

AP Chemistry Atomic Structure - 3 Worksheet

Name: Kay Date: _____ Per: _____

1. At its closest approach, Mars is 36 million km from Earth. How long would it take a radio message that is sent from Earth to Mars when the planets are at this closest distance?

$$c = 3 \times 10^8 \text{ m/s} \quad \lambda = 36 \times 10^6 \text{ km} = 36 \times 10^9 \text{ m} \quad t = \frac{d}{c} = \left(\frac{36 \times 10^9 \text{ m}}{3 \times 10^8 \text{ m/s}} \right) = \boxed{120 \text{ s}}$$

2. The second is defined as the time it takes for 919,263,173 wavelengths of a certain transition of the cesium-133 atom to pass a fixed point. What is (a) the frequency of the electromagnetic radiation? (b) its wavelength?

Frequency: $f = \frac{1}{\Delta t} = \frac{1}{919,263,173 \text{ s}} = \frac{1}{9.19263173 \times 10^8 \text{ s}} = \frac{1.08356735 \times 10^9 \text{ s}^{-1}}{9.19263173 \times 10^8} = \boxed{1.17857 \times 10^9 \text{ s}^{-1}}$

3. The energy required to dissociate the O_2 molecule to O atoms is 248 kJ/mol O_2 . If the dissociation of 1 mol O_2 molecule were accomplished by the absorption of a single photon, what energy would such a photon possess? What would be its wavelength (in meters)?

$$\frac{248 \text{ kJ/mol}}{6.022 \times 10^{23} \text{ mol}^{-1}} = 4.118 \times 10^{-19} \text{ J} \quad \lambda = \frac{hc}{E} = \frac{6.626 \times 10^{-34} \text{ J}\cdot\text{s} \times 3.00 \times 10^8 \text{ m/s}}{4.118 \times 10^{-19} \text{ J}} = \boxed{4.85 \times 10^{-7} \text{ m}}$$

4. In the atmosphere, ultraviolet radiation with a frequency of $1.06 \times 10^{15} \text{ s}^{-1}$ can break C-C bonds in chlorofluorocarbons (CFCs), which can lead to destruction of the ozone layer. Calculate the energy per quantum of this radiation.

$$E = hf = 6.626 \times 10^{-34} \text{ J}\cdot\text{s} \times (1.06 \times 10^{15} \text{ s}^{-1}) = \boxed{7.02 \times 10^{-19} \text{ J}}$$

5. Four possible electron transitions in a hydrogen atom are given below:

	From	To
(a)	2	1
(b)	3	1
(c)	3	2
(d)	4	2

(a) Which transition(s) represent a loss of energy? $n=2 \rightarrow 1$ and $n=3 \rightarrow 1$

(b) For which transition does the atom gain the greatest quantity of energy?

$$n=1 \rightarrow n=3$$

(c) Which transition corresponds to emission of the greatest quantity of energy?

$$n=3 \rightarrow n=1$$

6. Li^{2+} is a hydrogen-like ion. Such an ion has a nucleus of charge +3e and a single electron outside this nucleus. The energy levels of the ion are $-Z^2 R_H/n^2$, where Z is the atomic number. What is the wavelength of the transition from $n = 2$ to $n = 1$ for Li^{2+} ? In what region of the spectrum does this emission occur?

$$\frac{1}{\lambda} = -Z^2 R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \quad R_H = 1.097 \times 10^7 \text{ m}^{-1}$$

$$\frac{1}{\lambda} = -3^2 (1.097 \times 10^7 \text{ m}^{-1}) \left(\frac{1}{1^2} - \frac{1}{2^2} \right) = -1.49 \times 10^8 \text{ m}^{-1} \quad \lambda = \frac{1}{1.49 \times 10^8 \text{ m}^{-1}} = \boxed{6.71 \times 10^{-9} \text{ m}}$$