Worksheet: The Quantization of Electromagnetic Radiation

Q1: A laser emits 4×10^{20} photons, each with a frequency of 6×10^{14} Hz. What is the total energy radiated by the laser? Use a value of 6.63×10^{-34} J·s for the Planck constant. Give your answer in joules to 3 significant figures.

A 26.5 J

B 159 J

C 35.4 J

D 39.8 J

E 124 J

Q2: Which of the following is the correct formula for the energy of a photon given its frequency, where h represents the Planck constant and c represents the speed of light?

A $E = hf$

B $E = \frac{hc}{f^2}$

C $E = \frac{h}{f}$

D $E = \frac{hc}{f}$

E $E = hf^2$

Q3: What is the difference in the energy of a 2×10^{14} Hz photon and a 5×10^{15} Hz photon? Use a value of 6.63×10^{-34} J·s for the value of the Planck constant. Give your answer in joules to 3 significant figures.

A 3.45×10^{-18} J

B 6.24×10^{-18} J

C 3.32×10^{-18} J

D 3.18×10^{-18} J

E 1.33×10^{-19} J

Q4: What is the wavelength of a photon that has an energy of 2.97×10^{-17} J? Use 6.63×10^{-34} J·s for the value of the Planck constant and 3.00×10^{8} m/s for the value of the speed of light in free space. Give your answer in meters to 3 significant figures.

A 36.2×10^{-9} m

B 3.24×10^{-9} m

C 9.98×10^{-9} m

D 1.49×10^{-9} m

E 6.70×10^{-9} m

Q5: What is the energy of a photon that has a wavelength of 400 nm? Use a value of 6.63×10^{-34} J·s for the value of the Planck constant and 3.00×10^{8} m/s for the value of the speed of light in free space. Give your answer in joules to 3 significant figures.

A 1.66×10^{-27} J

B 4.98×10^{-22} J

C 1.99×10^{-25} J

D 4.97×10^{-19} J

E 6.23×10^{-17} J

Q6: Photon *A* has twice the frequency of photon *B*. What is the ratio of the energy of photon *A* to the energy of photon *B*?

A 0.5

B 0.7

C 1

D 4

E 2

Q7: Photon A has a wavelength that is four times that of photon B. What is the ratio of the energy of photon A to the energy of photon B?

A 4

B $\frac{1}{4}$

C $\frac{1}{2}$

D 2

E 1

Q8: What is the frequency of a photon that has an energy of 2.52×10^{-19} J? Use a value of 6.63×10^{-34} J·s for the value of the Planck constant. Give your answer in hertz to 3 significant figures.

A 1.1×10^{9} Hz

B 1.90×10^{14} Hz

C 1.95×10^{7} Hz

D 2.63×10^{15} Hz

E 3.80×10^{14} Hz

Q9: What is the difference in the energy of a blue photon, with a wavelength of 400 nm, and a red photon, with a wavelength of 700 nm? Use a value of 6.63×10^{-34} J·s for the value of the Planck constant and 3.00×10^{8} m/s for the value of the speed of light in free space. Give your answer in joules to 3 significant figures.

A 2.84×10^{-19} J

B 3.25×10^{-19} J

C 4.32×10^{-19} J

D 2.13×10^{-19} J

E 4.97×10^{-19} J

Q10: What is the frequency of a photon that has an energy of 3.00 eV? Use 4.14×10^{-15} eV·s for the value of the Planck constant. Give your answer in hertz to 3 significant figures.

A 6.98×10^{14} Hz

B 5.32×10^{14} Hz

C 3.25×10^{14} Hz

D 1.38×10^{15} Hz

E 7.25×10^{14} Hz

Q11: What is the energy of a photon that has a frequency of 5×10^{15} Hz? Use 4.14×10^{-15} eV·s for the value of the Planck constant. Give your answer in electron volts to 3 significant figures.

A 0.0480 eV

B 30.2 eV

C 20.7 eV

D 3.20 eV

E 11.3 eV

Q12: What is the energy of a photon that has a frequency of 5.50×10^{14} Hz? Use a value of 6.63×10^{-34} J·s for the value of the Planck constant. Give your answer in joules to 3 significant figures.

A 8.30×10^{-21} J

B 3.65×10^{-19} J

C 1.53×10^{-25} J

D 1.21×10^{-20} J

E 1.33×10^{-37} J

Q13: A laser emits light with a wavelength of 200 nm. How many photons must be emitted by the laser for the amount of energy emitted to be 1 J? Use a value of 6.63×10^{-34} J · s for the value of the Planck constant and 3.00×10^{8} m/s for the value of the speed of light in free space. Give your answer to 3 significant figures.

A 8.32×10^{18}

B 1.36×10^{18}

C 3.2×10^{18}

D 9.95×10^{19}

E 1.01×10^{18}