

P809 3, 5, 7

$$(3) \Delta p \Delta x \geq \frac{h}{4\pi}$$

$$\begin{aligned} \Delta x &= \frac{h}{4\pi \Delta p} \\ &= \frac{6.63 \times 10^{-34}}{4\pi (2 \times 10^{-24})} \\ &= \underline{3 \times 10^{-11}} \end{aligned}$$

error in p

$$\begin{aligned} \Delta p &= (1.67 \times 10^{-27} \text{ kg}) (.012 \times 10^5) \\ &= 2 \times 10^{-24} \end{aligned}$$

$$(5) \Delta E \Delta t \geq \frac{h}{4\pi}$$

$$\begin{aligned} \Delta E &= \frac{h}{4\pi \Delta t} \\ &= \frac{6.63 \times 10^{-34}}{4\pi (10^{-9})} \\ &= \frac{5.28 \times 10^{-27} \text{ J}}{1.6 \times 10^{-19}} = \underline{3.3 \times 10^{-8} \text{ eV}} \end{aligned}$$

$$(7) \Delta E \Delta t \geq \frac{h}{4\pi}$$

$$\begin{aligned} \Delta E &= \frac{h}{4\pi \Delta t} \\ &= \frac{6.63 \times 10^{-34}}{4\pi (2.2 \times 10^{-6} \text{ s})} = \frac{2.398 \times 10^{-29} \text{ J}}{1.6 \times 10^{-19} \text{ J eV}^{-1}} = \underline{1.5 \times 10^{-10} \text{ eV/c}^2} \end{aligned}$$