

$$1. \text{由 } \tilde{\nu} = R_H \left( \frac{1}{3^2} - \frac{1}{n^2} \right), n=4, 5, \dots \quad \tilde{\nu}_{\max} = \frac{1}{9} \cdot R_H, \quad \lambda_{\min} = \frac{1}{\tilde{\nu}_{\max}} = \frac{9}{R_H} \\ = 8.2 \times 10^{-7} \text{m} \quad \text{在红外波段}$$

$$2. (1) \Delta E = |E_1 - E_4| = \left| -13.6 + \frac{13.6}{16} \right| = 12.75 \text{eV}$$

$$(2) 4 \rightarrow 1: 12.75 \text{eV}$$

$$4 \rightarrow 2: -\frac{13.6}{16} + \frac{13.6}{4} = 2.55 \text{eV}$$

$$4 \rightarrow 3: -\frac{13.6}{16} + \frac{13.6}{9} = 0.66 \text{eV}$$

$$3 \rightarrow 2: -\frac{13.6}{9} + \frac{13.6}{4} = 1.89 \text{eV}$$

$$3 \rightarrow 1: -\frac{13.6}{9} + 13.6 = 12.09 \text{eV}$$

$$2 \rightarrow 1: -\frac{13.6}{4} + 13.6 = 10.20 \text{eV}$$

$$(3) \Delta E = h\nu, \quad p = \frac{h}{\lambda}$$

$$\frac{h}{\lambda} = \frac{\Delta E}{c} = m_H \cdot v_H, \quad v_H = \frac{\Delta E}{c \cdot m_H} = 4.07 \text{m/s}$$

$$3. \begin{cases} L = mvr = n \cdot \frac{h}{2\pi} \\ m \frac{v^2}{r} = \frac{Ze^2}{4\pi\epsilon_0 r^2} \end{cases} \Rightarrow \begin{cases} r_n = n^2 \frac{\epsilon_0 h^2}{\pi m Z e^2} = n^2 \cdot \frac{r_1}{Z} \\ v_n = \frac{Ze^2}{4\pi\epsilon_0 \hbar n} = Z \cdot \alpha \cdot \frac{c}{n}, \quad \alpha = \frac{e^2}{2\epsilon_0 \hbar c} \end{cases}$$

$$E_n = \frac{1}{2} m v_n^2 - \frac{Ze^2}{4\pi\epsilon_0 r_n} = -\frac{Ze^2}{8\pi\epsilon_0 r_n} = -Z^2 \frac{|E_1|}{n^2}, \quad E_1 \approx -13.6 \text{eV}$$

$$\text{从 } n \rightarrow m \text{ 级: } h\nu = \Delta E = E_n - E_m, \quad \nu = \frac{Z^2}{h} |E_1| \cdot \left( \frac{1}{m^2} - \frac{1}{n^2} \right)$$

4. 由上结果,  $Z=2$  则对应  $m=4$ , 跃迁至  $m=4$  能级

$$J. E_1 = -13.6 \text{eV}, E_2 = -3.4 \text{eV}, E_3 = -1.5 \text{eV}, E_4 = -0.85 \text{eV}$$

$$E_5 = -0.544 \text{eV}, \quad E_5 - E_1 = 13.056 \text{eV} > 12.8 \text{eV} \text{ 跃迁至 } E_4$$

$$h \cdot \frac{c}{\lambda} = \Delta E, \quad \lambda = \frac{h \cdot c}{\Delta E}$$

4 → 1 : 97.4 nm

4 → 2 : 487.2 nm

4 → 3 : 1911.3 nm

3 → 2 : 653.9 nm

3 → 1 : 102.7 nm

2 → 1 : 121.8 nm

10