AP Chemistry Quiz: Ch. 7, Quantum Theory

Name_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) What is the wavelength of light (nm) that has a frequency $4.62 \times 10^{14}\ s^{-1}$?
   A) 1.54×10^{-3} B) 1.39×10^{23} C) 649 D) 1.07×10^{6} E) 932

2) The energy of a photon that has a wavelength of 12.3 nm is _____ J.
   A) 2.72×10^{-50} B) 1.62×10^{-17} C) 4.42×10^{-23} D) 1.99×10^{-25} E) 1.51×10^{-17}

3) Which one of the following represents an impossible set of quantum numbers for an electron in an atom? (arranged as n, l, m_l, and m_s)
   A) 2, 1, –1, –1/2 B) 1, 0, 0, 1/2 C) 5, 4, – 3, 1/2 D) 5, 4, –3, –1/2 E) 3, 3, 3, 1/2

4) The n = 5 to n = 3 transition in the Bohr hydrogen atom corresponds to the _____ of a photon with a wavelength of _____ nm.
   A) absorption, 657
   B) emission, 657
   C) emission, 1280
   D) absorption, 1280
   E) emission, 389

5) An electron cannot have the quantum numbers n = _____, l = _____, m_l = _____.
   A) 1, 0, 0 B) 3, 2, 3 C) 6, 1, 0 D) 3, 2, –2 E) 3, 2, 1

Answer Key
Testname: QUIZ_QUANTUM_THEORY_CH_07.TST

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) C
ID: chem9b 6.1–12

2) B
ID: chem9b 6.1–17

3) E
ID: chem9b 6.1–104

4) C
ID: chem9b 6.1–46

5) B
ID: chem9b 6.1–70

AP Chemistry Quiz
Ch. 7 - Quantum Theory

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Version A

(1) $\nu = 4.62 \times 10^{14}\ s^{-1}$ $\quad c = \lambda\nu$

$\lambda = ?$

$$\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^{8}\ \frac{m}{s}}{4.62 \times 10^{14}\ \frac{1}{s}} = 6.49 \times 10^{-7}\ m$$

$$6.49 \times 10^{-7}\ m \times \frac{10^{9}\ nm}{1\ m} = 649\ nm \quad (C)$$

(2) $E = h\nu$

$$\lambda = 12.3\ nm \times \frac{1\ m}{10^{9}\ nm} = 1.23 \times 10^{-8}\ m$$

$$c = \lambda\nu \Rightarrow \nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\ \frac{m}{s}}{1.23 \times 10^{-8}\ m} = 2.44 \times 10^{16}\ \frac{1}{s}$$

$$E = h\nu = (6.626 \times 10^{-34}\ Js)(2.44 \times 10^{16}\ \tfrac{1}{s})$$

$$E = 1.62 \times 10^{-17}\ J \quad (B)$$

(3) (E) $\quad n, l, m_l, m_s$

$3, 3, 3, +1/2$

for $n=3$, the allowed values for $\underline{l}$ are 0, 1, 2

(4) $E_n = \dfrac{-2.178 \times 10^{-18}}{n^2}\ J$ $\quad E_5 = \dfrac{-2.178 \times 10^{-18}\ J}{5^2} = -8.712 \times 10^{-20}\ J$

$$E_3 = \frac{-2.178 \times 10^{-18}\ J}{3^2} = -2.42 \times 10^{-19}\ J$$

(after - before)

$$\Delta E = (E_3 - E_5) = (-2.42 \times 10^{-19}\ J) - (-8.712 \times 10^{-20}\ J) = -1.549 \times 10^{-19}\ J$$

(4) continued

the energy released as a photon of light because $\Delta E = -1.549 \times 10^{-19}$ J

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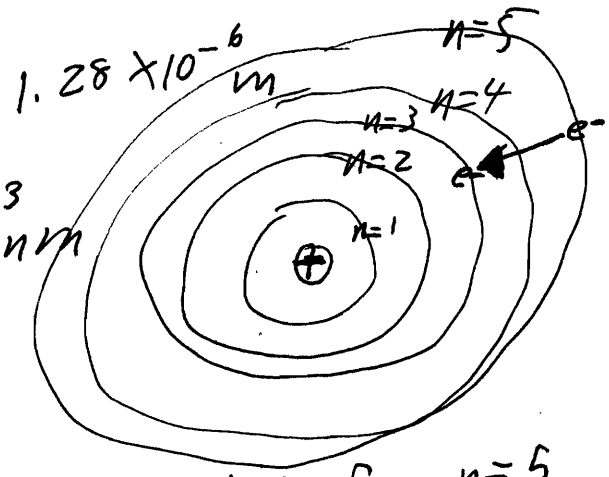
$$E = h\nu$$

$$\nu = \frac{E}{h} = \frac{+1.549 \times 10^{-19}\ J}{6.626 \times 10^{-34}\ J\,s} = 2.34 \times 10^{14}\ \frac{1}{s}$$

$$c = \lambda\nu \Rightarrow \lambda = \frac{c}{\nu} = \frac{3.00 \times 10^{8}\ \frac{m}{s}}{2.34 \times 10^{14}\ \frac{1}{s}} = 1.28 \times 10^{-6}\ m$$

$$1.28 \times 10^{-6}\ m \times \frac{10^{9}\ nm}{1\ m} = 1.28 \times 10^{3}\ nm$$



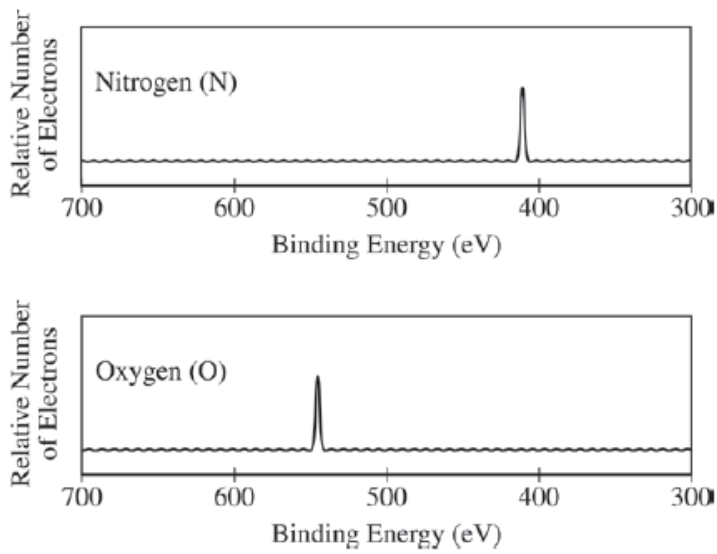
1280nm, emission (C)

transition from n=5 down to n=3 <u>emits</u> energy.

(5) (B) 3, 2, 3 (n, l, m_l)

for $l=2$, the allowed values of m_l are $m_l = -2, -1, 0, +1, +2$

6.



The photoelectron spectra above show the energy required to remove a 1*s* electron from a nitrogen atom and from an oxygen atom. Which of the following statements best accounts for the peak in the upper spectrum being to the right of the peak in the lower spectrum?

(A) Nitrogen atoms have a half-filled *p* subshell.

(B) There are more electron-electron repulsions in oxygen atoms than in nitrogen atoms.

(C) Electrons in the *p* subshell of oxygen atoms provide more shielding than electrons in the *p* subshell of nitrogen atoms.

(D) Nitrogen atoms have a smaller nuclear charge than oxygen atoms.

7. Give the electron configuration for Pb.

Answers:

6) The problem states that both electrons are 1s electrons. 1s electrons are not valence electrons for either of these elements, both of which have highest occupied energy levels of n=2. Electrons in the same energy level do not significantly shield one another. There are no further shells of electrons between the nucleus and the 1st energy level. The difference in the spectra is due to the fact that the charge on the N nucleus if +7 and on O it is +8. Therefore, it requires more energy to remove electrons from a nearby oxygen nucleus than a nitrogen nucleus.

7) $[Xe]6s^2 4f^{14} 5d^{10} 6p^2$

(If you got the correct answer but with some of the sublevels switched after the "[Xe]", then that is OK.)