Review for Chapter 3: Atoms, Electrons and Periodic Trends

Terms: atomic emission (bright line) spectrum, quantum, ground (stationary) state, atom, atomic number, mass number, isotope, average atomic mass, ion, cation, anion, orbital, Pauli Exclusion principle, Hund's rule, aufbau principle, principal quantum number, orbital shape (angular momentum) quantum number, magnetic quantum number, magnetic spin quantum number, shielding effect, net nuclear attraction (Z_{eff}), atomic radius, first ionization energy, electronegativity, electron affinity, second ionization energy, Alkali metals, Alkaline Earth metals, Halogens, Noble gases, inner transition elements, transition elements

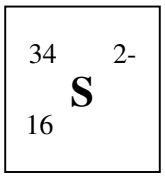
Text review questions: p. 159 – 161: 1 – 4, 6, 7, 8, 9, 13, 14, 15, 16a,b,c,d,e,h,i,j, 20, 21

Practice multiple choice questions:

1. The value of Z for a neutral atom of the most common isotope of manganese is:

a) 25
b) 54.94
c) 55
d) s^2p^5

2. Which of the following statements are true about the atom:



I) it contains 34 protons
II) it contains 18 neutrons
III) it contains 16 electrons
IV) it is an isotope of S – 32

a) I and II
b) II and III
c) I, II, and III
d) II and IV

3. A mythical element galtium (Gm) has four isotopes: Gm-65, Gm-67, Gm-68 and Gm-70. The average atomic mass of Gm is 69.63 amu. Which isotope is most prevalent (abundant)?

a) Gm-65
b) Gm-68
c) Gm-67
d) Gm-70

4. Which of the following is/are isoelectronic with a Ca^{2+} ion?

a) K^{1+}
b) Ar
c) P^{3-}
d) all of the above

5. Which researcher discovered that a quantum is equivalent to a particle of light (a photon)?

a) Louis de Broglie
b) Max Planck
c) Albert Einstein
d) Erwin Schrodinger

6. Which atomic model(s) take into account the wave-like properties of electrons?

I) Thomson's raisin-bun model
II) Rutherford's electron cloud model
III) Bohr's planetary model
IV) the quantum mechanical model

a) IV only
b) III and IV
c) II and III
d) II, III, and IV

7. Which scientist first postulated (suggested) a nuclear atom?

a) Rutherford
b) Dalton
c) Bohr
d) Thomson

8. Which experiment was instrumental in the discovery that an atom is mostly empty space?
a) the cathode ray tube
b) the gold foil experiment
c) the light spectrum of hydrogen
d) the atomic absorption of hydrogen

9. Which observation indicated that Rutherford's model of the atom was too simple?
a) atoms combine in simple, whole number ratios to form compounds
b) when alpha particles hit gold foil, about 1 in every 8000 particles bounce back
c) a cathode ray gives off a beam of negatively charged particles called electrons
d) the atomic emission spectra of hydrogen shows several distinct coloured lines

10. The energy of a photon is proportional to which of the following?
a) its momentum
b) its velocity
c) its amplitude
d) its wavelength

11. In modern chemical theory, an **occupied orbital** is pictured to be:
a) a precise, predictable spherical or dumbbell-shaped route traced by the electron in its rapid movement
b) a 3–D region having a precise shape, which is completely filled by a dense electron cloud
c) a 3–D region in space in which the probability of finding an electron is greater than 95%
d) a precise, predictable pathway, outside the nucleus, followed by an electron

12. Which of the following is true about an orbital's boundary?
a) an electron can not go past an orbital's boundary
b) an electron spends more than 95% of its time travelling along the orbital's boundary
c) an electron spends more than 95% of its time travelling within the orbital's boundary
d) an electron spends more than 95% of its time travelling outside the orbital's boundary

13. Hund's Rule states that:
a) we can never know both the location and momentum (motion) of an electron
b) an orbital can hold a maximum of two electrons with opposite spin
c) electrons will occupy the lowest energy level available to them
d) electrons do not pair up until all orbitals in a sub-level are half full

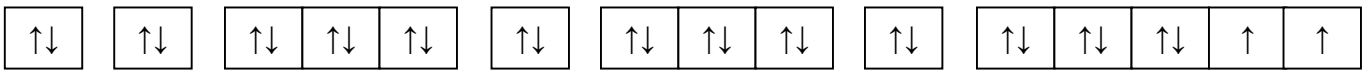
14. No more than two electrons can occupy an orbital. This is a consequence of:
a) Hund's Rule
b) Pauli Exclusion principle
c) Heisenberg's Uncertainty principle
d) aufbau principle

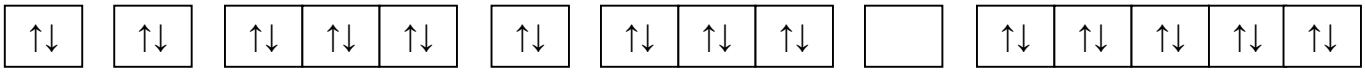
15. Which rule or principle states that an electron will occupy the lowest available energy level?
a) Hund's Rule
b) Pauli Exclusion principle
c) Heisenberg's Uncertainty principle
d) aufbau principle

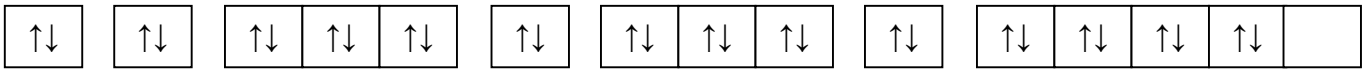
16. Which quantum number governs (indicates) the energy of an electron?
a) n
b) m
c) l
d) m_l

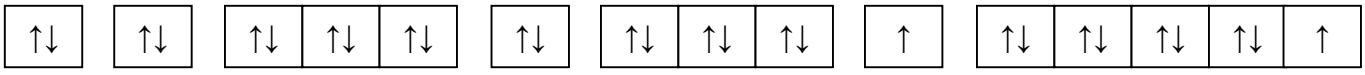
17. What does the magnetic quantum number, m_l, describe?
a) the average distance of the electron from the nucleus
b) the three dimensional orientation of the electron in space
c) the shape of the orbital
d) the direction of spin of the electron

18. Which of the following is the correct orbital box diagram for a neutral, ground state nickel atom?

a) 

b) 

c) 

d) 

19. What is the range of allowed values for n?
a) 0, 1, 2, 3 … infinity
b) 1, 2, 3 … infinity
c) – 3, –2, –1, 0, +1, +2, +3
d) + ½ or – ½

20. The value of the orbital shape quantum number that represents an "s" orbital is:
a) 0
b) 1
c) 2
d) + ½ or – ½

21. What are the allowed values for the orbital shape quantum number?
a) 0, 1, 2 … $(n - 1)$
b) 1, 2 … $(n - 1)$
c) 0, 1, 2….n
d) $-n$ … –3, –2, –1, 0, +1, +2, +3 … $+n$

22. When $l = 3$, the allowed values for m_l are:
a) 0
b) –1, 0, +1
c) –2, –1, 0, +1, +2
d) –3, –2, –1, 0, +1, +2, +3

23. When $n = 2$, the allowed values for l are:
a) 0
b) 0 or 1
c) 0, 1 or 2
d) –1, 0, +1

24. The allowed value(s) for the magnetic spin quantum number when $n = 3$, $l = 0$ is/are:
a) 0
b) 0 or 1
c) 0, 1 or 2
d) + ½ or – ½

25. What are the numerical limits (allowed values) for the magnetic quantum number?
a) 0, 1, 2, 3 … l
b) 1, 2, 3 … l
c) $-l$ … 0 … $+l$
d) + ½ or – ½

26. Which orbital has the quantum numbers $n = 4$, $l = 2$, $m_l = +1$?
a) 4s
b) 4p
c) 4d
d) 4f

27. How many orbitals can have the quantum numbers $n = 3$ and $l = 2$?
a) 1
b) 3
c) 5
d) 7

28. The maximum number of electrons that can have the quantum levels $n = 2$ and $l = 1$:
a) 2
b) 3
c) 6
d) 8

29. Which of the following orbitals can have a magnetic quantum number of +2?
a) 2s
b) 2p
c) 3p
d) 3d

30. The last electron of a neutral phosphorus atom would have the quantum numbers:
a) n = 3, l = 1 and m_l = +1
b) n = 3, l = 2 and m_l = 0
c) n = 4, l = 1 and m_l = –1
d) n = 3, l = 2 and m_l = +1

31. A $4p^1$ (↑) electron would be given the quantum numbers:
a) n = 4, l = 1, m_l = –1 and m_s = + ½
b) n = 4, l = 1, m_l = 0 and m_s = – ½
c) n = 3, l = –1, m_l = +1 and m_s = – ½
d) n = 4, l = 2, m_l = –1 and m_s = + ½

32. A $2s^2$ (↓) electron would be given the quantum numbers:
a) n = 2, l = 1, m_l = 0 and m_s = + ½
b) n = 2, l = 0, m_l = 0 and m_s = – ½
c) n = 2, l = –1, m_l = 0 and m_s = – ½
d) n = 2, l = 0, m_l = 1 and m_s = + ½

33. Which of the following combinations of quantum numbers is **impossible**?
a) n = 3, l = 2, m_l = 0 and m_s = – ½
b) n = 2, l = 2, m_l = 0 and m_s = – ½
c) n = 1, l = 0, m_l = 0 and m_s = – ½
d) n = 2, l = 1, m_l = +1 and m_s = – ½

34. Which of the following orbitals does **not** exist?
a) 1s
b) 2p
c) 2d
d) 3p

35. Which of the following sub-levels of an atom is shielded most from the nucleus?
a) 3s
b) 3p
c) 3d
d) all are equally shielded

36. The maximum number of electrons in the second principle quantum level is:
a) 2
b) 6
c) 8
d) 18

37. How many electrons can be designated (named) 3d?
a) 3
b) 6
c) 8
d) 10

38. How many orbitals are there **with the same energy** in the 4f sub-level?
a) 1
b) 5
c) 7
d) 14

39. How many electron-containing orbitals, in total, does a neutral strontium atom have in its ground state?
a) 38
b) 19
c) 18
d) 5

40. Which sub-level has 3 orbitals with the same amount of energy?
a) s
b) p
c) d
d) f

41. Which of the following electron configurations shows an atom in an **excited** state?
a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6 5s^2\ 5d^1$
b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6$
c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^3$
d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2$

42. Which of the following electron configurations shows an atom in its **ground** state?

a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4p^3$
b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^7$
c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 5p^2$
d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6$

Answer questions 43 – 45 for the following electron configurations:

I $1s^2\ 2s^2\ 2p^6 3s^2$
II $1s^2\ 2s^2\ 2p^6$
III $1s^2\ 2s^2\ 2p^6\ 3s^1$
IV $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^8$
V $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6$

43. Referring to the electron configurations above, which ones represent elements of the same group?

a) IV and V
b) II and V
c) I and IV
d) II and III

44. Referring to the electron configurations above, which is/are transition elements?

a) I and II
b) I and III
c) IV
d) II and V

45. Referring to the electron configurations above, which are found in the third period?

a) I and II
b) I and III
c) IV and V
d) I, III, IV and V

46. What is the ground state electron configuration for the atom: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4p^2$?

a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^2$
b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 5s^2$
c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4$
d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4p^2$

47. The correct (actual) electron configuration for a neutral, ground state atom of silver is:

a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}$
b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^9$
c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^1\ 4d^{10}$
d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 4d^{11}$

48. What is the condensed electron configuration for a ground state sulfide ion, S^{2-} ?

a) [Ar]
b) [Ne] $3s^2\ 3p^4$
c) [Ne] $3s^2\ 3d^2\ 3p^4$
d) [Ne] $3s^2\ 3p^6$

49. Which of the following can be used to measure the radius of a carbon atom?

a) C – C
b) C = C
c) C ≡ C
d) any of these bonding arrangements can be used

50. Which of the following will have the smallest ionic radius?

a) Si^{4+}
b) Si
c) Si^{4-}
d) Na^{1+}

51. Which of the following electron configurations represents a non-metal?

a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
b) $1s^2 2s^2 2p^6 3s^2 3p^5$
c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{11}$

52. Which of the following atoms has the highest electronegativity?

a) Ar
b) Mg
c) Ca
d) P

53. Which of the following statements is **incorrect**?

a) electronegativity decreases down an group
b) atomic radius increases down a group
c) atomic radius increases left to right across a period
d) first ionization energy decreases down a group

54. The ionization energies for an unknown element are:

$IE_1 = 5.4$ eV $IE_2 = 8.4$ eV $IE_3 = 15.7$ eV $IE_4 = 85.4$ eV $IE_5 = 98.6$ eV

Which is the most probable electron configuration for a neutral atom of this element?

a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
b) $1s^2 2s^2 2p^6 3s^2 3p^6$
c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
d) $1s^2 2s^2 2p^6 3s^2 3p^1$

55. An element has the ionization energies (eV) shown below:

IE_1	IE_2	IE_3	IE_4	IE_5	IE_6	IE_7	IE_8
17.4	35.0	62.6	87.2	114.2	157.1	185.1	953.8

This atom is probably:

a) nitrogen
b) oxygen
c) fluorine
d) neon

56. Which of the following statements is **true**?

a) as electronegativity increases, ionization energy also increases
b) as electronegativity increases, atomic radius also increases
c) as net nuclear attraction increases, atomic radius also increases
d) none of the above statements is true

57. Which of the following explains why atomic radius decreases from left to right across a period?

I) increasing shielding effect
II) decreasing shielding effect
III) increasing Z_{eff}
IV) decreasing Z_{eff}

a) I and III
b) II and III
c) II and IV
d) III only

58. Which of the following explains why the reactivity of metals increases down a group?

I) increasing shielding effect
II) decreasing shielding effect
III) increasing Z_{eff}
IV) decreasing Z_{eff}

a) I only
b) I and III
c) IV only
d) I and IV

59. Which of the following is usually a property of the main group metals?

a) high electronegativity
b) large, positive electron affinity
c) high first ionization energy
d) ions that have a radius larger than their neutral atom

60. The metals Li, Na, K and Rb represent:

a) a period
b) a group
c) an octave
d) a heavy metal band

61. The "f" block of elements is also known as:
a) the Alkaline Earth metals
b) the coinage metals
c) the transition elements
d) the inner transition elements

62. The value of A for a neutral atom of the most common isotope of scandium is:
a) 21
b) 44.96
c) 45
d) 3+

63. Which of the following statement(s) is true when comparing infrared and ultraviolet light?
I. ultraviolet has a longer wavelength
II. ultraviolet travels faster in a vacuum
III. ultraviolet has higher energy

a) I only
b) I and III
c) III only
d) I, II and III

64. The magnitude of an atom's first ionization energy depends on:
a) shielding effect
b) net nuclear attraction
c) whether it is removing an electron from a full or half-full sub-level (set of orbitals)
d) all of the above

65. Which of the following elements would have the largest, most negative electron affinity?
a) Sc
b) Cr
c) Se
d) Kr

66. What is the identity of the unknown element, X, if its **ion** has the following electron configuration:
X^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$
a) Ba
b) Te
c) Xe
d) Sn

Answers to multiple choice questions for Chapter 3:

1. a	11. c	21. a	31. a	41. a	51. b	61. d
2. d	12. c	22. d	32. b	42. d	52. d	62. c
3. d	13. d	23. b	33. b	43. b	53. c	63. c
4. d	14. b	24. d	34. c	44. c	54. d	64. d
5. c	15. d	25. c	35. c	45. b	55. c	65. c
6. a	16. a	26. c	36. c	46. a	56. a	66. a
7. a	17. b	27. c	37. d	47. c	57. d	
8. b	18. a	28. c	38. c	48. d	58. a	
9. d	19. b	29. d	39. b	49. a	59. b	
10. d	20. a	30. a	40. b	50. a	60. b	