Ch 12 Practice MC Problems

1. Which of the following frequencies corresponds to light with the longest wavelength?
   A) \(3.00 \times 10^{13}\) s\(^{-1}\)
   B) \(4.12 \times 10^{15}\) s\(^{-1}\)
   C) \(8.50 \times 10^{20}\) s\(^{-1}\)
   D) \(9.12 \times 10^{12}\) s\(^{-1}\)
   E) \(3.20 \times 10^{9}\) s\(^{-1}\)

2. From the following list of observations, choose the one that most clearly supports the conclusion that electromagnetic radiation has wave characteristics.
   A) the emission spectrum of hydrogen
   B) the photoelectric effect
   C) the scattering of alpha particles by metal foil
   D) diffraction
   E) cathode "rays"

3. Light has a wavelength of \(6.0 \times 10^{2}\) nm. What is the energy of a photon of this light?
   A) \(1.10 \times 10^{-19}\) J
   B) \(3.31 \times 10^{-19}\) J
   C) \(2.71 \times 10^{-18}\) J
   D) \(3.68 \times 10^{-20}\) J
   E) \(1.33 \times 10^{-18}\) J

4. What is the wavelength, in nanometers, of a photon of light whose frequency is \(5.86 \times 10^{14}\) Hz?
   A) \(1.95 \times 10^{2}\) nm
   B) \(5.12 \times 10^{2}\) nm
   C) \(3.39 \times 10^{2}\) nm
   D) \(2.95 \times 10^{2}\) nm
   E) \(1.29 \times 10^{-7}\) nm

5. Consider an atom traveling at 1% of the speed of light. The de Broglie wavelength is found to be \(3.31 \times 10^{-3}\) pm. Which element is this?
   A) He
   B) Ca
   C) F
   D) Be
   E) P

6. From the following list of observations, choose the one that most clearly supports the conclusion that electrons in atoms have quantized energies.
   A) the emission spectrum of hydrogen
   B) the photoelectric effect
   C) the scattering of alpha particles by metal foil
   D) diffraction
   E) cathode "rays"
7. Which of the following statements is(are) true?
   I. An excited atom can return to its ground state by absorbing electromagnetic radiation.
   II. The energy of an atom is increased when electromagnetic radiation is emitted from it.
   III. The energy of electromagnetic radiation increases as its frequency increases.
   IV. An electron in the \( n = 4 \) state in the hydrogen atom can go to the \( n = 2 \) state by emitting electromagnetic radiation at the appropriate frequency.
   V. The frequency and wavelength of electromagnetic radiation are inversely proportional to each other.
   A) II, III, IV
   B) III, V
   C) I, II, III
   D) III, IV, V
   E) I, II, IV

8. In an investigation of the electronic absorption spectrum of a particular element, it is found that a photon having \( \lambda = 500 \) nm provides just enough energy to promote an electron from the second quantum level to the third. From this information, we can deduce
   A) the energy of the \( n = 2 \) level.
   B) the energy of the \( n = 3 \) level.
   C) the sum of the energies of the \( n = 2 \) and \( n = 3 \) levels.
   D) the difference between the energies of the \( n = 2 \) and \( n = 3 \) levels.
   E) all of these.

9. What is the wavelength of light that is emitted when an excited electron in the hydrogen atom falls from the \( n = 5 \) level to the \( n = 2 \) level?
   A) \( 5.12 \times 10^{-7} \) m
   B) \( 4.34 \times 10^{-7} \) m
   C) \( 6.50 \times 10^{-7} \) m
   D) \( 5.82 \times 10^{-7} \) m
   E) none of these

10. For which of the following transitions does the light emitted have the longest wavelength?
    A) \( n = 4 \) to \( n = 3 \)
    B) \( n = 4 \) to \( n = 2 \)
    C) \( n = 4 \) to \( n = 1 \)
    D) \( n = 3 \) to \( n = 2 \)
    E) \( n = 2 \) to \( n = 1 \)

11. On a planet where the temperature is so high, the ground state of an electron in the hydrogen atom is \( n = 4 \). What is the ratio of IE on this planet to that on earth?
    A) 1:4
    B) 4:1
    C) 1:16
    D) 16:1
    E) 1:1

12. The wavelength of light associated with the \( n = 2 \) to \( n = 1 \) electron transition in the hydrogen spectrum is \( 1.216 \times 10^{-7} \) m. By what coefficient should this wavelength be multiplied to obtain the wavelength associated with the same electron transition in the Li\(^{2+}\) ion?
    A) \( 1/9 \)
    B) \( 1/7 \)
    C) \( 1/4 \)
    D) \( 1/3 \)
    E) 1
13. Which of the following statements about quantum theory is incorrect?
   A) The energy and position of an electron cannot be determined simultaneously.
   B) Lower energy orbitals are filled with electrons before higher energy orbitals.
   C) When filling orbitals of equal energy, two electrons will occupy the same orbital before filling a new orbital.
   D) No two electrons can have the same four quantum numbers.
   E) All of these are correct.

14. Which of the following is not determined by the principal quantum number, \( n \), of the electron in a hydrogen atom?
   A) the energy of the electron
   B) the minimum wavelength of the light needed to remove the electron from the atom.
   C) the size of the corresponding atomic orbital(s)
   D) the shape of the corresponding atomic orbital(s)
   E) All of the above are determined by \( n \).

15. Which of the following statements is true?
   A) We can determine the exact location of an electron if we know its energy.
   B) An electron in a 2s orbital can have the same \( n, l, \) and \( m_l \) quantum numbers as an electron in a 3s orbital.
   C) Ni has 2 unpaired electrons in its 3d orbitals.
   D) In the building up of atoms, electrons occupy the 4f orbitals before the 6s orbitals.
   E) Only three quantum numbers are needed to uniquely describe an electron.

16. How many electrons in an atom can have the quantum numbers \( n = 3, l = 1 \)?
   A) 10
   B) 2
   C) 6
   D) 18
   E) 32

17. How many electrons can be described by the quantum numbers \( n = 3, l = 3, m_l = -1 \)?
   A) 0
   B) 2
   C) 6
   D) 10
   E) 14

18. Which of the following combinations of quantum numbers is not allowed?
   (Combinations are listed as follows: \( n, l, m_l, m_s \))
   A) 1 1 0 -1/2
   B) 3 0 0 -1/2
   C) 3 1 1 1/2
   D) 5 3 1 -1/2
   E) 3 2 0 1/2

19. How many electrons can be described by the quantum numbers \( n = 4, l = 3, m_l = 0 \)?
   A) 0
   B) 2
   C) 6
   D) 10
   E) 14

20. In which orbital does an electron experience the highest \( Z_{eff} \)?
   A) Na (3s)
   B) Mg (3s)
   C) Al (3p)
   D) P (3p)
   E) S (3p)
21. How many electrons can be described by the quantum number \( n = 4 \)?
   A) 8
   B) 10
   C) 2
   D) 18
   E) 32

22. Which of the following atoms or ions has 3 unpaired electrons?
   A) Co
   B) O
   C) Ca
   D) Br
   E) Zn²⁺

23. What is the electron configuration for the barium atom?
   A) 1s²2s²2p⁶3s²3p⁶3d¹⁰4s²
   B) [Xe] 6s²
   C) 1s²2s²2p⁶3s²3p⁶4s¹
   D) 1s²2s²2p⁶3s²3p⁶4s²
   E) none of these

24. What is the electron configuration of the element with atomic number 113?
   A) [Rn] 7s²7f¹⁴7d¹⁰⁷p¹
   B) [Rn] 7s²5f¹⁴7d¹⁰⁷p¹
   C) [Rn] 7s²6d¹⁰⁷p¹
   D) [Rn] 7s²5f¹⁴6d¹⁰⁷p¹
   E) none of these

25. Of the following elements, which has occupied d orbitals in its ground-state neutral atoms?
   A) Ba
   B) Na
   C) Al
   D) P
   E) F

26. Of the following elements, which needs 3 electrons to complete its valence shell?
   A) Ba
   B) K
   C) Si
   D) P
   E) Cl

27. Which is the highest occupied energy orbital in a silicon atom?
   A) 1s
   B) 2s
   C) 3s
   D) 3p
   E) 3d

28. What is the total number of electrons that can be accommodated in the level corresponding to \( n = 5 \)?
   A) 2
   B) 8
   C) 18
   D) 32
   E) 50
29. What is the valence electron configuration of S?
   A) 3s²3p⁴
   B) 1s²2s²2p⁶3s²3p⁴
   C) 4s²4p⁴
   D) 1s²2s²2p⁴
   E) none of these

30. Place the elements Ge, Br, and Ar in order of increasing atomic radius.
   A) Ge, Br, Ar
   B) Ar, Br, Ge
   C) Br, Ar, Ge
   D) Ge, Ar, Br
   E) Br, Ge, Ar

31. Place the elements C, N, and O in order of increasing ionization energy.
   A) C, N, O
   B) O, N, C
   C) C, O, N
   D) N, O, C
   E) none of these

32. Which of the following statements is true about the ionization energy of Mg⁺?
   A) It will be equal to the ionization energy of Li.
   B) It will be equal to and opposite in sign to the electron affinity of Mg.
   C) It will be equal to and opposite in sign to the electron affinity of Mg⁺.
   D) It will be equal to and opposite in sign to the electron affinity of Mg²⁺.
   E) none of the above

Use the following to answer questions 33-34:

Consider the following orderings.

I. Al < Si < P < Cl
II. Be < Mg < Ca < Sr
III. I < Br < Cl < F
IV. Na⁺ < Mg²⁺ < Al³⁺ < Si⁴⁺

33. Which of these give(s) a correct trend in size?
   A) I
   B) II only
   C) III
   D) IV only
   E) II, IV

34. Which of these give(s) a correct trend in ionization energy?
   A) III only
   B) I, II only
   C) I, IV only
   D) I, III, IV
   E) none of them
35. Which of the following statements is true of second ionization energies?
   A) That of Al is higher than that of Mg because Mg wants to lose the second electron, so it is easier to take the second electron away.
   B) That of Al is higher than that of Mg because the electrons are taken from the same energy level, but the Al atom has one more proton.
   C) That of Al is lower than that of Mg because Mg wants to lose the second electron, so the energy change is greater.
   D) That of Al is lower than that of Mg because the second electron taken from Al is in a p orbital, so it is easier to take away.
   E) The second ionization energies are equal for Al and Mg.

Answers: