CH 121 Homework Chapter 3

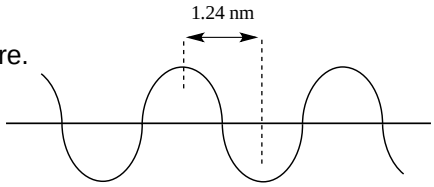
Adapted by O. Pattawong from T. Brown, et. al. *Chemistry: The Central Science, 12th ed.* 2011, and N. Hudak, et. al. *Chemistry: A Case-Study Approach, Chemistry 116,* 2011.

Out: Saturday, October 9 Due: Monday, October 18 by 11:59 pm

Submission Instruction: Please scan your completed homework and upload on Moodle.
This homework is graded based on completion. It is your responsibility to check your answers against the answer key provided on Moodle.

STUDENT NAME _____

1. Consider the electromagnetic wave diagrammed below.
   a) How many nodes are represented in the diagram? Indicate where they are.
   b) On the diagram, indicate the amplitude of the wave
   c) What is the wavelength of the radiation?



2. What is the frequency of radiation whose wavelength is 0.50 micrometers (μm)?

3. a) What is the wavelength of radiation that has a frequency of $2.5 \times 10^{18}\ s^{-1}$?

   b) Would the radiation in part (a) be detected by an X-ray detector?
   Hint: check your answer in part (a) against the electromagnetic spectrum on Lecture manual p. 35, figure 3.3

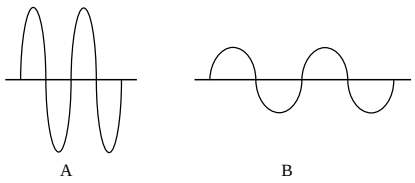
4. What distance does electromagnetic radiation travel in 10.5×10^{-15} s?

Hint: All electromagnetic radiations travel the same speed as speed of light ($C = 3.00 \times 10^8$ m/s).

5. The distance from the sun to Earth is 93 million miles. How long (in milliseconds) does it take light to reach Earth from the sun? Hint: use speed of light.

6. Microwave ovens produce electromagnetic radiation with a wavelength of 20.0 cm. Convert this wavelength to frequency, in Hz

7. The following diagrams represent two electromagnetic waves. Which wave corresponds to the higher-energy radiation? Explain.



8. The energy from radiation can be used to cause the rupture of chemical bonds. A minimum energy of 941 kJ/mol is required to break the nitrogen – nitrogen bond in N_2. What is the longest wavelength of radiation that possesses the necessary energy to break the bond? What type of electromagnetic radiation is this?

9. Place the following types of radiation in order of increasing energy per photon:
   a) a green light from a mercury lamp
   b) x-rays from an instrument in a dentist's office
   c) an FM music station at 101.9 MHz
   d) infrared radiation from a heat lamp

10. Microwave ovens produce electromagnetic radiation with a wavelength of 10.0 cm.
   a) Convert this wavelength to frequency, in Hz

b) How much energy, in J, is contained in one photon of microwave radiation?

c) How much energy, in J/mol, is contained in one mole of microwave radiation?

11. Which of the transition will result in light with the longest wavelength? Explain.

A. n = 4 to n = 1

B. n = 4 to n = 3

C. n = 5 to n = 1

D. n = 3 to n = 2

12. Indicate whether energy is emitted or absorbed when the following electronic transitions occur:

_____a) from n = 2 to n = 6

_____b) from an orbit of radius 4.76 Å to one of radius 0.529 Å

_____c) from the n = 6 to the n = 9

13. An excited hydrogen atom emits light with a frequency of 1.141×10^{14} Hz and ends up in the n = 4 energy level

a) Calculate the wavelength (in nm) of light with this frequency.

b) In which region of the electromagnetic spectrum is this light?

c) In which energy level (n = ?) was the electron initially?

14. The following transitions listed below refer to an electron in a hydrogen atom. For each transition, calculate transition energy, ΔE (in J) and the wavelength of the emitted light (in nm). Assign each wavelength

    a) n = 3 to n = 1

b) n = 5 to n = 3

15. What is **one** major difference between the Bohr model of the atom and the quantum mechanical model? A drawing and/or graph may help you answer this question succinctly.

16. What are the characteristic shapes of s, p, and d orbitals?

17. What quantum number identifies the shape of an orbital?

18. What quantum number identifies the spin of an electron in an orbital? What are the possible values for this quantum number?

19. What happens to the size of a particular orbital, as the principal quantum number increases?

20. For each value of n = 1, 2, 3, and 4 what are the possible values for *l*, and what are the labels for the orbitals with these *l* values? (For example: s, p, d, or f)

n	**possible *l* values**	**orbital labels**

21. For each value of *l* = 0,1, 2, and 3 what are the possible values of m_l?

l	**possible m_l values**

22. Which of the following sets of quantum numbers describe actual orbitals, and which are nonexistent? For each one that is nonexistent, list the restriction that makes it forbidden.

	n	*l*	m_l	m_s
a)	4	1	1	0
b)	4	4	1	1/2
c)	4	0	1	-1/2
d)	4	2	2	-1/2

23. For each value of *l* = 0,1, 2, and 3 how many orbitals are there and what is the total number of electrons that can be placed in these orbitals?

l	**Number of orbitals**	**Possible number of e^-**

24. a) How many orbitals exist when n = 5, l = 3?

b) What are these orbitals called (orbital label)?

c) What is the maximum number of electrons that can have n = 5, l = 3 ?

25. What are the quantum numbers associated with orbitals in the 2p subshell? 3s subshell? 4d subshell? 4f subshell? 1s subshell?