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15-1 D

15-3 B

15-12

$h\gamma = \frac{1}{2}mv^2 + W$

$\gamma = \frac{c}{\lambda}$

$W = h\gamma_0$

$\therefore v = 5.74 \times 10^5 m \cdot s^{-1}$

15-2 B

15-14

(1) $\Delta\lambda = \frac{h}{m_0 c}(1-\cos\theta) = 1.22 \times 10^{-3} nm$

$\gamma_0 = \frac{E}{h}$

$\lambda_0 = \frac{c}{\gamma_0}$

$\lambda = \lambda_0 + \Delta\lambda$

$\therefore \Delta\gamma = \gamma - \gamma_0 = \frac{c}{\lambda} - \frac{c}{\lambda_0} = -2.30 \times 10^{16} Hz$

$\Delta E = h\gamma - h\gamma_0 = h\Delta\gamma = -95.3 eV$

(2)

$E_{ke} = |\Delta E| = 95.3 eV$

$E_e^2 = E_{0e}^2 + p^2c^2$

$E_e = E_{0e} + E_{ke}$

$\therefore p = 5.27 \times 10^{-24} kg \cdot m \cdot s^{-1}$

y方向上动量守恒 $\frac{h\gamma}{c}\sin\theta = p\sin\varphi$

$\therefore \varphi = 59°32'.$

15-4 C

15-18 $\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

$\lambda = 434 \times 10^{-7} m$

15-22 $\Delta E = E_2 - E_\infty = \frac{E_1}{2^2} - 0 = -3.4 eV$

$E_0 = m_0 c^2 = 0.512 MeV >> E_K$

$\therefore p = m_0 v = \sqrt{2m E_K}$

$\therefore \lambda = \frac{h}{p} = 1.23 nm$

15-25 动量均为 $p = \frac{h}{\lambda} = 3.22 \times 10^{-24} kg \cdot m \cdot s^{-1}$

电子的动能为 $E_K = \frac{p^2}{2m} = 37.8 eV$

光子的动能为 $E_K' = E - E_0 = h\nu - 0 = \frac{hc}{\lambda} = 6.22 keV$

15-27 $\Delta x \Delta p_x \geq h$

$\Delta p_x = m \Delta v_x$

$\therefore \Delta v_x = 1.46 \times 10^7 m \cdot s^{-1}$

15-29 (1) $p = mv$

$\lambda = \frac{h}{p} = 1.66 \times 10^{-35} m$

(2) $\Delta p_x = m \Delta v_x$

$\Delta x \Delta p_x \geq h$

$\therefore \Delta v_x = 1.66 \times 10^{-28} m \cdot s^{-1}$

15-5 C

15-33 (1) $\int_{-\infty}^{\infty} \varphi^2(x) dx = \frac{A^2}{4\lambda^3} = 1$

$\therefore A = 2\lambda^{\frac{3}{2}}$

(2) $|\varphi(x)|^2 = \begin{cases} 4\lambda^3 x^2 e^{-2\lambda x} & x \geq 0 \\ 0 & x < 0 \end{cases}$

(3) $\frac{d|\varphi(x)|^2}{dx} = 4\lambda^3 (2x e^{-2\lambda x} - 2\lambda x^2 e^{-2\lambda x}) = 0$, $x_1 = 0$, $x_2 = \frac{1}{\lambda}$, $x_3 \to \infty$

由 $\frac{d^2|\varphi(x)|^2}{dx^2} < 0$ 可得在 $x = \frac{1}{\lambda}$ 处有最大值

15-34 (1) $E_n = \frac{n^2 h^2}{8ma^2}$

$E_1 = 1.51 \times 10^{-18} J$

(2) $\psi(x) = \sqrt{\frac{2}{a}} \sin \frac{2\pi}{a} x \quad 0 \le x \le a$

$|\psi(x)|^2 = \frac{2}{a} \sin^2 \frac{2\pi}{a} x$

$\frac{d|\psi(x)|^2}{dx} = \frac{8\pi}{a^2} \sin \frac{2\pi}{a} x \cos \frac{2\pi}{a} x = 0$

$\therefore x = 0, \frac{a}{4}, \frac{a}{2}, \frac{3}{4}a, a$

由 $\frac{d^2|\psi(x)|^2}{dx^2} > 0$，得 $x_1 = 0, x_2 = 0.1nm, x_3 = 0.2nm$.

15-36 (1) $E_n = \frac{n^2 h^2}{8ma^2}$

$\Delta E = E_2 - E_1 = \frac{4h^2}{8ma^2} - \frac{h^2}{8ma^2} = 112eV$

(2) $\psi(x) = \sqrt{\frac{2}{a}} \sin \frac{\pi}{a} x$

$|\psi(x)|^2 = \frac{2}{a} \sin^2 \frac{\pi}{a} x$

$P = \int_{x_1}^{x_2} |\psi(x)|^2 dx = 0.0038$

(2) $\psi_2(x) = \sqrt{\frac{2}{a}} \sin \frac{2\pi}{a} x$

$|\psi_2(x)|^2 = \frac{2}{a} \sin^2 \frac{2\pi}{a} x$

$P_2 = \int_{x_1'}^{x_2'} |\psi_2(x)|^2 dx = \frac{1}{4}$