Name: _____

Photon Energy and deBroglie Wavelength worksheet

1) The alpha line in the Balmer series of the hydrogen spectrum consists of light having a wavelength of $6.56 \times 10^{-7}$ meter.

(a) Calculate the frequency of this light. [*Show all work, including the equation and substitution with units.*]

(b) Determine the energy in joules of a photon of this light.

(c) Determine the energy in electronvolts of a photon of this light.

2) Louis de Broglie extended the idea of wave-particle duality to *all* of nature with his matterwave equation, $\lambda = \frac{h}{mv}$, where $\lambda$ is the particle's wavelength, *m* is its mass, *v* is its velocity, and *h* is Planck's constant.

(a) Using the given equation, calculate the de Broglie wavelength of a helium nucleus (mass = $6.7 \times 10^{-27}$ kg) moving with a speed of $2.0 \times 10^{6}$ meters per second. [*Show all work, including the equation and substitution with units.*]

(b) The wavelength of the given particle is of the same order of magnitude as which type of electromagnetic radiation?

3) Determine the frequency of a photon whose energy is $3.00 \times 10^{-19}$ joule.

4) A photon has a wavelength of $9.00 \times 10^{-10}$ meter. Calculate the energy of this photon in joules. [*Show all work, including the equation and substitution with units.*]

Questions 5 through 7 refer to the following:

A photon with a frequency of $5.02 \times 10^{14}$ hertz is absorbed by an excited hydrogen atom. This causes the electron to be ejected from the atom, forming an ion.

5) Calculate the energy of the photon described in joules. [*Show all work, including the equation and substitution with units.*]

6) Determine the energy of the photon described in electronvolts.

7) What is the number of the lowest energy level (closest to the ground state) of a hydrogen atom that contains an electron that would be ejected by the absorption of the photon described?

8) Which type of photon is emitted when an electron in a hydrogen atom drops from the $n = 2$ to the $n = 1$ energy level? See attached Diagram

A) radio wave B) infrared C) ultraviolet D) visible light

9) What is the energy of a quantum of light having a frequency of $6.0 \times 10^{14}$ hertz?

A) $3.0 \times 10^{8}$ J B) $5.0 \times 10^{-7}$ J C) $4.0 \times 10^{-19}$ J D) $1.6 \times 10^{-19}$ J

10) The energy of a photon is inversely proportional to its

A) frequency B) phase C) wavelength D) speed

11) What is the energy of a photon with a frequency of $5.00 \times 10^{14}$ hertz?

A) $3.20 \times 10^{-6}$ eV B) 3.32 eV C) $3.32 \times 10^{-19}$ J D) $3.00 \times 10^{48}$ J

12) Compared to a photon of red light, a photon of blue light has a

A) longer wavelength B) lower frequency C) greater energy D) smaller momentum

13) The bright-line emission spectrum of an element can *best* be explained by

A) electrons transitioning between discrete energy levels in the atoms of that element
B) protons being dispersed uniformly throughout the atoms of that element
C) electrons being located in the nucleus
D) protons acting as both particles and waves

14) A photon of which electromagnetic radiation has the *most* energy?

A) microwave B) infrared C) x-ray D) ultraviolet

15) Wave-particle duality is *most* apparent in analyzing the motion of

A) an electron B) a space shuttle C) a galaxy D) a baseball

Use the table below for question #8

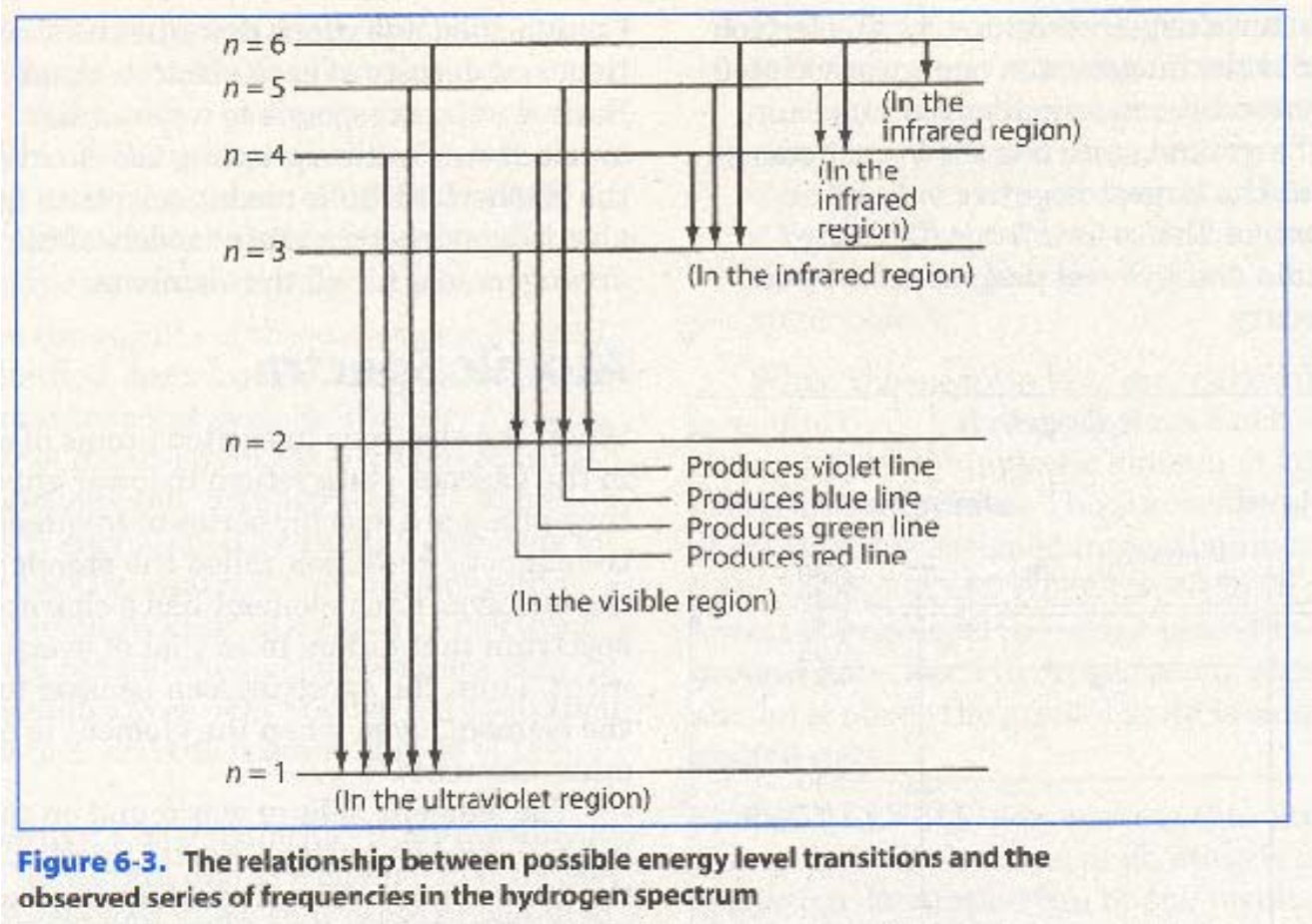


**Figure 6-3. The relationship between possible energy level transitions and the observed series of frequencies in the hydrogen spectrum**