Quantum Mechanics Calculations

1. A quantum of electromagnetic radiation has an energy of 1×10^{-20} J. Calculate :
a) its frequency (b) its wavelength (c) using the electromagnetic spectrum, decide what type of electromagnetic radiation it represents.

2. Use the equation $f = c\, R_H (1/n_1^2 - 1/n_2^2)$ where $R_H = 1.09 \times 10^7\, m^{-1}$, and $c = 3.0 \times 10^8\, ms^{-1}$ to calculate the frequency of spectral line produced when an electron drops from level 4 to level 3 in the hydrogen atom. In which of the named series of lines does this appear?

3. A neon light emits radiation of 616 nm wavelength.. What is the frequency of this radiation? Use the electromagnetic spectrum to predict the colour associated with this wavelength.

4. Excited barium atoms emit visible light whose frequency is $6.59 \times 10^{14}\, s^{-1}$. What is the wavelength of this light? Use the electromagnetic spectrum to predict its colour.

5.a) What is the wavelength of radiation whose frequency is $6.24 \times 10^{14}\, s^{-1}$?
b) What is the frequency of radiation whose wavelength is 3.55 μm?
c) Would you be able to see either of the radiations specified in parts (a) and (b)?

6. Under appropriate conditions, copper emits X-rays that have a characteristic wavelength of 1.54 Å. Calculate and compare the energy of photons of these X-rays to those emitted by a microwave source that radiates at a frequency of $5.87 \times 10^{10}\, s^{-1}$.

7. For each of the following electronic transitions in the hydrogen atom, calculate the energy, frequency, and wavelength of the associated radiation:
a) from $n = 1$ to $n = 3$, (b) from $n = 2$ to $n = 5$, (c) from $n = 6$ to $n = 7$.
Will the radiation be absorbed or emitted during these transitions?

8. A laser used to weld detached retinas produces radiation with a frequency of $4.69 \times 10^{14}\, s^{-1}$. What is the wavelength of this radiation?

9. What is the characteristic wavelength of an electron with a velocity of $5.97 \times 10^6\, ms^{-1}$? The mass of the electron is 9.11×10^{-28} g. (Use the de Broglie equation: $\lambda = h / mv$, where the Planck's constant, h, is 6.63×10^{-34} Js, note $1J = 1\, kg\, m^2 s^{-2}$.)

10. At what velocity must a neutron be moving in order for it to exhibit a wavelength of 500 pm? The mass of the neutron is 1.675×10^{-24}g.

Common Wavelength Units for Electromagnetic Radiation

Unit	Symbol	Length (m)	Type of Radiation
Angstrom	Å	10^{-10}	X-ray
Nanometer	nm	10^{-9}	Ultraviolet, visible
Micrometer	μm	10^{-6}	Infrared
millimeter	mm	10^{-3}	Infrared
Centimeter	cm	10^{-2}	microwave
Meter	m	1	TV, radio