Modern physics Chapter 5-6. Solutions to exercises.

5.3.1 $v_p = \sqrt{\frac{2kT}{m}} = \sqrt{\frac{2\times 1.3805\times 10^{-23}(273+20)}{2\times 14\times 1.67\times 10^{-27}}} m/s = 416 m/s \approx 420 m/s$

5.3.2 Mean velocity $\bar{v} = \sqrt{\frac{8kT}{\pi m}} = \frac{2}{\sqrt{\pi}} v_p = \frac{2}{\sqrt{\pi}} 416 m/s \approx 470 m/s$

5.3.3 RMS-velocity $v_{RMS} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3}{2}} v_p = \sqrt{\frac{3}{2}} 416 m/s \approx 510 m/s$

5.3.4 Wien's law $\lambda_{\max} = \frac{2.898\times 10^{-3}}{T}$ gives the temperature $T = \frac{2.898\times 10^{-3}}{730\times 10^{-9}} K \approx 3970 K$

5.3.5 The emission at 300K is $e(300)=e_0$. The emission at 400K is looked for.

$e = \sigma T^4$ gives $e(400) = e_0 \left(\frac{400}{300}\right)^4 = 3.160 e_0 \approx 3.2 e_0$

6.1.1 $n = 2$ gives $l = 0,1$
For $l = 0$ the possible quantum number is $m_l = 0$
For $l = 1$ the possible quantum numbers are $m_l = -1, 0, 1$

6.1.2 The energy levels are $E_n = -\frac{me^4}{8\varepsilon_0^2 h^2}\left(\frac{1}{n^2}\right) = -13.6\left(\frac{1}{n^2}\right) eV$

$E_2 = -13.6\left(\frac{1}{2^2}\right) eV = -3.4 eV = 5.4\times 10^{-19} J$