Conceptual Questions

1. When a third polarizer is inserted at 45° between two orthogonal polarizers, some light is transmitted. If, instead of a single polarizer at 45°, we insert a large number ***N*** of polarizers, each time rotating the axis of polarization over an angle 90°/***N***,
   a) no light b) less light c) the same amount of light d) more light gets through. [1]

2. Explain the advantage of polarized sunglasses over normal tinted sunglasses. [2]

3. If the Earth's atmosphere were 50 times denser than it is, would sunlight still be white, or would it be some other colour? Explain. [3]

4. a) Does a beam of infrared photons always have less energy than a beam of ultraviolet electrons? Explain.
   b) Does a single infrared photon always have less energy than a single ultraviolet photon? Explain.[4]

5. Is it possible for the de Broglie wavelength of a "particle" to be greater than the dimensions of the particle? To be smaller? Is there any direct connection? [5]

Problems

6. Calculate the percentage of light travelling through two crossed polarizing filters if the angle between the polarizing directions is
   a) 10° b) 30° c) 70° d) 85° [6]

7. At what angle should two polarizing filters be positioned to reduce the intensity of light by 60°? [7]

8. Three polarizing filters are placed on top of one another. If the angle between the first two filters is 60° and the angle between the first and third filter is 70°, find the percentage of light exiting the last polarizing filter. [8]

9. Unpolarized light passes through five successive Polaroid sheetsm each of whose axis makes a 45° angle with the previous one. What is the intensity of the transmitted beam, in terms of the original intensity I_0? [9]

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[1] Peer Instruction – A User's Guide, Mazur, Optics CT 4
[2] Physics 6th Edition, Giancoli, Chapter 24 Questions, #28
[3] Physics 6th Edition, Giancoli, Chapter 24 Questions, #32
[4] Physics 6th Edition, Giancoli, Chapter 27 Questions, #26
[5] Physics 6th Edition, Giancoli, Chapter 27 Questions, #20
[6] Physics Book Two, Irwin Publishing, Chapter 10 Problems, #60
[7] Physics Book Two, Irwin Publishing, Chapter 10 Problems, #61
[8] Physics Book Two, Irwin Publishing, Chapter 10 Problems, #62
[9] Physics 6th Edition, Giancoli, Chapter 24 Problems, #61

10. A 2.0-W laser emits a coherent light beam at a wavelength of 632.4 nm. Assuming that all the power is radiated, how many photons leave the laser tube every second? [10]

11. The human eye can respond to as little as 10^{-18} J of light energy. For a wavelength at the peak of visual sensitivity (550 nm), how many photons lead to an observable flash? [11]

12. A photon has a wavelength of 400 pm.
    a) What is its frequency?
    b) What is its momentum?
    c) What is its mass equivalence? [12]

13. An electric stove produces many infrared photons. If the peak wavelength of the radiation coming from the stove element is 10μm, what is the momentum of the released photons? [13]

14. An electron at rest is struck be an x-ray photon. If the scatter angle is 180° and the final speed of the electron is 7.12×10^{5} m/s, what was the wavelength of the incident photon? [14]

15. If a photon with an incident wavelength of 18 pm loses 67% of its energy, what is the corresponding change in the photon's wavelength (i.e. Compton shift) as a percentage? [15]

16. A 45-g golf ball is struck and leaves the club at a speed of 50 m/s. What is the de Broglie wavelength associated with this ball? [16]

17. What is the de Broglie wavelength of an electron with a kinetic energy of 50 eV? [17]

18. In some scattering experiments, the speed of the particles is tuned so that their de Broglie wavelength has a specific value. If a wavelength of 0.117 nm is required, how fast must a neutron be travelling to achieve this wavelength? [18]

19. An electron has a de Broglie wavelength of 7.12×10^{5} m.
    a) What is its momentum?
    b) What is its speed?
    c) What voltage was needed to accelerate it to this speed? [19]

[10] Physics Book Two, Irwin Publishing, Chapter 12 Problems, #22
[11] Physics 6th Edition, Giancoli, Chapter 27 Problems, #16
[12] Physics Book Two, Irwin Publishing, Chapter 12 Problems, #30
[13] Physics Book Two, Irwin Publishing, Chapter 12 Problems, #32
[14] Physics Book Two, Irwin Publishing, Chapter 12 Problems, #34
[15] Physics Book Two, Irwin Publishing, Chapter 12 Problems, #35
[16] Physics Book Two, Irwin Publishing, Chapter 12 Problems, #36
[17] Physics Book Two, Irwin Publishing, Chapter 12 Problems, #39a
[18] Physics Book Two, Irwin Publishing, Chapter 12 Problems, #37
[19] Physics 6th Edition, Giancoli, Chapter 27 Problems, #41