Physics with neutrons 1

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Exercise sheet 1
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Exercise 1.1

The Curie-Joliot hypothesis was introduced in the lecture. It was very controversial from the very beginning. In particular the high proton energy could not be explained: based on Compton-scattering a γ energy of $h\nu = 55\,\mathrm{MeV}$ is needed to produce a 5.7 MeV proton. Such a high γ energy seems to be impossible since the energy of the Po-α radiation is only 5 MeV.
Prove and explain — based on the Compton process — the following expression, which casts the Curie-Joliot hypothesis into doubt:

$$E_p = \frac{2(h\nu)^2}{2h\nu + m_p c^2}$$

The proton rest mass is given by $m_p = 1.6726 \cdot 10^{-27}\,\mathrm{kg}$.

Exercise 1.2

Complement the following table, assuming nonrelativistic matter waves of neutrons and electrons:

	E (eV)	T (K)	λ (Å)	v (m/s)	$Q_{\max}$ (Å^{-1})
Light (Red Laser)			6320		
X-rays (Cu K_α)					
Cold neutrons			6		
Thermal neutrons				2200	
Hot neutrons		2300			
Fission neutrons	$2.1\cdot10^6$				
Electrons				$1.57\cdot10^6$	

Fission neutrons are the ones created in the fission. Then the neutrons are converted to other (much lower) energies to be used in scattering experiments.
$Q_{\max}$ is the theoretical maximal momentum transfer that can be reached in an scattering experiment, defined by

$$Q = \frac{4\pi}{\lambda} \sin\left(\frac{2\theta}{2}\right)$$

where 2θ is the scattering angle.