$E = hf \quad h = 6.63\times10^{-34}\ J\cdot s$

$C = f\lambda \quad C = 3.00\times10^{8}\ m/s$

Name STURMAN KEY
Period _____ Date __________

Sample Light Energy Problems

1. Find the smallest increment of energy that a water molecule can absorb from a single microwave photon, wavelength 4.00×10^{6} nm.

$\lambda = 4.00\times10^{6}\ nm$
$= 4.00\times10^{6}\times10^{-9}\ m$
$= 4.00\times10^{-3}\ m$

$c = f\lambda$
$3.00 = f(4.00\times10^{-3})$
$f = 7.50\times10^{10}\ s^{-1}$

$E = 6.63\times10^{-34}(7.50\times10^{10})$
$= 4.97\times10^{-23}\ J$

2. Find the wavelength, in nm, of a photon that gives off 7.53×10^{-20} J of energy.

$E = 7.53\times10^{-20}\ J$
$\lambda = ?\ nm$

$E = hf$
$7.53\times10^{-20} = 6.63\times10^{-34} f$
$f = 1.14\times10^{14}\ s^{-1}$

$c = f\lambda$
$3.00\times10^{8} = 1.14\times10^{14}\lambda$
$\lambda = 2.63\times10^{-6}\ m$
$= 2.63\times10^{-6}\times10^{9}\ nm$
$= 2.63\times10^{3}\ nm$ or $2630\ nm$

3. Compare the energy entering your eyes, per photon, for blue sunglasses and red sunglasses.

Blue
$\lambda = 450\ nm$
$= 450\times10^{-9}\ m$

Red
$\lambda = 750\ nm$
$= 750\times10^{-9}\ m$

Blue
$c = f\lambda$
$3.00\times10^{8} = f(450\times10^{-9})$
$f = 6.67\times10^{14}\ s^{-1}$
$E = 6.63\times10^{-34}(6.67\times10^{14})$
$= 4.42\times10^{-19}\ J$

Red
$C = f\lambda$
$3.00\times10^{8} = f(750\times10^{-9})$
$f = 4.00\times10^{14}\ s^{-1}$
$E = 6.63\times10^{-34}(4\times10^{14})$
$= 2.65\times10^{-19}\ J$

$\frac{Blue}{Red} = \frac{4.42\times10^{-19}}{2.65\times10^{-19}} = 1.67$

Blue emits 1.67x more energy into your eye!

4. A carbon dioxide laser used in surgery has a frequency of 30 GHz. What is the energy of a single photon emitted from this laser?

$f = 30\ GHz$
$= 30\times10^{9}\ Hz$

$E = hf =$
$= 6.63\times10^{-34}(30\times10^{9}) = 1.989\times10^{-23} \Rightarrow 2.0\times10^{-23}\ J$

5. If this laser emits 1.0×10^{4} J of energy every second, then how many photons are emitted each second?

$\frac{1.0\times10^{4}\ J}{1\ s}\cdot\frac{1\ photon}{2.0\times10^{-23}\ J} = 5.0\times10^{26}\ photons/sec$

6. Satellite dishes are designed to receive waves of 3.90m. What is the frequency of these waves in MHz?

$\lambda = 3.90\ m$
$C = 3.00\times10^{8}\ m/s$
$f = ?\ MHz$

$C = f\lambda$
$3.00\times10^{8} = f(3.90)$
$f = 7.69\times10^{7}\ Hz$

$\frac{7.69\times10^{7}\ Hz}{1}\cdot\frac{1\ MHz}{10^{6}\ Hz}$
$= 7.69\times10^{1}\ MHz$
or $76.9\ MHz$

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