Modern physics Chapter 7-8. Solutions to exercises.

7.1.1 The wavelength for the transition between $n = 2$ and $m = 10$ is given by

$$\frac{1}{\lambda_{10}} = R\left(\frac{1}{2^2} - \frac{1}{10^2}\right) = R\left(\frac{1}{4} - \frac{1}{100}\right) = R\left(\frac{96}{400}\right) = R\frac{24}{100}$$

λ_{10} = 100/24R där R = 1.0974x10^7 m^{-1}

$$\lambda_{10} = \frac{100}{24 \times 1.0974 \times 10^7} m \approx 380nm$$

7.3.1 The energy difference is given by

$$\Delta E = E_2 - E_1 = -13.6\left(\frac{1}{2^2}\right) - \left[-13.6\left(\frac{1}{1^2}\right)\right]3V = 13.6\left(1 - \frac{1}{4}\right)eV = 13.6\frac{3}{4}eV \approx 10.2eV$$

7.3.2 The convergence limit when $n \to \infty$ for $m = 2$, i.e $\frac{1}{\lambda_{konv}} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$ and $\frac{1}{n^2} \to 0$

$$\lambda_{konv} = \frac{4}{R} = \frac{4}{1.0974 \times 10^7} m \approx 365nm$$

7.3.3 The convergence limit for the Lyman series means that $n \to \infty$ and $m = 1$ giving

$$\lambda_{konv} = \frac{1}{R} = \frac{1}{1.0974 \times 10^7} m \approx 91.2nm$$

7.4.1 Maximum kinetic energy of the electrons K = eV gives the shortest wavelength from $E = hf = \frac{hc}{\lambda}$ where we put $E = K$: $\frac{hc}{\lambda} = eV$ and

$$\lambda = \frac{hc}{eV} = \frac{6.63 \times 10^{-34} \times 3.00 \times 10^8}{1.602 \times 10^{-19} \times 40000} m \approx 31pm$$

7.4.2 The ionization energy for hydrogen is 13.6eV. For the element with med Z = 10 we have $E_J = 13.6(Z-1)^2 eV = 13.6 \times 9^2 eV \approx 1.1keV$

7.4.3 See 7.3.1 where $E_2 - E_1$=10.2 eV for hydrogen. We get

$$E_2 - E_1 = 10.2 \times (Z-1)^2 eV = 10.2 \times 9^2 eV \approx 826eV$$

7.4.4 Calculate f when $E = hf$. $f = \frac{E}{h} = \frac{826 \times 1.602 \times 10^{-19}}{6.63 \times 10^{-34}} Hz \approx 1.99 \times 10^{17} Hz$

8.4.1 The vibrational energy is given by $E_u = (u + ½)\omega_e$ Here $u = 0$ why we get 212 = (0 + ½) ω_e giving $\omega_e = 414$ cm^{-1}.

.

8.4.2 The rotational energy is given by $F(J) = B\,J(J + 1)$ of a diatomic molecule. We look for $F(J = 5)$.
$F(J = 5) = 4.4 \text{ x } 5 (5 + 1)$ cm^{-1} = 132 cm^{-1}.