

Questions in Quantum Physics — Assignment

Name: Edward Van Welzen, Group No. EE1, Date: 14/11/20

(Submit your solutions to all four questions to your tutor in Week 12)

1. The visible intensity threshold of a night-vision device is $(4.0 \times 10^{-11} \text{ W/m}^2)$ at the wavelength of (600 nm) . If the light with this intensity and wavelength enters an eye and the pupil is open to its maximum diameter of 8.5 mm , how many photons per second enter the eye? (25 Marks)

$$I = 4 \times 10^{-11}$$

$$\begin{aligned} \text{Surface Area} &= \pi r^2 \\ &= \pi \times \left(\frac{8.5 \times 10^{-3}}{2}\right)^2 \\ &= 5.6745017 \times 10^{-6} \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{Energy} &\Rightarrow \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{500 \times 10^{-9}} \\ &= 3.98 \times 10^{-19} \text{ J} \end{aligned}$$

$$\text{Power} = \text{Intensity} \times \text{Surface Area} \quad (25 \text{ Marks})$$

$$= 5.6745017 \times 10^{-6} \times 4 \times 10^{-11}$$

$$= 2.2698 \times 10^{-16} \text{ W}$$

$$\text{number of photons (s}^{-1}\text{)}$$

$$\Rightarrow \frac{2.2698 \times 10^{-16}}{3.98 \times 10^{-19}} = 5705.73 \text{ s}^{-1}$$

~~2.2698~~ 5705 photons per second

2. A 0.6 MeV photon is scattered by a free electron initially at rest. After scattering, the scattering angle of the scattered photon is 90° .

- (i) Determine the energy and the momentum of the scattered photon.
(ii) Determine the kinetic energy of the scattered electron.

(i) Compton Effect Equation: \rightarrow Scatter at 90° since normal

$$\lambda' - \lambda_0 = \frac{h}{mc} (1 - \cos \theta) \quad p = \frac{h}{\lambda}$$

$$\lambda' = \frac{h}{mc} (1 - \cos \theta) + \lambda_0$$

$$\theta = 90^\circ \quad \lambda_0 = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{0.6 \times 10^6 \times 1.6 \times 10^{19}}$$

$$\lambda' = \frac{h}{mc} + \lambda_0 = 2.426 \times 10^{-12} \text{ m}$$

$$\lambda' = \frac{6.63 \times 10^{-34}}{9.11 \times 10^{-31} \times 3 \times 10^8} + 2.426 \times 10^{-12}$$

$$= 4.4978 \times 10^{-12}$$

(25 marks)

$$p' = \frac{6.63 \times 10^{-34}}{4.4978 \times 10^{-12}}$$

$$= 1.474 \times 10^{-22} \text{ kg m s}^{-1}$$

$$E' = \frac{hc}{\lambda'}$$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{4.4978 \times 10^{-12}}$$

$$= 4.42 \times 10^{-14} \text{ J}$$

$$= 276385 \text{ eV} = 0.276385 \text{ MeV}$$

(ii) Kinetic energy

$$= \text{difference in energy} = 0.6 \text{ MeV} - 0.276385 \text{ MeV}$$

$$= 0.323615 \text{ MeV}$$

Physics 12 Assignment Quantum Physics

L Cohen



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Introduction to Modern Physics Floyd Karker Richtmyer, 1928 **Statistical Mechanics with Applications to Physics and Chemistry** Richard Chace Tolman, 1927 *Grants and Awards for Fiscal Year...* National Science Foundation (U.S.), 1979 **Japanese Journal of Physics**, 1922 **Proceedings of the National Academy of Sciences of the United States of America** National Academy of Sciences (U.S.), 1926 The Proceedings of the National Academy of Sciences PNAS publishes research reports commentaries reviews colloquium papers and actions of the Academy PNAS is a multidisciplinary journal that covers the biological physical and social sciences **International Critical Tables of Numerical Data, Physics, Chemistry and Technology**, 1929 *Proceedings of the Blended Learning in Science, Teaching and Learning Symposium*, 2005 Presents proceedings of the annual Uniserve Conference The papers contained in this book includes topics as teaching science online tutorial benefits of online assignments blended learning and other related issues in relation to teaching science at a university level International Critical Tables of Numerical Data, Physics, Chemistry and Technology: X-ray data National Research Council (U.S.), 1928 **The President's Report** University of Chicago, 1930 1897 98 includes summaries for 1891 to 1897 **Quantum Analysis of the Beryllium Oxide Bands ; Perturbations in Band Spectra I** Jenny Eugénie Rosenthal, F. A. Jenkins, 1929 **International Critical Tables of Numerical Data, Physics, Chemistry and Technology** National Research Council (U.S.), 1929 **Some Contemporary Advances in Physics** Karl Kelchner Darrow, 1923 *International Critical Tables of Numerical Data, Physics, Chemistry and Technology: Viscosity and fluidity* National Research Council (U.S.), 1929 **Science**, 1929 Vols for 1911 13 contain the Proceedings of the Helminothological Society of Washington ISSN 0018 0120 1st 15th meeting **Cornell University Courses of Study** Cornell University, 2001 **U.S. Government Research and Development Reports**, 1965
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