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ENGINEERING NOTE

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#5.

(337)

when $KE = 0$, $hf = \varphi + KE \Rightarrow \varphi = hf$

$$\varphi = hf = \frac{hc}{\lambda} = \frac{1240\ eV\,nm}{270\ nm} = 4.59\,eV$$

$$hf = \varphi + KE$$

$$f = \frac{\varphi + KE}{h} = \frac{2 + 4.59\,eV}{4.136\times10^{-15}\,eV\,s} = \boxed{1.59\times10^{15}\ Hz}$$

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(3.47)

maximum KE occurs during back scattering of photon

$$\lambda' - \lambda = \frac{hc}{mc^2}(1-\cos\theta) = \frac{2hc}{mc^2}$$

$$\Delta\lambda = \frac{2 \cdot 1240}{.511\times10^6} = 4.853\times10^{-3}\ n.m$$

$$E = hf = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E} = \frac{1240\ eV\ nm}{40\times10^3} = 0.031\ nm$$

$$\Rightarrow \lambda' = \lambda + \Delta\lambda = 0.031 + 4.853\times10^{-3}$$

$$KE = \frac{hc}{\lambda} - \frac{hc}{\lambda'} = 40\times10^3 - \frac{1240}{0.031+4.85\times10^{-3}}$$

$$= \boxed{5.411\ keV}$$

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3.55

a

$\gamma e^- \to e^+ e^- e^-$ charge conservation

$$s^2 = (m_e c^2 + m_e c^2 + m_e c^2)^2 = 9 m_e^2 c^4 \quad \text{cms}$$

$$s^2 = (E_1 + E_2)^2 - (p_1 c + p_2 c)^2 \quad \text{lab}$$

$$= E_1^2 + 2E_1 M_2 c^2 + m_2^2 c^4 - p_1^2 c^2$$

but $E = pc$ for a photon

$M_2 = m_e$

$$\Rightarrow \quad s^2 = 2E_1 m_e c^2 + m_e^2 c^4 = 9 m_e^2 c^4$$

$$E_1 = 4 m_e c^2 = \boxed{2.044 \text{ MeV}}$$

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(4.10)

$$\frac{N(50^\circ)}{N(6^\circ)} = \frac{\dfrac{1}{\sin^4 50/2}}{\dfrac{1}{\sin^4 6/2}} = \frac{\sin^4 3^\circ}{\sin^4 25^\circ} = 2.35 \times 10^{-4}$$

$$N(50^\circ) = N(6^\circ) \times 2000$$

$$= 0.47$$

so likely the experiment won't work

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4.21

$$hc = 6.6261 \times 10^{-34}\ \mathrm{J\,s} \cdot \frac{1\ \mathrm{eV}}{1.6022 \times 10^{-19}\ \mathrm{J}} \cdot 2.9979 \times 10^{8}\ \mathrm{m/s}$$

$$= \boxed{1239.8\ \mathrm{eV}}$$

$$F = \frac{C}{V}$$

$$\frac{e^2}{4\pi\epsilon_0} = \frac{(1.6021733 \times 10^{-19}\ \mathrm{C})^2}{4\pi\,(8.85 \times 10^{-12}\ \mathrm{F/m})}$$

$$= \frac{(1.60221733 \times 10^{-19}\ \mathrm{C})^2}{4\pi\,(8.85 \times 10^{-12}\ \mathrm{C^2/Jm})} \cdot \frac{1\ \mathrm{eV}}{1.6022 \times 10^{-19}\ \mathrm{J}} \times \frac{10^9\ \mathrm{nm}}{\mathrm{m}}$$

$$= \boxed{1.4400\ \mathrm{eV\,nm}}$$

$$mc^2 = 510.99906\ \mathrm{keV}/c^2\ c^2 = \boxed{511.00\ \mathrm{keV}}$$

$$a_0 = \frac{4\pi\epsilon_0 \hbar^2}{m e^2} = \frac{1}{1.4400 \, eV \, nm} \cdot \frac{(\hbar c)^2}{m_e c^2}$$

$$= \frac{(1239.8)^2}{(2\pi)^2} \cdot \frac{1}{0.511 \times 10^6} \frac{1}{1.4400}$$

$$= \boxed{5.2918 \times 10^{-2} \, nm}$$

$$E_0 = \frac{e^2}{8\pi\epsilon_0 a_0} = \frac{1.4400 \, eV \, nm}{2} \cdot \frac{1}{5.2918 \times 10^{-2}}$$

$$= \boxed{13.606 \, eV}$$

(4.27)

$$\mu_H = \frac{m_e m_H}{m_e + m_H} = \frac{0.511 \cdot 938.27}{0.511 + 938.27} = 0.510722$$

$$\mu_D = \frac{m_e m_D}{m_e + m_D} = \frac{0.511 \cdot 1875.61}{0.511 + 1875.61} = 0.510861$$

$$\mu_T = \frac{m_e m_T}{m_e + m_T} = \frac{0.511 \cdot (3.015500 \cdot 931.494)}{0.511 + (3.015500 \cdot 931.494)} = 0.51090$$

2808.920

$$E_0^H = 13.606 \frac{\mu}{m_e} = 13.5986 \text{ eV}$$

$$E_0^D = 13.606 \frac{\mu}{m_e} = 13.6023 \text{ eV}$$

$$E_0^T = 13.606 \frac{\mu}{m_e} = 13.6035 \text{ eV}$$