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13 ELECTRONS IN ATOMS
PRACTICE PROBLEMS

In your notebook, solve the following problems.

SECTION 13.1 MODELS OF THE ATOM

1. How many sublevels are in the following principal energy levels?
   - **a.** $n = 1$
   - **b.** $n = 2$
   - **c.** $n = 3$
   - **d.** $n = 4$
   - **e.** $n = 5$
   - **f.** $n = 6$
2. How many orbitals are in the following sublevels?
   - **a.** 1*s* sublevel
   - **b.** 5*s* sublevel
   - **c.** 4*d* sublevel
   - **d.** 4*f* sublevel
   - **e.** 7*s* sublevel
   - **f.** 3*p* sublevel
   - **g.** fifth principal energy level
   - **h.** 6*d* sublevel
3. What are the types of sublevels and number of orbitals in the following energy levels?
   - **a.** $n = 1$
   - **b.** $n = 2$
   - **c.** $n = 3$
   - **d.** $n = 4$
   - **e.** $n = 5$

SECTION 13.2 ELECTRON ARRANGEMENT IN ATOMS

1. Write a complete electron configuration of each atom.
   - **a.** hydrogen
   - **b.** vanadium
   - **c.** magnesium
   - **d.** barium
   - **e.** bromine
   - **f.** sulfur
   - **g.** krypton
   - **h.** arsenic
   - **i.** radon

SECTION 13.3 PHYSICS AND THE QUANTUM MECHANICAL MODEL

1. What is the wavelength of the radiation whose frequency is $5.00 \times 10^{15}\ s^{-1}$? In what region of the electromagnetic spectrum is this radiation?
2. An inexpensive laser that is available to the public emits light that has a wavelength of 670 nm. What are the color and frequency of the radiation?
3. What is the energy of a photon whose frequency is $2.22 \times 10^{14}\ s^{-1}$?
4. What is the frequency of a photon whose energy is 6.00×10^{-15} J?
5. Arrange the following types of electromagnetic radiation in order of increasing frequency.
   - **a.** infrared
   - **b.** cosmic rays
   - **c.** visible light
   - **d.** radio waves
   - **e.** microwaves
   - **f.** ultraviolet
6. Suppose that your favorite AM radio station broadcasts at a frequency of 1600 kHz. What is the wavelength in meters of the radiation from the station?

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13 INTERPRETING GRAPHICS

USE WITH SECTION 13.3

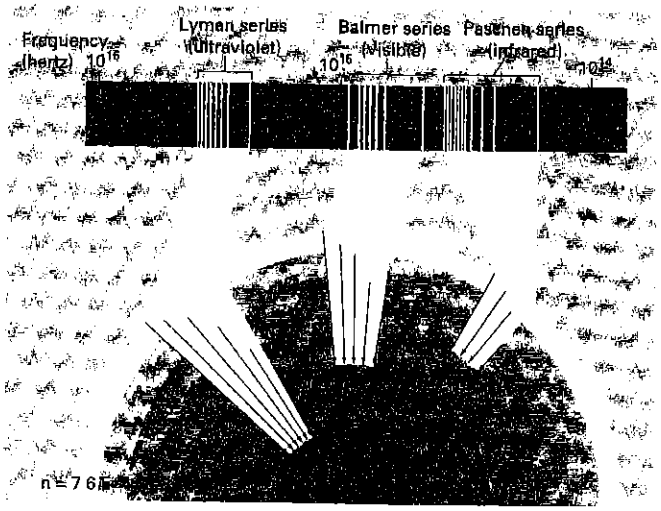

Figure 1 The emission spectrum and orbit-transition diagram for hydrogen.

Table 1

Transition	E (J)	ν (s^{-1})	λ(m)	Type of Radiation
$n = 6 \rightarrow n = 5$	2.66×10^{-20}			
$n = 6 \rightarrow n = 4$	7.57×10^{-20}			
$n = 6 \rightarrow n = 3$	1.82×10^{-19}			
$n = 6 \rightarrow n = 2$	4.84×10^{-19}			
$n = 6 \rightarrow n = 1$	2.12×10^{-18}			
$n = 5 \rightarrow n = 4$	4.91×10^{-20}			
$n = 5 \rightarrow n = 3$	1.55×10^{-19}			
$n = 5 \rightarrow n = 2$	4.56×10^{-19}			
$n = 5 \rightarrow n = 1$	2.09×10^{-18}			
$n = 4 \rightarrow n = 3$	1.06×10^{-19}			
$n = 4 \rightarrow n = 2$	4.09×10^{-19}			
$n = 4 \rightarrow n = 1$	2.04×10^{-18}			
$n = 3 \rightarrow n = 2$	3.03×10^{-19}			
$n = 3 \rightarrow n = 1$	1.94×10^{-18}			
$n = 2 \rightarrow n = 1$	1.64×10^{-18}			

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1. Figure 1 summarizes the quantum model of the hydrogen atom originally proposed by Neils Bohr to account for the interaction of hydrogen with electromagnetic radiation. The energy changes associated with each electron transition for the lowest six energy levels of hydrogen are listed in Table 1. Calculate the frequency of the emitted radiation for each transition.

2. Calculate the wavelength in meters for each energy level transition and fill in the column for wavelength.

3. Determine the type of radiation (ultraviolet, visible, or infrared) that corresponds to each wavelength.

4. Which transitions resulted in the emission of visible light?

5. If the wavelengths of blue, green, and red light are approximately 400 nm, 500 nm, and 650 nm respectively, what colors in the visible spectrum correspond to the transitions stated in your answer to question 4.

6. What is the common feature among transitions where the resulting radiation lies within the visible light range of the electromagnetic spectrum?

7. The Bohr model, although historically important, was limited in its ability to explain the behavior of more complex elements and ions. To which of the following atoms or ions would you expect the Bohr model to apply?

   Be, He^{+}, K, Li^{2+}

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13 VOCABULARY REVIEW

Select the term from the following list that best matches each description.

quantum	Hund's rule
photons	atomic emission spectrum
hertz	photoelectrons
Pauli exclusion principle	Aufbau principle
wavelength	quantum mechanical model

1. The lowest-energy arrangement of electrons in a subshell is obtained by putting electrons into separate orbitals of the subshell before pairing electrons.

_____

2. packets/quanta of electromagnetic energy

_____

3. the SI unit of frequency

_____

4. An atomic orbital can hold no more than two electrons.

_____

5. the amount of energy required to move an electron from its present energy level to the next higher one

_____

6. the modern description of the location and energy of electrons in an atom

_____

7. This principle states that electrons enter orbitals of lowest energy first.

_____

8. the distance between two adjacent crests of an electromagnetic wave

_____

9. This is produced by passing the light emitted by an element through a prism.

_____

10. These are sometimes produced when light shines on metals.

_____