

2111033艾明旭原子物理第三次作业

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3-3 (1) $E = mc^2 = E_k + m_0c^2$ $mc^2 = 2m_0c^2$ $m = 2m_0$
 $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} = 2m_0$ $v = \frac{\sqrt{3}}{2}c$

(2) $\lambda = \frac{1.226 \text{ nm}}{\sqrt{E_k}} = 0.001715 \text{ nm}$

3-7 (1) $E = h\nu = h\frac{c}{\lambda}$ $\Delta E = hc \frac{\Delta \lambda}{\lambda^2}$
 $\Delta t > \frac{h}{2\Delta E} = \frac{h}{2hc\Delta \lambda} = \frac{\lambda}{4\pi c} \cdot \frac{\lambda}{\Delta \lambda} = \frac{6 \times 10^{-7} \times 10^7}{4 \times 3.14 \times 3 \times 10^8} = 1.6 \times 10^{-9} \text{ s}$

3-8 $\Delta x \Delta p_x \geq \frac{h}{2}$ $\Delta p_x \geq \frac{h}{2\Delta x}$ $\therefore \Delta p_x = \sqrt{(p_x - \bar{p}_x)^2}$ $\bar{p}_x = 0$
 $(\Delta p_x)^2 = \frac{p^2}{3}$ $E_k = \frac{3h^2}{8\pi m r^2} = 2.848 \times 10^8 \text{ eV}$

5-3 $E = Pt = 100 \text{ W} \times 365 \times 24 = 876000 \text{ Wh}$
 $m = \sqrt{\frac{E}{c^2}} = \frac{876000 \times 3600}{(3 \times 10^8)^2} = 9.734 \times 10^{-12} \text{ kg}$

5-5 $E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{1.75 \times 10^{-7}} \approx 1.2 \times 10^{-18} \text{ J}$ $E_{02} = 2E = 2.4 \times 10^{-18} \text{ J}$

5-14 $E = \frac{hc}{\lambda} = \frac{4.136 \times 10^{-15} \times 3 \times 10^8}{3.6 \times 10^{-7}} \approx 3.45 \text{ eV}$ $K = E - \phi = 3.45 - 2.25 = 1.20 \text{ eV}$

$K = \frac{1}{2}mv_{\text{max}}^2$ $v = \sqrt{\frac{2 \times 1.20 \times 1.602 \times 10^{-19}}{9.109 \times 10^{-31}}} = 2.055 \times 10^6 \text{ m/s}$

6-7 德布罗意波长
 $1 \text{ eV}: \lambda = \frac{4.13567 \times 10^{-15}}{\sqrt{2 \times 9.1 \times 10^{-31}}} \approx 12.26 \text{ pm}$ $100 \text{ eV}: \lambda = \frac{4.13567 \times 10^{-15}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 100}} \approx 1.23 \text{ pm}$
 $1000 \text{ eV}: \lambda = \frac{4.13567 \times 10^{-15}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 1000}} \approx 0.389 \text{ pm}$ $100 \text{ keV}: \lambda = \frac{4.13567 \times 10^{-15}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 100000}} \approx 0.123 \text{ pm}$

我们关注 $\lambda \approx 2.15 \text{ \AA}$ 则动能为 $1000 \text{ eV}, 100 \text{ keV}$ 晶格常数与德布罗意波长相当
 $2d \sin \theta = n\lambda$ $\lambda = \frac{2 \times 2.15 \times 10^{-10} \cdot \sin 15^\circ}{1} \approx 1.13 \times 10^{-10} \text{ m}$
 $E = \frac{hc}{\lambda} = \frac{4.13567 \times 10^{-15} \times 3 \times 10^8}{1.13 \times 10^{-10}} \approx 1.107 \times 10^5 \text{ eV}$

6.43

$$E = \frac{3}{2} kT = \frac{3}{2} \times 1.38 \times 10^{-23} \times 298.15 \approx 6.2104 \times 10^{-21}$$

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.626 \times 10^{-34}}{\sqrt{2 \times 1.675 \times 10^{-27} \times 6.2104 \times 10^{-21}}} \approx 2.47 \times 10^{-10} \text{ m}$$

$$\text{由 } 2d \sin \theta = n\lambda \quad \sin \theta = \frac{2.47 \times 10^{-10}}{2 \times 2.82 \times 10^{-10}} \approx 0.438$$

$$\theta \approx 25.75^\circ$$