ATOMIC STRUCTURE

Set 4

1. Dalton's atomic theory could NOT explain:
a) Law of conservation of mass
b) Law of constant composition
c) Law of multiple proportion
d) The phenomenon of electricity

2. The charge on the particles in canal rays depends on:
a) The nature of the gas
b) The material of the cathode
c) The voltage applied
d) The size of the tube

3. The specific charge (e/m) of a proton is _____ that of an electron.
a) Greater than
b) Less than
c) Equal to
d) Sometimes greater, sometimes less

4. The neutron is:
a) Positively charged
b) Negatively charged
c) Neutral
d) Both positive and negative

5. In Rutherford's nuclear model, the electrons:
a) Are stationary
b) Revolve around the nucleus
c) Are embedded in the nucleus
d) Are outside the nucleus but not moving

6. The ratio of the atomic radius to the nuclear radius is about:

a) 10
b) 10^2
c) 10^5
d) 10^{10}

7. The number of electrons in an ion with 16 protons and a charge of -2 is:
a) 14
b) 16
c) 18
d) 20

8. Which of the following pairs are isobars?
a) ^1H and ^2H
b) ^{14}C and ^{14}N
c) ^{16}O and ^{18}O
d) ^{23}Na and ^{24}Mg

9. All isotopes of an element have the same:
a) Mass number
b) Number of neutrons
c) Atomic number
d) Atomic mass

10. The major problem with Rutherford's model concerning atomic stability was resolved by:
a) Introducing quantized orbits
b) Introducing a positive nucleus
c) Introducing neutrons
d) Introducing wave nature

11. The energy of a quantum of radiation is:
a) Inversely proportional to its frequency
b) Directly proportional to its wavelength
c) Directly proportional to its frequency

d) Independent of frequency

12. A black body is:
a) A perfect absorber and emitter of radiation
b) A body that appears black
c) A body that reflects all radiation
d) A body at 0 K

13. In the photoelectric effect, the number of ejected electrons is proportional to the:
a) Frequency of light
b) Wavelength of light
c) Intensity of light
d) Work function

14. The kinetic energy of photoelectrons increases with:
a) Increase in wavelength
b) Decrease in frequency
c) Increase in intensity
d) Increase in frequency

15. The line spectrum of hydrogen demonstrates that energy is:
a) Continuous
b) Quantized
c) Wave-like
d) Not conserved

16. The wavelength of the first line in the Balmer series is:
a) 656.3 nm
b) 486.1 nm
c) 434.0 nm
d) 410.2 nm

17. The energy of an electron in the first excited state (n=2) of hydrogen is:

a) -2.18×10^{-18} J
b) -1.09×10^{-18} J
c) -5.45×10^{-19} J
d) -2.42×10^{-19} J

18. The radius of the Bohr orbit is proportional to:
a) n
b) n^2
c) 1/n
d) $1/n^2$

19. The energy of an electron in a hydrogen-like ion (He^+) in the ground state is:
a) -2.18×10^{-18} J
b) -4.36×10^{-18} J
c) -8.72×10^{-18} J
d) -1.09×10^{-18} J

20. The de Broglie wavelength of a ball of mass 100g moving at 100 m/s is:
a) 6.626×10^{-34} m
b) 6.626×10^{-35} m
c) 6.626×10^{-36} m
d) 6.626×10^{-32} m

21. The Heisenberg Uncertainty Principle is negligible for:
a) Electrons
b) Protons
c) Macroscopic objects
d) Atomic nuclei

22. The Schrödinger wave equation is a:
a) Simple algebraic equation
b) Differential equation
c) Trigonometric equation

d) Vector equation

23. The probability density (ψ^2) is always:
a) Positive
b) Negative
c) Zero
d) Complex

24. For l=3, the subshell is:
a) s
b) p
c) d
d) f

25. The number of orbitals with n=3 and l=1 is:
a) 1
b) 3
c) 5
d) 7

26. The maximum number of electrons that can be accommodated in all the orbitals with n=2 and l=1 is:
a) 2
b) 6
c) 8
d) 10

27. The correct set of quantum numbers for an electron in a 2p orbital is:
a) n=2, l=1, m_l=0, m_s=+1/2
b) n=2, l=0, m_l=0, m_s=+1/2
c) n=2, l=1, m_l=2, m_s=+1/2
d) n=2, l=1, m_l=-1, m_s=0

28. The electronic configuration of Titanium (Z=22) is:

a) [Ar] $4s^2\ 3d^2$
b) [Ar] $4s^2\ 3d^{10}$
c) [Ar] $4s^1\ 3d^3$
d) [Ar] $4s^2\ 4p^2$

29. The element with the configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$ is:
a) Vanadium (V)
b) Chromium (Cr)
c) Manganese (Mn)
d) Iron (Fe)

30. Which of the following has the highest number of unpaired electrons?
a) Fe^{2+}
b) Fe^{3+}
c) Co^{2+}
d) Ni^{2+}

31. The total number of electrons that can be accommodated in the f subshell is:
a) 2
b) 6
c) 10
d) 14

32. The number of angular nodes for a d orbital is:
a) 0
b) 1
c) 2
d) 3

33. The number of radial nodes for a 3s orbital is:
a) 0
b) 1
c) 2

d) 3

34. The electronic configuration of Cu^{+} ion is:
a) [Ar] $4s^1$ $3d^9$
b) [Ar] $4s^2$ $3d^9$
c) [Ar] $3d^{10}$
d) [Ar] $4s^2$ $3d^8$

35. The pair of ions with the same electronic configuration is:
a) Na^{+}, Mg^{2+}
b) K^{+}, Cl^{-}
c) Ca^{2+}, S^{2-}
d) Al^{3+}, O^{2-}

36. The wavelength of a photon with energy 3.3×10^{-19} J is:
a) 600 nm
b) 500 nm
c) 400 nm
d) 300 nm

37. The frequency of light required to eject an electron with kinetic energy 4.2×10^{-19} J from a metal with work function 3.0×10^{-19} J is:
a) 1.74×10^{15} Hz
b) 1.09×10^{15} Hz
c) 7.24×10^{14} Hz
d) 5.43×10^{14} Hz

38. The maximum number of electrons that can have the quantum number n=3, l=0 is:
a) 2
b) 6
c) 10
d) 14

39. The orbital with zero angular momentum is:
a) s orbital
b) p orbital
c) d orbital
d) f orbital

40. The number of unpaired electrons in Ni^{2+} (Z=28) is:
a) 0
b) 2
c) 4
d) 6

41. The correct order of increasing energy of orbitals for multi-electron atoms is:
a) 3s < 3p < 3d < 4s
b) 3s < 3p < 4s < 3d
c) 3s < 4s < 3p < 3d
d) 4s < 3s < 3p < 3d

42. The element with the configuration $[Xe]4f^{14}5d^{10}6s^{2}6p^{3}$ is:
a) Bismuth (Bi)
b) Lead (Pb)
c) Polonium (Po)
d) Astatine (At)

43. The number of electrons with l=1 in a nitrogen atom is:
a) 2
b) 3
c) 5
d) 7

44. The ratio of the radii of the first three Bohr orbits is:
a) 1:2:3
b) 1:4:9

c) 1:8:27
d) 1:1/2:1/3

45. The velocity of an electron in the first Bohr orbit of hydrogen is:
a) c/137
b) 137c
c) c/100
d) 100c

46. The ionization energy of a hydrogen atom in its ground state is:
a) 2.18×10^{-18} J
b) 1.09×10^{-18} J
c) 13.6 eV
d) 3.4 eV

47. The number of waves made by an electron in one complete revolution in the n=3 Bohr orbit is:
a) 1
b) 2
c) 3
d) 4

48. The magnetic quantum number specifies the:
a) Energy of the orbital
b) Shape of the orbital
c) Orientation of the orbital
d) Spin of the electron

49. The energy of an orbital depends on 'n' and 'l' for:
a) Hydrogen atom
b) Hydrogen-like ions
c) Multi-electron atoms
d) All atoms

50. The electronic configuration that violates the Aufbau principle is:
a) $1s^2 2s^2 2p^6 3s^2$
b) $1s^2 2s^2 2p^6 3s^1 3p^1$
c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

Answer Key: Set 4

1. d) The phenomenon of electricity
2. a) The nature of the gas
3. b) Less than (because mass of proton is larger)
4. c) Neutral
5. b) Revolve around the nucleus
6. c) 10^5
7. c) 18 (16 protons + 2 extra electrons)
8. b) ^{14}C and ^{14}N
9. c) Atomic number
10. a) Introducing quantized orbits
11. c) Directly proportional to its frequency
12. a) A perfect absorber and emitter of radiation
13. c) Intensity of light
14. d) Increase in frequency
15. b) Quantized
16. a) 656.3 nm
17. c) -5.45×10^{-19} J ($E_2 = -R_H/4$)
18. b) n^2
19. c) -8.72×10^{-18} J ($E = -R_H * Z^2/n^2$, for He^+, Z=2, n=1)
20. b) 6.626×10^{-35} m ($\lambda = h/mv$)
21. c) Macroscopic objects
22. b) Differential equation
23. a) Positive
24. d) f
25. b) 3 (For any p subshell (l=1), $m_l = -1, 0, +1$)
26. b) 6 (3 orbitals * 2 electrons each)
27. a) n=2, l=1, m_l=0, m_s=+1/2
28. a) [Ar] $4s^2$ $3d^2$

29. a) Vanadium (V) (Z=23)
30. b) Fe^{3+} ([Ar] $3d^5$ - 5 unpaired electrons)
31. d) 14 (7 orbitals * 2 electrons)
32. c) 2 (Number of angular nodes = l)
33. c) 2 (Number of radial nodes = n - l - 1 = 3 - 0 - 1)
34. c) [Ar] $3d^{10}$ (Cu is [Ar] $4s^1$ $3d^{10}$, Cu^+ loses the 4s electron)
35. b) K^+, Cl^- (Both have 18 electrons: [Ar])
36. a) 600 nm (E = hc/λ, calculate λ)
37. a) 1.74×10^{15} Hz (Use hv = K.E. + W_0)
38. a) 2 (n=3, l=0 is the 3s orbital)
39. a) s orbital (l=0)
40. b) 2 (Ni is [Ar] $4s^2$ $3d^8$, Ni^{2+} is [Ar] $3d^8$ → 2 unpaired electrons)
41. b) 3s < 3p < 4s < 3d
42. a) Bismuth (Bi) (Z=83)
43. b) 3 (Electrons in p orbitals: $2p^3$)
44. b) 1:4:9 ($r_n \propto n^2$)
45. a) c/137 (≈ 1/137 of the speed of light)
46. c) 13.6 eV ($|E_1|$ = 2.18×10^{-18} J / 1.6×10^{-19} J/eV)
47. c) 3 (de Broglie's condition for stationary orbits: circumference = nλ)
48. c) Orientation of the orbital
49. c) Multi-electron atoms
50. b) $1s^2 2s^2 2p^6 3s^1 3p^1$ (The 3p orbital is filled before the 3s orbital is fully occupied, violating Aufbau)