

Project Advance Chemistry 106 Sample Questions
on Material in *General Chemistry*, Brown, LeMay, and Bursten, 6th ed.

Chapter 6. Electronic Structure of Atoms

1. Electromagnetic radiation of which of the following wavelengths (in nm) is of the lowest energy?
(a) 526 (b) 493
(c) 623 (d) 277
(e) 532
2. Which one of the following is *not* a form of electromagnetic radiation?
(a) radiant heat (b) radio waves
(c) gamma rays (d) microwaves
(e) sound waves
3. Ham radio operators often broadcast on the 6 meter band. What is the frequency (in MHz) of this electromagnetic radiation?
(a) 500 (b) 200
(c) 50 (d) 20
(e) none of these.
4. Which of the following transactions in the Bohr hydrogen atom model afford emission of the highest-energy photon? ($n_i = n_{\text{final}}$)
(a) $n_i = 1 \rightarrow n_f = 6$
(b) $n_i = 6 \rightarrow n_f = 3$
(c) $n_i = 3 \rightarrow n_f = 6$
(d) $n_i = 4 \rightarrow n_f = 1$
(e) $n_i = 6 \rightarrow n_f = 1$
5. Which one of the following electron transitions would result in the loss of energy from a hydrogen atom?
(a) $n = 7$ to $n = 9$
(b) $n = 7$ to $n = 5$
(c) $n = 5$ to $n = 6$
(d) $n = 1$ to $n = 2$
(e) $n = 3$ to $n = \infty$
6. What is the frequency (in Hz) of electromagnetic radiation necessary to move an electron from $n=2$ to $n=4$ in a hydrogen atom?
(a) 6.2×10^{14} (b) 4.1×10^{-19}
(c) 5.4×10^{-19} (d) 8.2×10^{14}
(e) none of these.

7. The maximum number of electrons that can exist at the $n=3$ level of an atom is:
- (a) 18 (b) 12
(c) 8 (d) 4
(e) none of these.
8. The de Broglie wavelength of an electron is 8.7×10^{-11} m. The mass of this electron is 9.1×10^{-31} kg. What is the velocity (in m/s) of this electron?
- (a) 8.4×10^3 (b) 1.2×10^{-7}
(c) 6.9×10^{-54} (d) 8.4×10^6
(e) none of these.
9. Two electrons in the same atom which have identical values of quantum numbers n , l , and m_l are said to be in
- (a) the same shell and subshell, but different orbitals.
(b) the same shell, but different subshells and orbitals.
(c) the same shell, subshell, and orbital.
(d) the same subshell and orbital, but different shells.
(e) different shells, subshells, and orbitals.
10. Which of the subshells below do not exist.
- I. $2d$ II. $2s$ III. $2p$ IV. $1p$ V. $6f$
- (a) II, III, and V (b) I only
(c) IV only (d) I, IV, and V
(e) I and IV
11. Which one of the following electron configurations would allow a hydrogen atom to absorb a photon of light, but not emit one?
- (a) $3s$ (b) $2s$
(c) $3p$ (d) $1s$
(e) none of these.
12. Which set of quantum numbers *cannot* be correct?
- (a) $n=6, l=0, m_l=0$
(b) $n=3, l=2, m_l=3$
(c) $n=3, l=2, m_l=-2$
(d) $n=1, l=0, m_l=0$
(e) none of these.

13. For the $4d_{yz}$ orbital, the yz specifies its
- (a) size
 - (b) shape
 - (c) spatial orientation
 - (d) electron spin
 - (e) degree of degeneracy
14. In the wave-mechanical model, the general shape of an orbital is determined by the quantum number()
- (a) m_s
 - (b) m_l
 - (c) l
 - (d) n
 - (e) both m_l and m_s
15. A major effect of the Pauli Exclusion rule is to allow
- (a) only one subshell in the first electron shell.
 - (b) only seven electron shells total for any atom.
 - (c) three orbitals in the $3p$ subshell.
 - (d) three orbitals in any p subshell.
 - (e) no more than two electrons per orbital.
16. Which one of the following represents a possible set of quantum numbers (in the order n, l, m_l, m_s)
- (a) 2, 1, -1, $\frac{1}{2}$
 - (b) 2, 1, 0, 0
 - (c) 2, 2, 0, $\frac{1}{2}$
 - (d) 2, 0, 1, $-\frac{1}{2}$
 - (e) none of these.
17. Which one of the following represents an *incorrect* set of quantum numbers for an electron in an atom? (arranged in the order n, l, m_l, m_s)
- (a) 2, 1, -1, $-\frac{1}{2}$
 - (b) 1, 0, 0, $\frac{1}{2}$
 - (c) 3, 3, 3, $\frac{1}{2}$
 - (d) 5, 4, -3, $\frac{1}{2}$
 - (e) none of these.
18. Which one of the following orbitals can hold two electrons?
- (a) $2p_z$
 - (b) $3s$
 - (c) $4d_{xy}$
 - (d) all of the above.
 - (e) none of the above.

19. How many electrons populate the complete 3p electron subshell in the ground state of atomic xenon?

- (a) 2
 (b) 6
 (c) 8
 (d) 10
 (e) 36

20. Which one of the following orbital diagrams violates the Pauli Exclusion Principle?

- (a) $\uparrow\downarrow$ $\uparrow\downarrow$ \uparrow \uparrow $\underline{\hspace{0.5cm}}$
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (b) $\uparrow\downarrow$ $\uparrow\downarrow$ \uparrow $\underline{\hspace{0.5cm}}$ \uparrow
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (c) $\uparrow\downarrow$ \uparrow \uparrow \uparrow \uparrow
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (d) $\uparrow\downarrow$ $\uparrow\uparrow$ \uparrow \uparrow $\underline{\hspace{0.5cm}}$
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (e) none of these.

21. Which one of the following orbital diagrams shows a violation of Hund's Rule for an atom in its ground state?

- (a) $\uparrow\downarrow$ $\uparrow\downarrow$ \uparrow $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (b) $\uparrow\downarrow$ $\uparrow\downarrow$ \uparrow $\underline{\hspace{0.5cm}}$ \uparrow
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (c) $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ \uparrow $\underline{\hspace{0.5cm}}$
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (d) \uparrow $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (e) none of these.

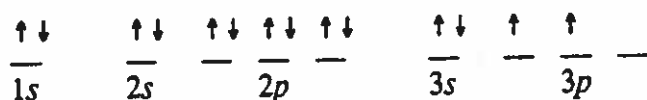
22. Which diagram represents an atom in the ground state?

- (a) \uparrow $\uparrow\downarrow$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (b) $\uparrow\uparrow$ $\uparrow\downarrow$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (c) $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (d) $\uparrow\downarrow$ $\uparrow\downarrow$ \uparrow $\underline{\hspace{0.5cm}}$ \uparrow
 $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$ $\underline{\hspace{0.5cm}}$
- (e) none of these.

23. Which one of the following orbital diagrams represents an excited atom?

- (a) $\begin{array}{ccccc} \uparrow\downarrow & \uparrow & _ & _ & _ \\ \hline & & & & \end{array}$
- (b) $\begin{array}{ccccc} \uparrow\uparrow & \uparrow\downarrow & \uparrow & \uparrow & _ \\ \hline & & & & \end{array}$
- (c) $\begin{array}{ccccc} \uparrow\downarrow & \uparrow\downarrow & \uparrow & \downarrow & _ \\ \hline & & & & \end{array}$
- (d) $\begin{array}{ccccc} \uparrow\downarrow & \uparrow\downarrow & \uparrow & _ & \uparrow \\ \hline & & & & \end{array}$
- (e) none of these.

24. Which one of the following elements is represented by the orbital diagram shown below?



- (a) Mg (b) Ge
 (c) Al (d) Si
 (e) none of these.

25. The electron configuration of Ga is given by

- (a) $1s^2 2s^2 3s^2 3p^6 3d^{10} 4s^2 4p^1$
 (b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^{10} 4p^1$
 (c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$
 (d) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4d^1$
 (e) none of these.

26. Which one of the following elements has the ground state electron configuration $[\text{Ar}]4s^1 3d^6$?

- (a) Cr (b) Fe
 (c) Mn (d) V
 (e) none of these.

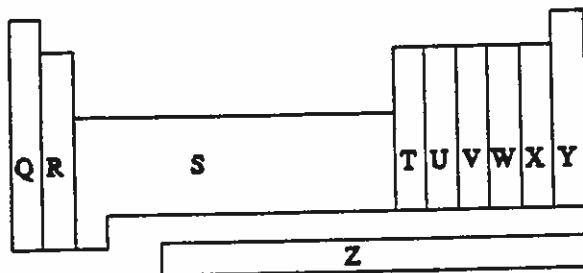
27. Which one of the following represents the electron configuration of an excited oxygen atom?

- (a) $1s^2 2s^2 2p^2$
 (b) $1s^2 2s^2 2p^2 3s^2$
 (c) $1s^2 2s^2 2p^1$
 (d) $1s^2 2s^2 2p^4$
 (e) none of these.

28. How many unpaired electrons are there in an unexcited phosphorus atom?

- (a) 0
 (b) 1
 (c) 2
 (d) 3
 (e) 4

29. Consider the schematic of the periodic table shown below. Which of the following statements is(are) *false*.



- I. Elements with the outermost electron configuration ns^2 are found in the portion of the periodic table labelled R.
- II. Elements with the outermost electron configuration ns^2np^1 are found in the portion of the periodic table labelled X.
- III. Elements with the outermost electron configuration ns^2np^3 are found in the portion of the periodic table labelled V.
- IV. Orbitals being filled for elements with the azimuthal quantum number, $\ell = 3$, are found in the portion of the periodic table labelled S.
- V. Orbitals being filled for elements with the azimuthal quantum number, $\ell = 1$, are found in the portion of the periodic table labelled T.

- (a) II only is false.
 (b) II and V are false.
 (c) None of the above statements is false.
 (d) I, II and V are false.
 (e) II and IV are false.

30. The following electronic transitions occur when lithium atoms are sprayed into a flame. The various steps are numbered for identification:



Which electronic transition would result in the *emission* of light?

- (a) Steps III and V only.
 (b) Steps I, II, and V.
 (c) Step III only.
 (d) All the steps.
 (e) Steps III, IV, and V.