KEY

Electronic structure 1 practice problems

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Arrange the following in order of increasing energy: ultraviolet radiation, visible radiation, x-rays, and microwaves. 1) _____

A) x-rays < microwave < ultraviolet < visible
B) visible < ultraviolet < x-rays < microwave
C) x-ray < microwave < visible < ultraviolet
D) ultraviolet < x-rays < microwave < visible
E) microwave < visible < ultraviolet < x-rays

2) Frequency and wavelength of electromagnetic radiation are related by which equation? 2) _____

A) $\lambda = v/c$ B) $\lambda = c/v$ C) $\lambda = c \cdot v$ D) $c = \lambda/v$

3) Frequency, wavelength and energy of electromagnetic radiation are related by which equation? 3) _____

A) $E = hv$ B) $\lambda = hc/v$ C) $c = \lambda v$ D) $E = hc/\lambda$

4) What is the frequency of electromagnetic radiation in a vacuum if it has a wavelength of 441 nm? 4) _____

A) $4.95 \times 10^{-12}\ s^{-1}$
B) $6.81 \times 10^{5}\ s^{-1}$
C) $6.80 \times 10^{14}\ s^{-1}$
D) $2.02 \times 10^{-11}\ s^{-1}$

USE $\nu = \frac{c}{\lambda}$

5) What is the wavelength in nm of electromagnetic radiation that has a frequency $2.8 \times 10^{13}\ s^{-1}$? 5) _____

A) 299 nm B) 1.1×10^{4} nm C) 2.8×10^{4} nm D) 840 nm

$\lambda = \frac{c}{\nu}$

6) Light passing through a liquid at 25°C was measured to have a wavelength of 466 nm and a frequency of $6.20 \times 10^{14}\ s^{-1}$. What is the speed of the light in this liquid? 6) _____

A) 7.52×10^{-22} m/s
B) 2.89×10^{17} m/s
C) 2.89×10^{8} m/s
D) 1.33×10^{12} m/s

$c = \nu\lambda$

7) A television signal has a wavelength of 10.0 km. What is its frequency in kilohertz? 7) _____

A) 3.33×10^{-7} kHz
B) 3.33×10^{-2} kHz
C) 30.0 kHz
D) 3.00×10^{7} kHz

8) Determine the energy of a photon with a frequency of $5.8 \times 10^{15}\ s^{-1}$. 8) _____

A) 1.7×10^{-16} J B) 1.7×10^{24} J C) 5.2×10^{-8} J D) 3.8×10^{-18} J

9) Calculate the energy in kJ/mol of light with a frequency of $8.31 \times 10^{14}\ s^{-1}$. 9) _____

A) 6.63×10^{3} kJ/mol
B) 5.52×10^{-22} kJ/mol
C) 332 kJ/mol
D) 0.332 kJ/mol

10) The quantized relationship between the frequency and the energy of blackbody radiation was postulated by: 10) _____

A) Johann Balmer
B) Albert Einstein
C) Johannes Rydberg
D) Max Planck
E) George W. Bush

$E = h\nu = (6.626 \times 10^{-34}\ J \cdot s)(8.31 \times 10^{14}\ s^{-1})$

$E = 5.51 \times 10^{-19}\ J$

$1 \quad 5.51 \times 10^{-19}\ J \times \frac{kJ}{10^{3} J} \times \frac{6.022 \times 10^{23}}{mol} = 332\ kJ/mol$

11) Calculate the energy in kJ/mol of light with a wavelength of 381 nm. 11) _____

A) 6.63×10^3 kJ/mol
B) 5.52×10^{-19} kJ/mol
C) 0.332 kJ/mol
D) 314 kJ/mol

12) The photoelectric effect: 12) _____

A) describes the phenomenon of producing light by shining a beam of electrons by on a metal surface until it glows.
B) results in the ejection of electrons by light at high intensity.
C) was explained by Max Planck.
D) is the phenomenon that electrons will only be ejected from the surface of a metal by light that has some minimum brightness, no matter what the frequency.
E) is the phenomenon that electrons will only be ejected from the surface of a metal by light that has some minimum frequency, no matter how bright or how long you apply the light at a lower frequency.

13) The Rydberg equation gives us the mathematical relationship between: 13) _____

A) an explanation for the continuous range of energy values associated with atomic spectra
B) wavelength and frequency
C) electron energy levels and hydrogen spectral wavelengths
D) atomic numbers and the energy values associated with them

14) For the Bohr hydrogen atom, determine the energy corresponding to $n = 3$. 14) _____

A) -7.36×10^{-35} J
B) -2.420×10^{-19} J
C) -1.96×10^{-17} J
D) -7.26×10^{-19} J

15) What is the energy of the 656 nm spectral line of hydrogen, sometimes referred to as H-α? 15) _____

A) 3.03×10^{-19} J B) 1.45×10^{-48} J C) 1.30×10^{-22} J D) 4.35×10^{-31} J

$E = \frac{hc}{\lambda}$

16) When an electron goes from a high energy state to a lower one, what occurs? 16) _____

A) The atom moves faster.
B) Energy is given off.
C) Another electron goes from a lower energy state to a higher one to replace it.
D) This process does not occur.
E) The answer depends on whether the electron is a particle or a wave.

17) Calculate the wavelength of light emitted by an electron in hydrogen as it moves from $n = 6$ to $n = 3$. 17) _____

A) 1.65×10^{-11} m B) 8.22×10^{-7} m C) 3.28×10^{-6} m D) 1.09×10^{-6} m

RYDBERG EQ

18) What is the wavelength of the line in the Balmer series of hydrogen corresponding to the transition from $n = 5$? 18) _____

A) 434 nm B) 329 nm C) 304 nm D) 30.4 nm E) 535 nm

19) The fact that we cannot simultaneously measure the exact position of an electron and its momentum is referred to as: 19) _____

A) The DeBroglie Relationship
B) Pauli's Exclusion Principle
C) Heisenberg's Uncertainty Principle
D) The Aufbau Principle
E) Hund's Rule

$\lambda = \frac{h}{mv}$ "deBROGLIE WAVELENGTH"

($h = 6.626 \times 10^{-34}\ kg \cdot m^2 s^{-2} \cdot s$)

20) What is the wavelength of a 25.0 g baseball traveling at 40.2 m/s (90.0 miles per hour)? 20) _____

A) 1.07×10^{-30} m B) 6.59×10^{-34} m C) 4.12×10^{-37} m D) 6.59×10^{-37} m

21) Calculate the deBroglie wavelength of a falling rock that has a mass 125 grams and a velocity of 90.0 m/s. 21) _____

A) 1.7×10^{34} m B) 0.59 m C) 5.89×10^{-31} m D) 5.89×10^{-35} m

22) What is the wavelength in nanometers associated with an electron traveling at one one-hundredth the speed of light? 22) _____

A) 12.5 nm B) 243 nm C) 412 nm D) 0.242 nm

23) Which of the following is NOT true of a standing wave? 23) _____

A) Standing waves were considered by Schrödinger as he developed a mathematical model of electronic structure.

B) Standing waves do not travel through space.

C) Standing waves such as those on a string can only have certain wavelengths that correspond to 2L/n where L is the length of the string and n = 1,2,3....

D) Standing waves do not have nodes. OF COURSE, THEY DO

24) All of the terms below are quantum numbers EXCEPT: 24) _____

A) principal B) spin C) magnetic D) valence E) azimuthal

25) What is the subshell designation for the quantum numbers $n = 2, l = 1$? 25) _____

A) 2*p* B) 2*d* C) 3*p* D) 2*s* E) 3*s*

26) Which of the following subshell designations does not exist? 26) _____

A) 4*d* B) 4*f* C) 5*f* D) 4*d* E) 3*f*

27) What is the smallest acceptable value for the missing quantum number? 27) _____

$n = ?\ \ell = 2, m_\ell = 0, m_S = +1/2$

A) −2 B) 4 C) 1 D) 3 E) 2

$n=3\ \ell=3$ ← NO!

28) What is an acceptable value for the missing quantum number? 28) _____

$n = 4, \ell = 2, m_\ell = 0, m_S = ?$

A) 3/2 B) 1 C) 0 D) 1/2 E) 2

→ OR $-\frac{1}{2}$

29) The possible values of the magnetic quantum number of a 3*p* electron are: 29) _____

A) 0, 1, 2

B) −1, 0, +1

C) 1, 2, 3

D) +1/2, −1/2

E) −2,−1, 0, +1, +2

30) The possible values of *n* if $\ell = 3$ are: 30) _____

A) 4, 5, 6.... B) 0, 1, 2.... C) −1, 0, +1 D) 3, 4, 5.... E) 0

31) _____ orbitals do not have a particular orientation in the xyz coordinate system. 31) _____

A) *f* B) *d* C) *p* D) *s*

→ SPHERICAL

32) Which one of the following set of quantum numbers is not observed? 32) _____

A) $n = 3, \ell = 0, m_\ell = 0$

B) $n = 3, \ell = 2, m_\ell = -1$

C) $n = 3, \ell = 1, m_\ell = -1$

D) $n = 3, \ell = 3, m_\ell = 1$ ← $n \neq \ell$

E) $n = 3, \ell = 2, m_\ell = 1$

33) What are the values of n and ℓ for 3p electrons. 33) _____

A) $n = 3, \ell =$ p

B) $n = 3, \ell = 1$

C) $n = 1, \ell = 3$

D) $n = 3, \ell = 0$

E) $n = 3, \ell = 2$

34) The possible value(s) of the magnetic quantum number of a 3s electron are: 34) _____

A) 2, 1, 0, −1, −2

B) 1, 2, 3

C) 0, 1, 2

D) −1, 0, +1

E) 0

35) Which of the following statements about electron spin is incorrect? 35) _____

A) The value of the spin quantum number does not depend on the other three quantum numbers.

B) m_S is the symbol for the spin quantum number.

C) The value of the spin quantum number can be +1/2 or −1/2.

D) electrons follow classical mechanics as they spin, producing an angular momentum and a magnetic field.

36) Placing electrons into orbitals one by one from low energy to high energy is one way of describing: 36) _____

A) the Pauli exclusion Principle

B) Hund's Rule

C) the Aufbau principle

D) Rydberg's Principle

E) tedious work

37) The principle that is based on electrons attempting to be as far apart as possible is: 37) _____

A) Bohr Theory

B) the Aufbau principle

C) the Pauli exclusion principle

D) Hund's Rule

E) Bohr-ing

38) The fact that the electron configuration of nitrogen in the ground state is $1s^2 2s^2 (2p_x^1 2p_y^1 2p_z^1)$ is an illustration of: 38) _____

A) Hund's Rule

B) the Heisenberg Uncertainty Principle

C) the Aufbau Principle

D) the Bohr Theory

E) the Pauli Exclusion Principle

39) Which series of subshells is arranged in order of increasing energy in a polyelectronic atom? 39) _____

A) 6*s*, 6*p*, 5*d*, 4*s* B) 4*f*, 5*d*, 6*s*, 6*p* C) 4*f*, 6*s*, 5*d*, 6*p* D) 6*s*, 4*f*, 5*d*, 6*p*

40) Chlorine has the electronic configuration: 40) _____

A) $1s^22s^22p^62d^53s^2$ B) $1s^22s^22p^63s^23p^5$

C) $1s^22s^22p^63s^23d^5$ D) $1s^22s^22d^{10}3s^2$

41) The ground state electron configuration of Sc is: 41) _____

A) $1s^22s^22p^63s^23p^64s^23d^1$ B) $1s^22s^22p^62d^{10}3s^1$

C) $1s^21p^62s^22p^63d^5$ D) $1s^22s^22p^63s^23p^63d^3$

42) The electron configuration of phosphorus is: 42) _____

A) $1s^22s^22p^43p^63d^1$ B) [Ar] $3s^23p^3$

C) $1s^22s^22p^63s^43p^1$ D) $1s^22s^22p^63s^23p^3$

43) Which of the following elements has the ground state electronic configuration of: 43) _____

$1s^22s^22p^63s^23p^64s^23d^3$

A) chromium B) vanadium C) niobium D) scandium

44) Which of the following elements has the ground state electronic configuration of: $[Kr]5s^24d^{10}5p^5$ 44) _____

A) Te B) At C) Br D) I

45) The correct electron configuration for Br^- is: 45) _____

A) [Br] $4p^6$ B) [Ar] $3d^{10}4s^24p^5$

C) [Ar] $4s^23d^{10}4p^6$ D) [Ar] $3d^{10}4s^24p^6$

46) The quantum numbers of the last ground state electron to be placed in arsenic could be: 46) _____

A) $n = 3, \ell = 1, m_\ell = 1, m_S = 1/2$ B) $n = 4, \ell = 1, m_\ell = 1, m_S = 1/2$

C) $n = 4, \ell = 3, m_\ell = 1, m_S = 1/2$ D) $n = 4, \ell = 2, m_\ell = 1, m_S = 1/2$

47) The quantum numbers of the last electron to be placed in nickel could be: 47) _____

A) $n = 3, \ell = 2, m_\ell = 0, m_S = 0$ B) $n = 3, \ell = 2, m_\ell = 0, m_S = 1/2$

C) $n = 3, \ell = 1, m_\ell = 0, m_S = 1/2$ D) $n = 3, \ell = 2, m_\ell = 1/2, m_S = 1/2$

48) Exceptions to _____ include chromium and copper in the 1st row of the transition metals. 48) _____

A) the Heisenberg Principle B) Hund's Rule

C) the Pauli Exclusion Principle D) the Aufbau Principle

49) According to quantum mechanics, an atomic orbital can be described as: 49) _____

A) the hard spherical shell of electrons in an atom

B) a fixed path that an electron follows around the nucleus of an atom

C) elliptical-shaped orbits similar to those taken by comets

D) the region of high probability of finding an electron around the nucleus

50) Which of the following orbitals have lobes aligned along the x-axis? 50) _____

A) d_{xy} B) d_{xz} C) s D) p_x E) d_{yz}

51) Which of the following orbitals does NOT have lobes aligned along the y-axis? 51) _____

A) d_{xy}
B) p_y
C) d_{x2-y2}
D) All are aligned along the y-axis.

52) Which pair of orbitals are located between the axes of the xyz coordinate system and not along the axes? 52) _____

A) d_{xy}, d_{z^2}
B) d_{xy}, p_y
C) d_{yz}, p_x
D) d_{xy}, d_{yz}
E) $d_{x^2-y^2}$, p_z

53) Which of the following best describes the orbital shown here: 53) _____

A) d_{z2}
B) d_{xy}
C) $d_{x^2-y^2}$
D) d_{yz}

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

54) The symbol "n" in the Bohr model of atomic structure refers to the number of electrons in the element. 54) F

55) The symbol "n" in the Bohr model of atomic structure refers to the energy level that an electron can occupy. 55) T

56) The Bohr model of atomic structure works well with polyelectronic elements as long as you make some slight modifications to account for electron-electron repulsions. 56) F

57) When an electron goes from a high energy state to a lower one, an X-ray might be given off. 57) T

58) When an electron goes from a high energy state to a lower one, a γ-ray might be given off. 58) F

59) The probability of finding a particle with n = 1, exactly in the center of a one-dimensional box is zero (a node). 59) F

60) The probability of finding a particle with n = 2, exactly in the center of a one-dimensional box is zero (a node). 60) T

61) The probability of finding a particle with n = 3, exactly in the center of a one-dimensional box is zero (a node). 61) F