Exercise 3.3
Calculations Based on Bohr's Model of the Atom

1.

(a) Calculate the energy of a photon emitted when a Li^{2+} ion relaxes from the $n = 5$ state to the $n = 4$ state.

(b) Calculate the wavelength of this photon. Report your answer in nanometers (nm).

(c) What type of electromagnetic radiation is this?

2.

(a) At what wavelength should you look for the line in the emission spectrum of He^+ corresponding to the transition from $n = 3$ to $n = 1$?
Express your final answer using an appropriate SI prefix so that the value is between 0.1 and 1000.

(b) Will the line in the emission spectrum of He^+ corresponding to the transition from $n = 5$ to $n = 3$ have a longer or shorter wavelength than the line corresponding to the transition from $n = 3$ to $n = 1$? Justify your answer.
It is not necessary to show a calculation for part (b) of this question.

3. Consider H and He^+ in the ground state.

(a) For which of these two species will it require more energy to remove the electron? Why?

(b) Calculate the energy required to excite the electron from an atom of H in the ground state. In other words, calculate the first ionization energy for H.

(c) Calculate the energy required to excite the electron from a He^+ cation in the ground state. In other words, calculate the second ionization energy for He.

(d) Did your calculations in parts (b) and (c) support your answer to part (a)?

(e) Why can we not calculate the first ionization energy for He?

4. An ultraviolet lamp produces electromagnetic radiation with a wavelength of 250. nm.

(a) Calculate the energy of one photon from this ultraviolet lamp.

(b) Would the radiation from this ultraviolet lamp be capable of exciting the last electron out of a ground state He^+ ion?
Your answer must be backed up by calculations.