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Sanjiv Kumar Physics and Devices: Basic Principles, 3rd edition Chapter 5
Solutions Manual Problem Solutions

2.111
(a) $\Delta p = \frac{h}{\lambda} = \frac{1.054 \times 10^{-34}}{10^{-10}} = 1.054 \times 10^{-24}$ kg m/s
(b) $\Delta p = 1.054 \times 10^{-24}$ kg m/s
(c) $\Delta p = 1.054 \times 10^{-24}$ kg m/s
So $\Delta E = \frac{h \nu}{2} = \frac{h}{2} \left(\frac{c}{\lambda} \right) = \frac{hc}{2\lambda}$
 $\Delta E = (6.63 \times 10^{-34}) \left(\frac{3.00 \times 10^8}{2 \times 10^{-10}} \right) = 4.97 \times 10^{-17}$ J
(d) $\Delta E = 1.64 \times 10^{-17}$ J
2.112
(a) $\Delta p = \frac{h}{\lambda} = \frac{1.054 \times 10^{-34}}{12.2 \times 10^{-12}} = 8.64 \times 10^{-23}$ kg m/s
(b) $\Delta p = 8.64 \times 10^{-23}$ kg m/s
 $\Delta E = \frac{1}{2} m v^2 = \frac{1}{2} (9.11 \times 10^{-31}) (5.79 \times 10^6)^2 = 1.51 \times 10^{-17}$ J
2.113
(a) Same as 2.110(a), $\Delta p = 5.79 \times 10^{-27}$ kg m/s
(b) $\Delta E = \frac{1}{2} m v^2 = \frac{1}{2} (9.11 \times 10^{-31}) (5.79 \times 10^6)^2 = 1.51 \times 10^{-17}$ J
2.114
 $\Delta p = \frac{h}{\lambda} = \frac{1.054 \times 10^{-34}}{10^{-10}} = 1.054 \times 10^{-24}$ kg m/s
 $p = mv \Rightarrow \Delta p = m \Delta v \Rightarrow \Delta v = \frac{\Delta p}{m} = \frac{1.054 \times 10^{-24}}{9.11 \times 10^{-31}} = 1.16 \times 10^6$ m/s
2.115
(a) $\Delta p = \frac{h}{\lambda} = \frac{1.054 \times 10^{-34}}{10^{-10}} = 1.054 \times 10^{-24}$ kg m/s

2.16
(a) If $\Psi(x,t)$ and $\Psi^*(x,t)$ are solutions to Schrödinger's wave equation, then
$$\frac{\partial^2 \Psi(x,t)}{\partial x^2} + V(x)\Psi(x,t) = -\frac{2mE}{\hbar^2} \Psi(x,t)$$

$$\frac{\partial^2 \Psi^*(x,t)}{\partial x^2} + V(x)\Psi^*(x,t) = -\frac{2mE}{\hbar^2} \Psi^*(x,t)$$

Adding the two equations, we obtain
$$\frac{\partial^2}{\partial x^2} [\Psi(x,t) + \Psi^*(x,t)] + V(x) [\Psi(x,t) + \Psi^*(x,t)] = -\frac{2mE}{\hbar^2} [\Psi(x,t) + \Psi^*(x,t)]$$

which is Schrödinger's wave equation. So $\Psi(x,t) + \Psi^*(x,t)$ is also a solution.
(b) If Ψ_1 and Ψ_2 were solutions to Schrödinger's wave equation, then we could write
$$\frac{\partial^2}{\partial x^2} (\Psi_1 + \Psi_2) + V(x) (\Psi_1 + \Psi_2) = -\frac{2mE}{\hbar^2} (\Psi_1 + \Psi_2)$$

which can be written as
$$\frac{\partial^2}{\partial x^2} \Psi_1 + V(x) \Psi_1 = -\frac{2mE}{\hbar^2} \Psi_1$$

$$\frac{\partial^2}{\partial x^2} \Psi_2 + V(x) \Psi_2 = -\frac{2mE}{\hbar^2} \Psi_2$$

Dividing by Ψ_1 and Ψ_2 we find
$$\frac{\partial^2}{\partial x^2} \left(\frac{\Psi_1 + \Psi_2}{\Psi_1 \Psi_2} \right) = \frac{1}{\Psi_1} \frac{\partial^2 \Psi_1}{\partial x^2} + \frac{1}{\Psi_2} \frac{\partial^2 \Psi_2}{\partial x^2} = -\frac{2mE}{\hbar^2} \left(\frac{1}{\Psi_1} + \frac{1}{\Psi_2} \right)$$