1. In the Planck theory for blackbody radiation, "oscillators" occupy discrete energy levels E_0, E_1, E_2, ...
   a. What is E_0, and what E_2? $E_0 = 0$, $E_2 = 2h\nu$
   b. Which level has the largest number of oscillators: E_0, E_1, or E_2?
   E_0
   c. Why does in contrast to the Planck theory the classical theory result in an ultra-violet catastrophe?
   E is continous in classicor theum
   d. What is the ultra-violet catastrophe?
   $\lambda \to 0 \Rightarrow E \to \infty$

2. A photoelectric experiment shows that UV light with λ=248 nm is required to remove an electron from a metal plate. Given $h = 6.63 \times 10^{-34}$ m^2kg/s; $c = 2.998 \times 10^8 m/s$, $m_e = 9.11 \times 10^{-31}$ kg,
   a. What is the minimum energy required to remove an electron?
   $$W = E_{min} = h\nu = h\frac{c}{\lambda} = 6.63 \times 10^{-34} m^2kg/s \cdot \frac{2.998 \times 10^{8} m/s}{248 nm}$$
   $$= 8.0 \times 10^{-19} m^2 kg/s^2$$
   b. What is the electron momentum if UV light of λ=150 nm is used?
   $$E_{tot} = E_{kin} + W = \frac{1}{2}mv^2 + W = \frac{1}{2m}p^2 + W = h\nu = h\frac{c}{\lambda}$$
   $$\Rightarrow p = \sqrt{2m(h\frac{c}{\lambda} - W)} = \sqrt{2 \times 9.11 \times 10^{-31} kg \left(6.63 \times 10^{-34} m^2kg/s \cdot \frac{2.998 \times 10^8 m/s}{150 \times 10^{-9} m} - 8.0 \times 10^{-19} m^2 kg\right)}$$
   $$= 9.73 \times 10^{-25} m kg/s$$
   c. What is the de Broglie wavelength of the electrons in this case?
   $$\lambda = \frac{h}{p} = \frac{6.63 \times 10^{-34} m^2kg/s}{9.73 \times 10^{-25} m kg/s} = 0.681 nm$$

3. Calculate, on the basis of the Bohr theory, the linear velocity of an electron in the ground state of the hydrogen atom. What is its De Broglie wavelength?
   $$L = mvr = n\hbar \Rightarrow v = \frac{nh}{2\pi m r} \; ; \; n=1, \; r = a_0 = 0.512 Å$$
   $$\Rightarrow v = \frac{h}{2\pi m_e a_0} = \frac{6.63 \times 10^{-34} m^2kg/s}{2 \times 3.14 \times 9.11 \times 10^{-31} kg \times 0.512 \times 10^{-10} m} = 2.26 \times 10^6 m/s$$
   $$\lambda = \frac{h}{p} = \frac{h}{mv} = 6.63 \times 10^{-34} m^2kg/s / 9.11 \times 10^{-31} kg \times 2.26 \times 10^6 m/s = 3.21 \times 10^{-10} m$$

4. Calculate the wavelength corresponding to the n=4 to n=5 transition in the hydrogen atom ($R_H = 1.0968 \times 10^7$ 1/m).
   $$\frac{1}{\lambda} = R_H \cdot \left(\frac{1}{4^2} - \frac{1}{5^2}\right) = R_H(0.0225) = 0.0247 \times 10^7 /m \quad \lambda = 40.5 \times 10^{-7} m$$