AP Chemistry Practice – Atomic Structure

Name Key Date 2018 Period

Show all formulas and calculations needed to solve the problem.

1. If an AM radio station broadcasts at 90.1 MHz, what is the wavelength of this radiation?

$c = \lambda\nu$

$\lambda = \frac{c}{\nu}$

$\lambda = \frac{2.998 \times 10^8 \, m\cancel{s^{-1}}}{90.1 \times 10^6 \, \cancel{s^{-1}}} = 3.33 \, m$

2. An argon ion laser emits light at 540 nm. What is the frequency of this radiation?

$\lambda = 540 \, nm$

$c = \lambda\nu$

$\nu = \frac{c}{\lambda}$

$\nu = \frac{2.998 \times 10^8 \, \cancel{m}s^{-1}}{540 \, \cancel{nm} \left(\frac{1 \, \cancel{m}}{1 \times 10^9 \, \cancel{nm}}\right)} = 5.6 \times 10^{14} \, s^{-1}$

3. A common infrared laser operates at 3.09 x 10^3 nm. What is the energy of a photon with this wavelength?

$E = h\nu$

$c = \lambda\nu$

$E = \frac{hc}{\lambda}$

$E = \frac{(6.626 \times 10^{-34} \, J\cancel{s})(2.998 \times 10^8 \, \cancel{m s^{-1}})}{(3.09 \times 10^3 \, \cancel{nm})\left(\frac{1 \, \cancel{m}}{1 \times 10^9 \, \cancel{nm}}\right)}$

$E_{photon} = 6.43 \times 10^{-20} \, J$

4. Photogray lenses incorporate small amounts of silver chloride in the glass of the lens. When light hits the AgCl particles, the following reaction occurs: AgCl → Ag + Cl. The silver metal that is formed causes the lenses to darken. The enthalpy change for this reaction is 312 kJ/mole. If we assume that all of this energy is supplied by light, what is the maximum wavelength of light that can cause this reaction?

$E = \frac{hc}{\lambda}$

$\lambda = \frac{hc}{E}$

$\lambda = \frac{(6.626 \times 10^{-34} \, \cancel{Js})(2.998 \times 10^8 \, m\cancel{s^{-1}})}{\left(\frac{312 \, \cancel{kJ}}{1 \, \cancel{mol}}\right)\left(\frac{1 \, \cancel{mol}}{6.02 \times 10^{23} \, photons}\right)\left(\frac{1000 \, \cancel{J}}{1 \, \cancel{kJ}}\right)}$

$\lambda = 3.83 \times 10^{-7} \, m = 383 \, nm$

5. Calculate the maximum wavelength of light (in nm) capable of exciting an electron for a hydrogen atom from the energy state characterized by n=2 to n=4.

$E = -2.178 \times 10^{-18} \, J \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

$= -2.178 \times 10^{-18} \, J \left(\frac{1}{4^2} - \frac{1}{2^2}\right)$

$= 4.084 \times 10^{-19} \, J$

$E = \frac{hc}{\lambda}$ $\lambda = \frac{hc}{E}$

$\lambda = \frac{(6.626 \times 10^{-34} \, \cancel{Js})(2.998 \times 10^8 \, m\cancel{s^{-1}})}{4.084 \times 10^{-19} \, \cancel{J}}$

$\lambda = \cancel{4.864} \times 10^{-7} \, m = 486.4 \, nm$

J · s

6. What is the wavelength of a 120 gram golf ball traveling at 65 mi/hr? (1.61 km = 1 mile) ______

$E = mc^2$

$E = \frac{hc}{\lambda}$

$mc^2 = \frac{hc}{\lambda}$

$\lambda = \frac{h\cancel{c}}{mc\cancel{\lambda}} = \frac{h}{mv}$

$\lambda = \frac{h}{mv} \Rightarrow \lambda = \frac{(6.626 \times 10^{-34} \, (\cancel{kg}\frac{m^{\cancel{2}}}{\cancel{s^2}})(\cancel{s})}{(.120 \, \cancel{kg})(29 \, \cancel{m}/\cancel{s})} = 1.9 \times 10^{-34} \, m$

negligible

$\frac{65 \, \cancel{mi}}{1 \, \cancel{hr}} \Big| \frac{5280 \, \cancel{ft}}{1 \, \cancel{mi}} \Big| \frac{12 \, \cancel{in}}{1 \, \cancel{ft}} \Big| \frac{2.54 \, \cancel{cm}}{1 \, \cancel{in}} \Big| \frac{1 \, (m)}{100 \, \cancel{cm}} \Big| \frac{1 \, \cancel{hr}}{3600 \, s} = 29 \, m/s$

J

7. If the wavelength of an electron is 530 nm, what is its velocity? The mass of an electron is 9.1×10^{-31} kg.

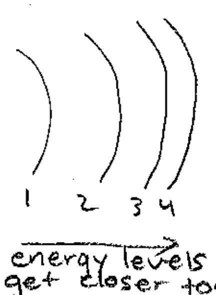
$$\lambda = \frac{h}{mv} \qquad v = \frac{h}{m\lambda}$$

$$v = \frac{6.626 \times 10^{-34} \left(kg \frac{m^2}{s^2}\right)(s)}{(9.1 \times 10^{-31} kg)(5.30 \times 10^{-7} m)} = 1374\ m/s = \boxed{1400\ m/s}$$

8. The ___E___ of a photon of light is ___directly___ proportional to its frequency and ___inversely___ proportional to its wavelength.
   A. velocity, directly, inversely
   B. velocity, inversely, directly
   C. amplitude, directly, inversely
   D. energy, directly, inversely
   E. energy, inversely, directly

$$E = h\nu \qquad E = \frac{hc}{\lambda}$$

9. Which of the following transitions in a hydrogen atom would emit the lowest energy photon?
   Hi to low
   low to hi ~~A. n=1 to n=2~~
   B. n=3 to n=2
   Big jump ~~C. n=5 to n=1~~
   low to hi ~~D. n=2 to n=8~~
   E. n=6 to n=5



$$\Delta E = -2.178 \times 10^{-18} J \underbrace{\left(\frac{1}{2^2} - \frac{1}{3^2}\right)}_{.139}$$

$$-2.178 \times 10^{-18} J \underbrace{\left(\frac{1}{5^2} - \frac{1}{6^2}\right)}_{.012} = \Delta E$$

10. When a barium salt is ignited, it burns with a green flame. The frequency of the light given off by barium is less than the frequency of
A.)orange light B.)infrared light C.)ultraviolet light D.)micro waves E.)radio waves

R M I V U X G

Low E
Low ν
Long λ

R O Y G B I V

High E
High ν
Short λ