

## Ch 12 Practice MC Problems

- Which of the following frequencies corresponds to light with the longest wavelength?
  - $3.00 \times 10^{13} \text{ s}^{-1}$
  - $4.12 \times 10^5 \text{ s}^{-1}$
  - $8.50 \times 10^{20} \text{ s}^{-1}$
  - $9.12 \times 10^{12} \text{ s}^{-1}$
  - $3.20 \times 10^9 \text{ s}^{-1}$
- From the following list of observations, choose the one that most clearly supports the conclusion that electromagnetic radiation has wave characteristics.
  - the emission spectrum of hydrogen
  - the photoelectric effect
  - the scattering of alpha particles by metal foil
  - diffraction
  - cathode "rays"
- Light has a wavelength of  $6.0 \times 10^2 \text{ nm}$ . What is the energy of a photon of this light?
  - $1.10 \times 10^{-19} \text{ J}$
  - $3.31 \times 10^{-19} \text{ J}$
  - $2.71 \times 10^{18} \text{ J}$
  - $3.68 \times 10^{-20} \text{ J}$
  - $1.33 \times 10^{-18} \text{ J}$
- What is the wavelength, in nanometers, of a photon of light whose frequency is  $5.86 \times 10^{14} \text{ Hz}$ ?
  - $1.95 \times 10^2 \text{ nm}$
  - $5.12 \times 10^2 \text{ nm}$
  - $3.39 \times 10^2 \text{ nm}$
  - $2.95 \times 10^2 \text{ nm}$
  - $1.29 \times 10^{-7} \text{ nm}$
- Consider an atom traveling at 1% of the speed of light. The de Broglie wavelength is found to be  $3.31 \times 10^{-3} \text{ pm}$ . Which element is this?
  - He
  - Ca
  - F
  - Be
  - P
- From the following list of observations, choose the one that most clearly supports the conclusion that electrons in atoms have quantized energies.
  - the emission spectrum of hydrogen
  - the photoelectric effect
  - the scattering of alpha particles by metal foil
  - diffraction
  - 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  $\text{Li}^{2+}$  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  $Z_{\text{eff}}$ ?
- 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)  $\text{Br}^-$
  - E)  $\text{Zn}^{2+}$
23. What is the electron configuration for the barium atom?
- A)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
  - B)  $[\text{Xe}] 6s^2$
  - C)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
  - D)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
  - E) none of these
24. What is the electron configuration of the element with atomic number 113?
- A)  $[\text{Rn}] 7s^2 7f^{14} 7d^{10} 7p^1$
  - B)  $[\text{Rn}] 7s^2 5f^{14} 7d^{10} 7p^1$
  - C)  $[\text{Rn}] 7s^2 6d^{10} 7p^1$
  - D)  $[\text{Rn}] 7s^2 5f^{14} 6d^{10} 7p^1$
  - 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)  $3s^23p^4$
  - B)  $1s^22s^22p^63s^23p^4$
  - C)  $4s^24p^4$
  - D)  $1s^22s^22p^4$
  - 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  $Mg^{2+}$ .
  - 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.  $Na^{+} < Mg^{2+} < Al^{3+} < Si^{4+}$

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:

1. B    2. D    3. B    4. B    5. B    6. A    7. D    8. D    9. B    10. A    11. C    12. A  
13. C    14. D    15. C    16. C    17. A    18. A    19. B    20. D    21. E    22. A    23. B    24. D  
25. A    26. D    27. D    28. E    29. A    30. B    31. C    32. D    33. B    34. D    35. B