De Broglie wavelength

1. HR.38.42. Calculate and compare the de Broglie wavelength for $1\ keV$ photons, electrons, and protons.
Answer: $1.24\ nm;\ 3.88\ 10^{-2} nm;\ 9.05\ 10^{-4} nm;\ \lambda_\gamma : \lambda_e : \lambda_p = 1 : 32 : 43$

2. BW.Ex.36.4. Raindrop sizes vary from approximately $0.5\ mm$ to $5\ mm$ diameter, corresponding to falling speeds from $2\ m/s$ to $9\ m/s$. What is the range of de Broglie wavelengths for raindrops and how does it compare to atom size?
Answer: $5\ 10^{-27} - 10^{-30} m$

3. HR.38.44. The smallest dimension that can be resolved by an electron microscope is comparable to the de Broglie wavelength of the electron beam. What accelerating voltage would be required for the electrons to have the same resolving power as could be obtained using $100\ keV$ gamma rays?
Answer: $9.78\ kV$

Bohr energy levels

4. BW.38.27 An excited hydrogen atom de-excites by emitting a photon with an energy of $1.133\ eV$. What were the initial and the final states of the hydrogen atom before and after emitting the photon?
Answer: $-0.379\ eV;\ -1.512\ eV$

5. BW.38.28. An $8\ eV$ photon is absorbed by an electron in the $n = 2$ state of a hydrogen atom. Calculate the speed of the electron in the final/free state. Is it below or above the relativistic limit?
Answer: $1.27\ 10^6 \frac{m}{s}$

6. HR.p.1104. a. What is the wavelength of the least energetic photon emitted in the Lyman series of the hydrogen atom spectrum lines?
b. What is the wavelength of the most energetic photon emitted in the Lyman series?
Answer: $121.6\ nm;\ 91.1\ nm$

Uncertainty principle

7. TR.5.42. Find the minimum uncertainty in the speed of a bacterium of mass $m = 3\ 10^{-15}\ kg$ if we know the position of the bacterium to within $1\ \mu m$, that is to about its size.
Answer: $1.76\ 10^{-14}\ m/s$

8. YF 38.26. A laser produces light of wavelength $\lambda = 625\ nm$ in an ultra-short pulse.
What is the minimum duration of the pulse if the minimum uncertainty in the energy of the photons is 1% ?
What is the spatial length of this pulse in meters and as multiple of the wavelength?
What is the minimum uncertainty in the photon momentum?
Answer: $16.6\ fs;\ 5\ \mu m\ or\ 8\ \lambda;\ 1.97\ eV/c$

Blackbody radiation

9. BW.36.23 The temperature of your skin is approximately $35℃$.
a) Assuming it is a BB, what is the peak wavelength of the radiation it emits?
b) Assuming a total surface area of $2\ m^2$, what is the total power emitted by your skin?
c) Based on b), why don't you glow as brightly as a light bulb?
Answer: $9.4\ \mu m;\ 1022\ W;\ IR$