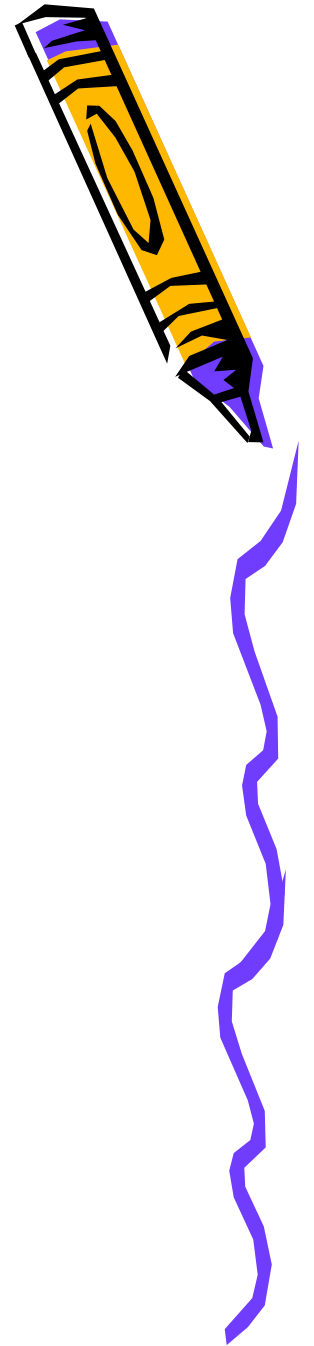


Footoni energia

$$E = m \times c^2$$

E – *footoni* energia

m - mass(kg)



Footoni mass

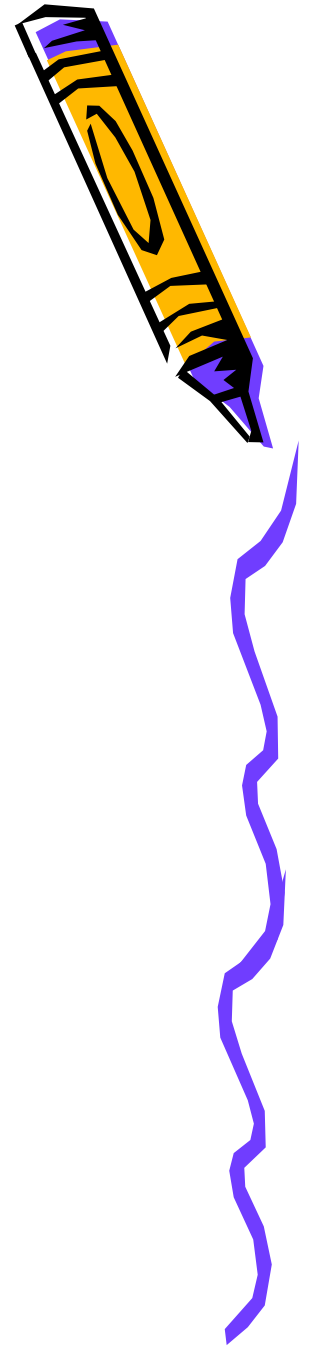
$$E = m \times c^2$$

$$E = h \times f$$

$$h \times f = m \times c^2$$

$$m = \frac{h \times f}{c^2}$$

f – sagedus (Hz), võib ka tähistada ν



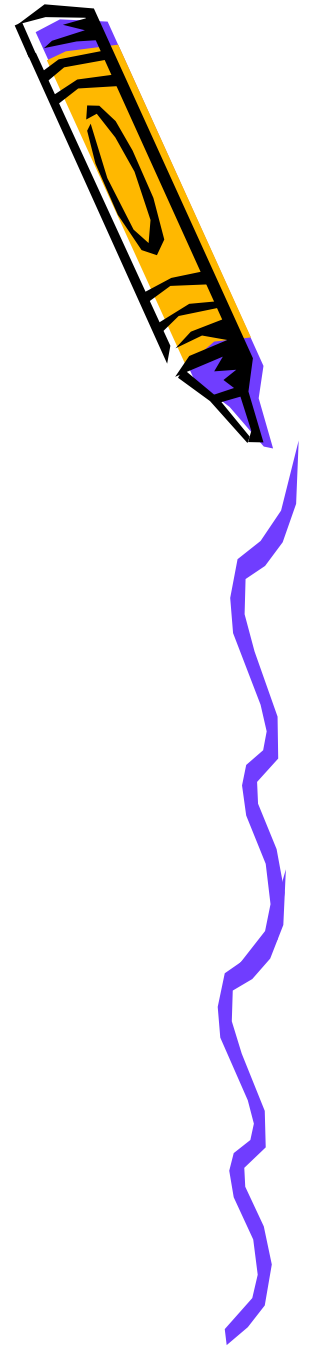
Footoni impulss

$$p = m \times c$$

$$p - \text{impulss} \left(\frac{\text{kg} \times \text{m}}{\text{s}} \right)$$

$$m - \text{mass} (\text{kg})$$

$$c = 3 \times 10^8 \frac{\text{m}}{\text{s}}$$



Footoni impulss

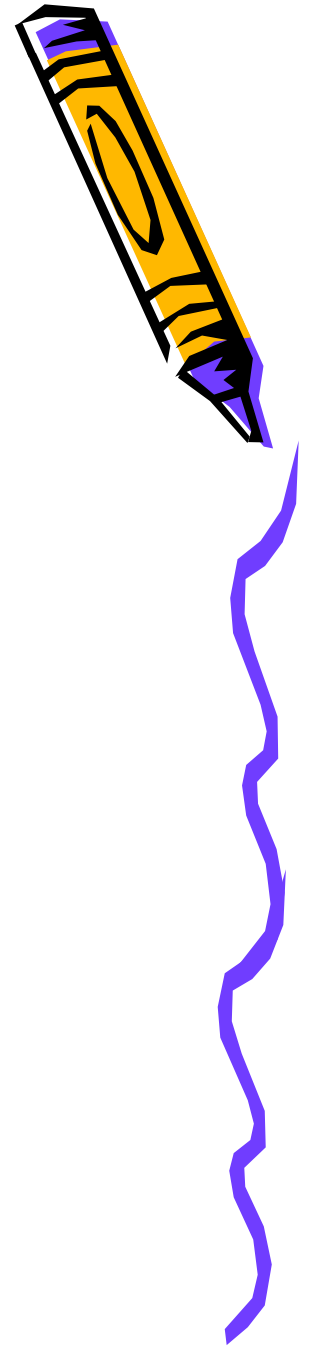
$$p = mc$$

$$c = \lambda \times f$$

$$m = \frac{h \times f}{c^2}$$

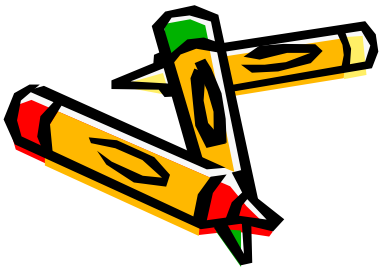
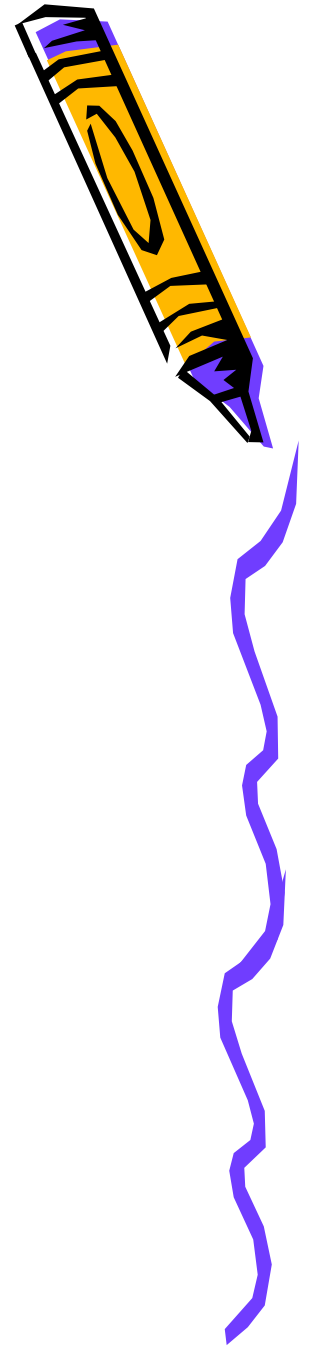
$$p = \frac{h \times f}{c^2} \times \lambda \times f = \frac{h \times f \times \lambda \times f}{\lambda \times f \times \lambda \times f}$$

$$p = \frac{h}{\lambda}$$



Kontrolltöö tagasiside

Ül.6



⑥

$$f = 7,5 \cdot 10^{14} \text{ Hz}$$

$$U = 1,0 \text{ V}$$

$$q = 1,6 \cdot 10^{-19} \text{ C}$$

$$h = 6,6 \cdot 10^{-34} \text{ J} \cdot \text{s}$$

$$c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}}$$

$$A_v = ?$$

$$\lambda_p = ?$$

$$c = f \cdot \lambda$$

$$E = h \cdot f$$

$$\bar{E} = A_v + E_{\text{kin}}$$

$$U = \frac{A}{q}$$

$$U = \frac{A}{q} \quad A = U \cdot q$$

$$A = 1,6 \cdot 10^{-19} \text{ C} \quad 1 \text{ V} = 1,6 \cdot 10^{-19} \text{ J}$$

$$A = E_K$$

$$E = h \cdot f \quad E = 6,6 \cdot 10^{-34} \text{ J} \cdot \pi \cdot 7,5 \cdot 10^{14} \text{ Hz}$$

$$E = 4,95 \cdot 10^{-19} \text{ J}$$

$$E = A_U + E_K \quad A_U = E - E_K$$

$$A_U = (4,95 \cdot 10^{-19} - 1,6 \cdot 10^{-19}) \text{ J}$$

$$A_U = \underline{\underline{3,4 \cdot 10^{-19} \text{ J}}}$$

$$f_p = \frac{A_U}{h}$$

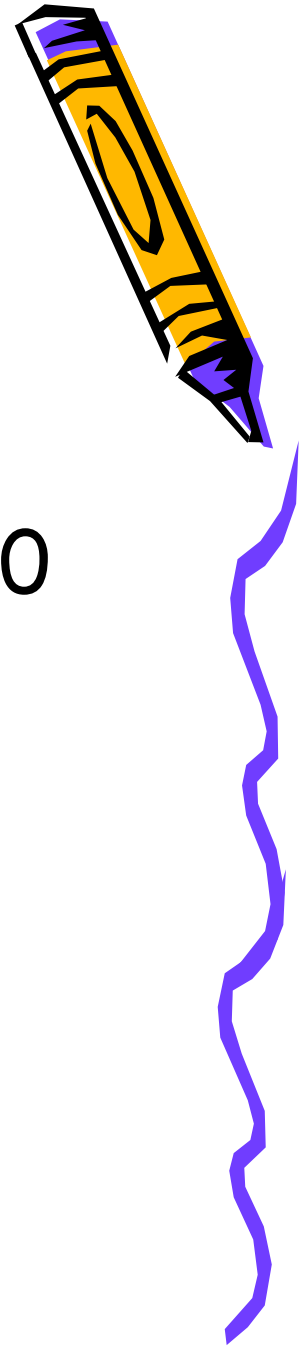
$$\lambda = \frac{c}{f}$$

$$\lambda_p = \frac{c \cdot h}{A_U}$$

$$\lambda_p = \underline{\underline{570 \text{ nm}}}$$

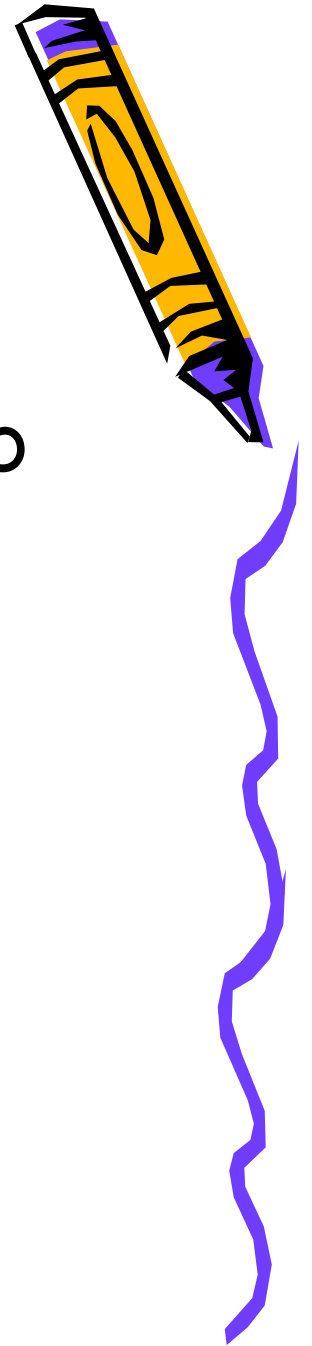
Ülesanne 1

Leia nähtava valguse suurimale (760 nm) ja väikseimale (380 nm) lainepikkusele vastavate footonite energiad.



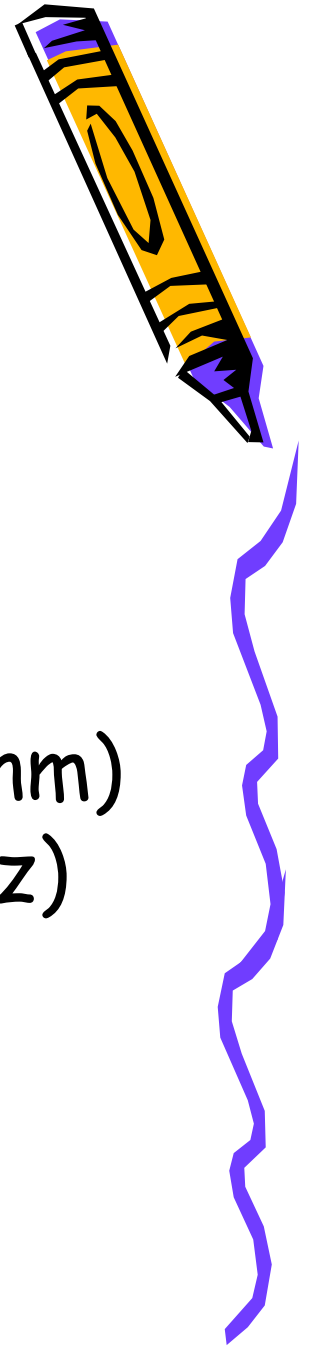
Ülesanne 2

Leia valguse lainepikkus, mis vastab energiale 4,1 eV



Ülesanne 3

Leia footoni mass ja impulss
infrapunase (sagedus: 10^{12} Hz),
roheline valguse (lainepikkus: 550 nm)
ja röntgenkiirguse (sagedus 10^{18} Hz)



Ülesanne 4

Milline peaks olema elektromagnetlaine sagedus ja lainepikkus, et tema footoni mass võrduks elektroni seisumassiga ($9,1 \cdot 10^{-31} \text{ kg}$)

