29. (c) Proton is represented by p having charge +1 discovered in 1988 by Goldstein.

31. (b) The nature of anode rays depends upon the nature of residual gas.

32. (d) H^+ (proton) will have very large hydration energy due to its very small ionic size

Hydration energy $\propto \frac{1}{\text{Size}}$

33. (b) Mass of a proton $= 1.673 \times 10^{-24}\ g$

$\therefore$ Mass of one mole of proton

$= 9.1 \times 10^{-24} \times 6.02 \times 10^{23} = 10.07 \times 10^{-1} = 1.008\ g$

Mass of a electron $= 9.1 \times 10^{-28}\ g$

$\therefore$ Mass of one mole of electron

$= 9.1 \times 10^{-28} \times 6.02 \times 10^{23} = 54.78 \times 10^{-5}\ g = 0.55\ mg$.

35. (c) One mole of electron = 6.023×10^{23} electron

Mass of one electron = 9.1×10^{-28} *gm*

Mass of one mole of electrons

$= 6.023 \times 10^{23} \times 9.1 \times 10^{-28}\ gm = 5.48 \times 10^{-4}\ gm$

$= 5.48 \times 10^{-4} \times 1000\ mg = 0.548\ gm \approx 0.55\ mg$.

36. (a) Charge on proton $= +1$ unit, charge on α particle = + 2 units, 2 : 1.

37. (b) $m_p / m_e \simeq 1837 \simeq 1.8 \times 10^3$.

38. (a) Splitting of signals is caused by protons attached to adjacent carbon provided these are not equivalent to the absorbing proton.

39. (d) Nucleus consists of proton and neutron both are called as nucleon.

40. (c) Positron $(+1e^0)$ has the same mass as that of an electron $(-1e^0)$.

41. (c) Electron $\frac{1}{1837}$ time lighter than proton so their mass ratio will be 1 : 1837

Atomic number, Mass number, Atomic species

1. (b) The number of electrons in an atom is equal to its atomic number *i.e.* number of protons.

2. (a) No. of protons = Atomic no. = 25 and no. of neutron = 55 – 25 = 30.

3. (b) No. of neutrons = mass number – no. of protons. = $W - N$.

4. (b) ${}_{30}Zn^{70}, Zn^{2+}$ has No. of Neutrons = 70 – 30 = 40.

5. (a) Na^+ and *Ne* are isoelectronic which contain 10 electrons.

6. (a) One molecule of CO_2 have 22 electrons.

7. (c) Cl and Cl^- differs in number of electrons. *Cl* has $17e^-$ while Cl^- has $18e^-$.

8. (b) *CO* and CN^- are isoelectronic.

$CO = 6 + 8 = 14$ and $CN^- = 6 + 7 + 1 = 14$.

9. (c) Mass of an atom is due to nucleus (neutron + proton).

10. (b) Atomic number is defined as the number of protons in the nucleus.

11. (b) ${}_{26}X^{56}$ $A = P + N = Z + N = E + N$

$N = A - E = 56 - 26 = 30$

12. (c) Most probable radius = a_0 / Z

where a_0 = 52.9 pm. For helium ion, Z = 2.

$r_{\text{mp}} = \frac{52.9}{2}$ = 26.45 *pm.*

13. (b) Four unpaired electron are present in the Fe^{2+} ion $Fe^{2+}_{26} = [Ar]3d^6, 4s^0$

14. (c) Na^+ has 10 electron and Li^+ has 2 electron so these are different number of electron from each other.

16. (c) $P_{15} = 2, 8, 5$

17. (c) ${}_8O = 1s^2 2s^2 2p^4$

18. (a) ${}_{35}Br^{80} = 1s^2\ 2s^2\ 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$

$A = 80$, $Z = 35$, $N = ?$

$N = A - Z = 80 - 35 = 45$

atomic number (Proton) is 35 and no. of neutron is 45.

19. (c) ${}^{16}_{8}O^{--}$ have more electrons than neutron $p = 8,\ e = 10,\ n = 8$.

20. (a) ${}_6A^{12}$ and ${}_6X^{13}$ both are isotopes but have different no. of neutrons.

${}_6A^{12}$, For *A* have $p = 6, e = 6$ and $n = 6$ and

${}_6X^{13}$, For *B* have $p = 6, e = 6$ and $n = 7$

21. (c) P = 20, mass no. (A) = 40

N = A–P = $40 - 20 = 20$

$P = N = 20.$

22. (b) Electrons in $Na^+ = 11 - 1 = 10$

Electrons in $Mg^{2+} = 12 - 2 = 10$

23. (c) ${}_{20}Ca^{40}$ has 20 proton, 20 neutron.

24. (d) $CH_3^+ = 6 + 3 - 1 = 8e^-$,

$H_3O^+ = 3 + 8 - 1 = 10e^-$,

$NH_3 = 7 + 3 = 10e^-$, $CH_3^- = 6 + 3 + 1 = 10e^-$

25. (b) $-CONH_2 = 6 + 8 + 7 + 2 + 1$ (from other atom to form covalent bond) = 24.

26. (b) Complete $E.C. = [Ar]^{18}\ 3d^{10}\ 4s^2\ 4p^6$.

Hence no. of e^- = no. of protons $= 36 = Z$.

28. (a) $K^+ = 1s^2\ 2s^2 2p^6 3s^2 3p^6$

$Cl^- = 1s^2 2s^2 2p^6 3s^2 3p^6$.

29. (c) Mass no. $\approx$ At. Wt.

Mass no. = no. of protons + no. of neutrons

At. no. = no. of protons.

30. (b) $N_2O = 14 + 8 = 22$

$CO_2 = 6 + 16 = 22.$

31. (c) Neutron in ${}^{12}_{6}C = 6,$, Neutrons in ${}^{28}_{14}Si = 14$

Ratio = 6 : 14 = 3 : 7.

33. (d) $N_7 = 1s^2\ 2s^2 2p^3$

$N^+ = 1s^2\ 2s^2 2p^2$

$C = 1s^2\ 2s^2 2p^2$.

34. (c) $O = C = O$, linear structure 180^o angle

$Cl - Hg - Cl$, linear structure 180^o angle.

35. (c) $H^- = 1s^2$ and $He^+ = 1s^2$.

36. (c) In the nucleus of an atom only proton and neutrons are present.

37. (c) Cu^{63}_{29} Number of neutrons = atomic mass – atomic number = 63 – 29 = 34.

38. (b) 21 Protons and 24 Neutrons are present in nucleus and element is *Sc*.

40. (c) $_7X^{14}, n = 14 - 7 = 7$

42. (c) Cl^- have 17 proton, 18 neutron and 18 electron.

43. (a) Number of unpaired electrons in inert gas is zero because they have full filled orbitals.

44. (c) Electrons and Protons are same in neutral atom.

48. (d) No. of proton and no. of electron = 18$[Ar^{36}_{18}]$ and No. of neutron = 20

Mass number = $P + N = 18 + 20 = 38$.

49. (c) In Xe^{231}_{89} number of protons and electrons is 89 and No. of neutrons = $A - Z$ = 231 – 89 = 142.

51. (a) NO_2^- and O_3 are isostere. The number of atoms in these $(= 3)$ and number of electrons (24) are same.

52. (c) Number of electrons in nitrogen = 7 and number of electron is oxygen = 8 we know that formula of nitrate ion is NO_3^- we also know that number of electron

= (1 × Number of electrons in nitrogen)

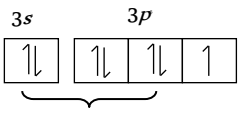
+ (3 × number of electrons in oxygen) + 1

= (1 × 7) + (3 × 8) + 1 = 32.

53. (b) Atomicity = $\frac{\text{Molecular mass}}{\text{Atomic mass}} = \frac{256}{32} = 8 = S_8$.

54. (a) In case of N^{3-}, $p = 7$ and $c = 10$

55. (c) Chlorine $Cl_{17} = [Ne]$



Three electron pair

56. (a) Bromine consists of outer most electronic configuration $[Ar]\ 3d^{10}\ 4s^2\ 4p^5$.

57. (d) $Na^+ = 1s^2\ 2s^2\ 2p^6$

$Mg = 1s^2\ 2s^2\ 2p^6$

$O^{2-} = 1s^2\ 2s^2\ 2p^6$

$Cl^- = 1s^2\ 2s^2\ 2p^6 3s^2 3p^6$

60. (a) Ar^{40}_{18} = atomic number 18 and no. of Neutron in case of Ar_{22}

Neutron = Atomic mass – Atomic number

$= 40 - 18 = 22$

61. (d) Nucleus of tritium contain $[H_1^3]$

$p = 1$, $e = 1$, $n = 2$

62. (b) N^{3-}, F^- and Na^+ (These three ions have $e^- = 10$, hence they are isoelectronic)

63. (a) NO_3^- and CO_3^{2-} consist of same electron and show same isostructural.

64. (c) Atomic number of chlorine 17 and in Cl^- ion total no. of electron =18.

65. (b) Tritium (H_1^3) has one proton and two neutron.

67. (c) $X_{35} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4s^2\ 4p^5$

Total no. of e^- is all *p*–orbitals $= 6 + 6 + 5 = 17$.

68. (a) Since its nucleus contain 9 proton so its. atomic number is 9 and its electronic configuration is 2, 7. So it require one more electron to complete its octet. Hence its valency is 1.

69. (d) K_2S formed by K^+ and S^{2-} ion. We know that atomic number of *K* is 19 and in K^+ ion its atomic number would be 18 similarly atomic number of *S* is 16 and in form S^{2-} ion its atomic number would be 18 so the K^+ and S^{2-} are isoelectronic with each other in K_2S.

70. (d) $_{20}Ca = 2,\ 8,\ 8,\ 2$

$Ca^{2+} = 2, 8, 8$

Hence, Ca^{2+} has 8 electrons each in outermost and penultimate shell.

71. (c) Atomic no. of *C* = 6 so the number of protons in the nucleus = 6

72. (a) No. of $P = Z = 7$; No. of electrons in $N^{3-} = 7 + 3 = 10$.

73. (b) Heavy hydrogen is $_1^2D$ .Number of neutrons = 1

74. (d) Atomic number is always whole number.

Atomic models and Planck's quantum theory

2. (a) The central part consisting whole of the positive charge and most of the mass caused by nucleus, is extremely small in size compared to the size of the atom.

3. (b) Electrons in an atom occupy the extra nuclear region.

4. (b) According to the Bohr model atoms or ions contain one electron.

5. (d) The nucleus occupies much smaller volume compared to the volume of the atom.

7. (c) α-particles pass through because most part of the atom is empty.

8. (b) An electron jumps from *L* to *K* shell energy is released.

9. (c) Neutron is a chargeless particles, so it does not deflected by electric or magnetic field.

10. (a) Energy is always absorbed or emitted in whole number or multiples of quantum.

11. (b) Both *He* and Li^+ contain 2 electrons each.

18. (c) During the experimental verification of de-Broglie equation, Davisson and Germer confirmed wave nature of electron.

19. (a) Increases due to absorption of energy and it shows absorption spectra.

20. (d) Rutherford α-Scattering experiment.

21. (d) It represents Heisenberg's uncertainty principle.

23. (d) $\frac{E_4}{E_2} = \frac{2^2}{4^2} = \frac{4}{16} = \frac{1}{4}$; $E_4 = \frac{E_2}{4} = \frac{-328}{4} = -82\ kJ/mol.$

27. (c) When $c = \nu \times \lambda$ than $\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{2 \times 10^6} = 1.5 \times 10^2 m$

28. (b) According to quantum theory of radiation, a hot body emits radiant energy not continuously but discontinuously in the form of small packets of energy called quanta or photons.

30. (a) $p = \frac{h}{\lambda} = \frac{6.6\times10^{-34}}{2.2\times10^{-11}} = 3\times10^{-23}\,kgms^{-1}$

34. (b) Bohr's radius $= \frac{n^2h^2}{4\pi^2me^2z}$. Which is a positive quantity.

40. (a) Gold used by Rutherford in scatting experiment.

41. (c) $\Delta E = E_3 - E_2 = 13.6\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] = 1.9\,eV$

42. (d) $R = R_0(=1.4\times10^{-13}\,cm)\times A^{1/3}$

43. (d) $\left(\frac{q}{m}\right)_\alpha = \frac{1}{2}\left(\frac{q}{m}\right)_p = \frac{1}{2}\times9.6\times10^7 = 4.8\times10^7\,C\,kg^{-1}$

44. (a) According to Hydrogen spectrum series.

45. (d) The electron can move only in these circular orbits where the angular momentum is a whole number multiple of $\frac{h}{2\pi}$ or it is quantised.

46. (b) Generally electron moving in orbits according to Bohr's principle.

47. (a) According to the planck's law that energy of a photon is directly proportional to its frequency *i.e.* $E = h\nu$

49. (d) Bohr's radius of the hydrogen atom

$r = \frac{n^2\times0.529\text{Å}}{z}$; where z = Atomic number,

n = Number of orbitals

51. (a) $E = -\frac{2.172\times10^{-18}}{n^2} = \frac{-2.172\times10^{-18}}{2^2}$

$= -5.42\times10^{-19}\,J$.

52. (c) $\Delta E = \frac{hc}{\lambda}$ or $\lambda = \frac{hc}{\Delta E}$

$= \frac{6.64\times10^{-34}\times3\times10^8}{3\times10^{-8}} = 6.64\times10^{-8}\,\text{Å}$

53. (d) $r_n = r_1\times n^2$

$r_3 = 0.53\times3^2 = 0.53\times9 = 4.77\text{Å}$

54. (c) According to Rutherford an atom consists of nucleus which is small in size but carries the entire mass (P+ N).

55. (b) Wavelength of spectral line emitted is inversely proportional to energy $\lambda \propto \frac{1}{E}$.

56. (b) $E \propto \frac{1}{\lambda}$; $E_1 = \frac{1}{8000}$; $E_2 = \frac{1}{16000}$

$\frac{E_1}{E_2} = \frac{16000}{8000} = 2 \Rightarrow E_1 = 2E_2$

58. (a) $\nu = \frac{c}{\lambda} = \frac{3\times10^8\,ms^{-1}}{600\times10^{-9}m} = 5.0\times10^{14}\,Hz$.

59. (b) $E = \frac{-13.6}{n^2}eV = \frac{-13.6}{2^2} = \frac{-13.6}{4} = -3.40\ eV$

65. (b) Bohr radius $= \frac{r_2}{r_1} = \frac{(2)^2}{(1)^2} = 4$.

66. (b) $\nu = \frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = 109678\left[\frac{1}{1} - \frac{1}{4}\right] = 82258.5$

$\lambda = 1.21567\times10^{-5}\,cm$ or $\lambda = 12.1567\times10^{-6}\,cm$

$= 12.1567\times10^{-8}\,m$

$\nu = \frac{c}{\lambda} = \frac{3\times10^8}{12.567\times10^{-8}} = 24.66\times10^{14}\,Hz$.

67. (c) We know that $\lambda = \frac{h}{m\nu}$; $\therefore\ m = \frac{h}{m\lambda}$

The velocity of photon (ν) = $3\times10^8\,m\,\text{sec}^{-1}$

$\lambda = 1.54\times10^{-8}\,cm = 1.54\times10^{-10}\,meter$

$\therefore\ m = \frac{6.626\times10^{-34}\,Js}{1.54\times10^{-10}\,m\times3\times10^8\,m\,\text{sec}^{-1}}$

$= 1.4285\times10^{-32}\,kg$.

68. (a) The spliting of spectral line by the magnetic field is called Zeeman effect.

69. (b) $r \propto n^2$ (excited state $n = 2$)

$r = 4a_0$

70. (d) $r_n \propto n^2 : A_n \propto n^4$

$\frac{A_2}{A_1} = \frac{n_2^4}{n_1^4} = \frac{2^4}{1^4} = \frac{16}{1} = 16:1$

71. (a) It will take $\frac{4\pi^2mr^2}{nh}$

72. (d) $r_H = 0.529\frac{n^2}{z}\text{Å}$

For hydrogen ; $n = 1$ and $z = 1$ therefore

$r_H = 0.529\text{Å}$

For Be^{3+} : $Z = 4$ and $n = 2$ Therefore

$r_{Be^{3+}} = \frac{0.529\times2^2}{4} = 0.529\text{Å}$.

73. (a) $E_{\text{ionisation}} = E_\infty - E_n = \frac{13.6Z_{eff}^2}{n^2}eV$

$= \left[\frac{13.6Z^2}{n_2^2} - \frac{13.6Z^2}{n_1^2}\right]$

$E = h\nu = \frac{13.6\times1^2}{(1)^2} - \frac{13.6\times1^2}{(4)^2}$; $h\nu = 13.6 - 0.85$

$\because\ h = 6.625\times10^{-34}$

$\nu = \frac{13.6-0.85}{6.625\times10^{-34}}\times1.6\times10^{-19} = 3.08\times10^{15}\,s^{-1}$.

74. (c) $\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$\frac{1}{\lambda} = 1.097\times10^7\,m^{-1}\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$

$\therefore\ \lambda = 91\times10^{-9}\,m$

We know $10^{-9} = 1nm$ So $\lambda = 91nm$

75. (d) $r \propto n^2$

For Ist orbit $\gamma = 1$

For IIIrd orbit = $\gamma \propto 3^2 = 9$

So it will 9 γ.

76. (b) Bohr suggest a formulae to calculate the radius and energy of each orbit and gave the following formulae

$$r_n = \frac{n^2h^2}{4\pi^2 kme^4 Z}$$

Where except n^2, all other unit are constant so $r_n \propto n^2$.

77. (a) Energy of an electron $E = \frac{-E_0}{n^2}$

For energy level $(n = 2)$

$$E = -\frac{13.6}{(2)^2} = \frac{-13.6}{4} = -3.4eV.$$

78. (a) Energy of ground stage $(E_0) = -13.6eV$ and energy level = 5

$$E_5 = \frac{-13.6}{n^2}eV = \frac{-13.6}{5^2} = \frac{-13.6}{25} = -0.54eV.$$

79. (c) Positive charge of an atom is present in nucleus.

81. (a) For $n_4 \to n_1$, greater transition, greater the energy difference, lesser will be the wavelength.

Dual nature of electron

1. (c) According to de-Broglie equation $\lambda = \frac{h}{mv}$ or $\frac{h}{p}$ or $\frac{h}{mc}$.

4. (b) $\lambda = \frac{h}{p}$ or $\frac{h}{mv}$ or $\frac{h}{mc}$ de-Broglie equation.

5. (c) Emission spectra of different λ accounts for quantisation of energy.

6. (b) According to de-Broglie equation

$$\lambda = \frac{h}{mv},\ p = mv,\ \lambda = \frac{h}{p},\ \lambda = \frac{h}{mc}$$

7. (d) According to de-Broglie $\left(\lambda = \frac{h}{mv}\right)$.

8. (a) $\lambda = \frac{h}{mv} = \frac{6.63\times10^{-34}}{10^{-3}\times100} = 6.63\times10^{-33}\,m$

9. (d) $\lambda = \frac{h}{mv}$. For same velocity $\lambda \propto \frac{1}{m}$.

SO_2 molecule has least wavelength because their molecular mass is high.

10. (d) de-Broglie equation is $\lambda = \frac{h}{p}$.

11. (c) Formula for de-Broglie wavelength is

$$\lambda = \frac{h}{p} \text{ or } \lambda = \frac{h}{mv} \Rightarrow eV = \frac{1}{2}mv^2 \text{ or } v = \sqrt{\frac{2eV}{m}}$$

$$\lambda = \frac{h}{\sqrt{2meV}} = \frac{6.62\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times2.8\times10^{-23}}}$$

$$\lambda = 9.28\times10^{-8}\,meter.$$

12. (c) $\lambda = \frac{h}{p},\ p = mv$

$$\lambda = \frac{h}{mv} = \frac{6.62\times10^{-34}}{9.1\times10^{-31}\times1.2\times10^{5}}$$

$$\lambda = 6.626\times10^{-9}\,m.$$

13. (b) Mass of the particle $(m) = 10^{-6}\,kg$ and velocity of the particle $(v) = 10\,ms^{-1}$

$$\lambda = \frac{h}{mv} = \frac{6.63\times10^{-34}}{10^{-6}\times10} = 6.63\times10^{-29}\,m$$

15. (b) According to de–Broglie

$$\lambda = \frac{h}{mv} = \frac{6.62\times10^{-20}\,erg.\sec}{\frac{2}{6.023\times10^{23}}\times5\times10^4\,cm/\sec}$$

$$= \frac{6.62\times10^{-27}\times6.023\times10^{23}}{2\times5\times10^4}\,cm = 4\times10^{-8}\,cm = 4\,\text{Å}.$$

16. (c) $\lambda = \frac{h}{mv} = \frac{6.625\times10^{-34}}{0.2\,kg\times\frac{5}{60\times60\,ms^{-1}}} = 10^{-30}\,m.$

17. (c) From de Broglie equation

$$\lambda = \frac{h}{mv} = \frac{6.62\times10^{-34}}{0.5\times100} = 1.32\times10^{-35}\,m.$$

18. (c) Dual nature of particle was proposed by de-broglie who gave the following equation for the wavelength.

$$\lambda = \frac{h}{mv}$$

19. (b) One percent of the speed of light is

$$v = \left(\frac{1}{100}\right)(3.00\times10^8\,ms^{-1}) = 3.00\times10^6\,ms^{-1}$$

Momentum of the electron $(p) = mv$

$$= (9.11\times10^{-31}kg)(3.00\times10^6\,ms^{-1})$$

$$= 2.73\times10^{-24}\,kg\,ms^{-1}$$

The de-broglie wavelength of this electron is

$$\lambda = \frac{h}{p} = \frac{6.626\times10^{-34}}{2.73\times10^{-24}\,kgms^{-1}}$$

$$\lambda = 2.424\times10^{-10}\,m.$$

20. (a) We know that the correct relationship between wavelength and momentum is $\lambda = \frac{h}{p}$. Which is given by de-Broglie.

21. (d) De-broglie equation applies to all the material object in motion.

Uncertainty principle and Schrodinger wave equation

1. (b) The uncertainty principle was enunciated by Heisenberg.

2. (b) According to uncertainty principle, the product of uncertainties of the position and momentum, is $\Delta x\times\Delta p \geq h/4\pi$.

5. (c) $\Delta x\times\Delta p = \frac{h}{4\pi}$ is not the correct relation. But correct Heisenberg's uncertainty equation is $\Delta x\times\Delta p \geq \frac{h}{4\pi}$.

7. (b) According to the Heisenberg's uncertainty principle momentum and exact position of an electron can not be determined simultaneously.

8. (d) $\Delta x.\Delta p \geq \frac{h}{4\pi}$, if $\Delta x = 0$ then $\Delta p = \infty$.

12. (c) According to $\Delta x\times\Delta p = \frac{h}{4\pi}$

$$\Delta x = \frac{h}{\Delta p\times4\pi} = \frac{6.62\times10^{-34}}{1\times10^{-5}\times4\times3.14} = 5.27\times10^{-30}\,m.$$

13. (a) Uncertainty of moving bullet velocity

$$\Delta v = \frac{h}{4\pi \times m \times \Delta v} = \frac{6.625\times10^{-34}}{4\times3.14\times.01\times10^{-5}}$$

$$= 5.2\times10^{-28}\, m/sec\,.$$

14. (b) $\Delta x\,.\Delta p \geq \frac{h}{4\pi}$ This equation shows Heisenberg's uncertainty principle. According to this principle the product of uncertainty in position and momentum of particle is greater than equal to $\frac{h}{4\pi}$.

15. (d) Spin quantum number does not related with Schrodinger equation because they always show $+1/2\,, -1/2$ value.

16. (b) According to $\Delta x \times m \times \Delta v = \frac{h}{4\pi}$; $\Delta v = \frac{h}{\Delta x \times m \times 4\pi}$

$$= \frac{6.6\times10^{-34}}{10^{-5}\times0.25\times3.14\times4} = 2.1\times10^{-29}\ \ m/s$$

17. (a) Uncertainity in position $\Delta x = \frac{h}{4\pi\times\Delta p}$

$$= \frac{6.63\times10^{-34}}{4\times3.14\times(1\times10^{-5})} = 5.28\times10^{-30}\, m\,.$$

18. (c) Given that mass of electron $= 9.1\times10^{-31}\, kg$

Planck's constant $= 6.63\times10^{-34}\, kg\, m^2 s^{-1}$

By using $\Delta x \times \Delta p = \frac{h}{4\pi}$; $\Delta x \times \Delta v \times m = \frac{h}{4\pi}$

where : Δx = uncertainity in position

Δv = uncertainity in velocity

$$\Delta x \times \Delta v = \frac{h}{4\pi\times m}$$

$$= \frac{6.63\times10^{-34}}{4\times3.14\times9.1\times10^{-31}} = 5.8\times10^{-5} m^2 s^{-1}\,.$$

Quantum number, Electronic configuration and Shape of orbitals

3. (b) The shape of an orbital is given by azimuthal quantum number 'l'.

5. (c) Hund's rule states that pairing of electrons in the orbitals of a subshell (orbitals of equal energy) starts when each of them is singly filled.

6. (c) $1s^2, 2s^2, 2p^6$ represents a noble gas electronic configuration.

7. (c) The electronic configuration of *Ag* in ground state is $[Kr]4d^{10}5s^1$.

8. (a) *n*, *l* and *m* are related to size, shape and orientation respectively.

9. (a) Electronic configuration of $Rb_{(37)}$ is

$$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$$

So for the valence shell electron $(5s^1)$

$$n = 5, l = 0, m = 0, s = +\frac{1}{2}$$

10. (a) $3d$ subshell filled with 5 electrons (half-filled) is more stable than that filled with 4 electrons. $1,4s$ electrons jumps into $3d$ subshell for more sability.

11. (c) In $2p$ – orbital, 2 denotes principal quantum number (n) and p denotes azimuthal quantum number $(l = 1)$.

12. (c) Electronic configuration of H^- is $1s^2$. It has 2 electrons in extra nuclear space.

13. (a) The electronic configuration must be $1s^2\, 2s^1$. Hence, the element is lithium $(z = 3)$.

14. (a) Principal quantum no. tells about the size of the orbital.

15. (d) An element has the electronic configuration $1s^2, 2s^2\, 2p^6,\ 3s^2\, 3p^2, (Si)$. It's valency electrons are four.

16. (c) The magnetic quantum number specifies orientation of orbitals.

17. (c) If $l = 2, m \neq -3.\ = (-e\ \text{to}\ +e)$.

18. (d) If $n = 3$ then $l = 0,\ 1,\ 2$ but not 3.

20. (c) Atomic number of *Cu* is $29 = (Ar)4s^1 3d^{10}$.

21. (c) The shape of $2p$ orbital is dumb-bell.

22. (a) When the value of $n = 2$, then $l = 1$ and the value of $m = -1, 0, +1$ *i.e.* 3 values.

23. (c) $Cr_{24} = (Ar)3d^5\, 4s^1$ electronic configuration because half filled orbital are more stable than other orbitals.

24. (d) *Kr* has zero valency because it contains 8 electrons in outermost shell.

25. (c) 2 electron in the valence shell of calcium $Ca_{20} = (2, 8, 8, 2)$.

27. (b) Value of $l = 1$ means the orbital is *p* (dumb-bell shape).

28. (d) *Cr* has $[Ar]4s^1 3d^5$ electronic configuration because half filled orbital are more stable than other orbitals.

31. (d) The two electrons will have opposite spins.

33. (c) If $m = -3$, then $l = 3$, for this value *n* must be 4.

34. (d) No. of electrons $= 2n^2$ hence no. of orbital $= \frac{2n^2}{2} = n^2$.

35. (d) No. of electrons $= 2n^2$ hence no. of orbital $= \frac{2n^2}{2} = n^2$.

36. (c) If $n = 3$ then $l = 0$ to $n-1$ & $m = -l$ to $+l$

37. (b) $Na_{11} = 2, 8, 1 = 1s^2, 2s^2\, 2p^6,\ 3s^1$

$n = 3, l = 0, m = 0, s = +1/2$

38. (b) Hund's rule states that pairing of electrons in the orbitals of a subshell (orbitals of equal energy) starts when each of them is singly filled.

39. (d) As a result of attraction, some energy is released. So at infinite distance from the nucleus energy of any electron will be maximum. For bringing electrons from ∞ to the orbital of any atom some work has to be done be electrons hence it bill loose its energy for doing that work.

40. (c) This space is called nodal space where there is no possibility of oressene of electrons.

41. (d) For *s* orbital $l = 0\ \ m = 0$.

42. (c) For M^{th} shell, $n = 3$; so maximum no. of electrons in M^{th} shell $= 2n^2 = 2\times3^2 = 18$.

43. (c) $m = -l$ to $+l$ including zero.

44. (a) Number of radial nodes = $(n - l - 1)$

For 3*s*: $n = 3$, $l = 0$

(Number of radial node = 2)

For 2*p*: $n = 2$, $l = 1$

(Number of radial node = 0)

45. (a) It consists only *s* orbital which is circular.

46. (a) Hund's rule states that pairing of electrons in the orbitals of a subshell (orbitals of equal energy) starts when each of them is singly filled.

47. (b) If value of *l* is 2 then $m = -2, -1, 0, +1, +2$. $m = -l$ to $+l$ including zero.

(5 values of magnetic quantum number)

48. (c) *s, p, d* orbitals present in *Fe*

$Fe_{26} = 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^2 3d^6$

50. (b) According to Aufbau rule.

51. (c) 3*d* subshell filled with 5 electrons (half-filled) is more stable than that filled with 4 electrons. $1, 4s$ electrons jumps into $3d$ subshell for more sability.

52. (b) $K_{19} = 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^1$

for $4s^1$ electrons.

$n = 4, l = 0, m = 0$ and $s = +\frac{1}{2}$.

54. (b) 3*d* subshell filled with 5 electrons (half-filled) is more stable than that filled with 4 electrons. $1, 4s$ electrons jumps into $3d$ subshell for more sability.

55. (c) It has 3 orbitals p_x, p_y, p_z.

57. (b) If $l = 2$ then it must be d orbital which can have 10 electrons.

59. (c) for d orbital $l = 2$.

60. (c) $m = -l$ to $+l$ including zero.

61. (d) When $n = 3$ shell, the orbitals are $n^2 = 3^2 = 9$.

No. of electrons $= 2n^2$

Hence no. of orbital $= \frac{2n^2}{2} = n^2$.

62. (d) Configuration of $Ne = 1s^2\ 2s^2\ 2p^6$

$F^- = 1s^2\ 2s^2\ 2p^6$

$Na^+ = 1s^2\ 2s^2\ 2p^6$

$Mg^{++} = 1s^2\ 2s^2\ 2p^6$

$Cl^- = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$.

63. (d) $Unh_{106} = [Rn]5f^{14}, 6d^5, 7s^1$

64. (c) K^+ and Ca^{++} have the same electronic configuration $(1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6)$

65. (b) For *s*-orbital, $l = 0$.

66. (d) $3s^1$ is valency electrons of Na for this $n = 3, l = 0, m = 0, s = \frac{+1}{2}$

67. (c) ${}_7N = 1s^2, 2s^2\ 2p_x^1, 2p_y^1, 2p_z^1$. Hund's rule states that pairing of electrons in the orbitals of a subshell (orbitals of equal energy) starts when each of them is singly filled.

68. (d) (4) and (5) belong to d -orbital which are of same energy.

69. (c) Atomic no. 17 is of chlorine.

70. (b) The *s*-orbital has spherical shape due to its non- directional nature.

71. (a) According to the Aufbau's principle the new electron will enter in those orbital which have least energy. So here $4p$ -orbital has least energy then the others.

72. (c) According to Aufbau's principle.

73. (c) $1s^2\ 2s^2\ 2p^6, 3s^2\ 3p^6, 4s^2\ 3d^6 = 2, 8, 14, 2$.

74. (c) Ground state of $Cu^{29} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$

$Cu^{2+} = 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^9$.

76. (c) No. of electrons in 3^{rd} shell = $2n^2 = 2(3)^2 = 18$

77. (c) $F_9 = 1s^2\ 2s^2\ 2p^5$

78. (c) When $l = 3$ then

$m = -3, -2, -1, 0, +1, +2, +3$. $m = -l$ to $+l$ including zero.

80. (d) $m = -1$ is not possible for s orbital $(l = 0)$.

84. (a) Both 2*p* and 3*p*-orbitals have dumb-bell shape.

85. (b) 3*d* subshell filled with 5 electrons (half-filled) is more stable than that filled with 4 electrons. $1, 4s$ electrons jumps into $3d$ subshell for more sability.

86. (c) The shape of $2p$ orbital is dumb-bell.

87. (a) ${}_{25}Mn = [Ar]3d^5\ 4s^2 \xrightarrow[\text{-2 electrons}]{} Mn^{2+} = [Ar]\ 3d^5\ 4s^0$

89. (c) For *p*-orbital, $l = 1$ means dumb-bell shape.

91. (d) $l = 3$ means *f* subshell maximum number of *e* in *f* subshell = 14.

93. (b) As per Aufbau principle.

94. (b) $l = 0$ is *s*, $l = 1$ is *p* and $l = 2$ is *d* and so on hence *s p d* may be used in state of no..

95. (d) For $4d, n = 4, l = 2, m = -2, -1, 0, +1, +2$, $s = +\frac{1}{2}$.

96. (d) *m* cannot be greater than $l(=0, 1)$.

97. (a) For $n = 1, l = 0$.

99. (d) $Na_{11} = 1s^2\ 2s^2 p^6\ 3s^2$

$n = 3, l = 0, m = 0$ and $s = +\frac{1}{2}$.

102. (d) According to Aufbau's rule.

105. (d) $2p_x, 2p_y, 2p_z$ sets of orbital is degenerate.

106. (a) Mg_{12} have $1s^2\ 2s^2\ 2p^6\ 3s^2$ electronic configuration

$n = 3,\ l = 0,\ m = 0,\ s = -\frac{1}{2}$.

107. (c) The principle quantum number $n = 3$. Then azimuthal quantum number $l = 3$ and number of orbitals $= n^2 = 3^2 = 9$. 3 and 9

108. (d) ${}_{29}Cu = [Ar]3d^{10}4s^1, Cu^{2+} = [Ar]3d^9.4s^0$.

Ground state of $Cu^{29} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$

$Cu^{2+} = 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^9$.

110. (d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$ it shows electronic configuration of Iron.

111. (d) Orbitals are $4s$, $3s$, $3p$ and $3d$. Out of these $3d$ has highest energy.

113. (c) For the $n = 2$ energy level orbitals of all kinds are possible $2^n, 2^2 = 4$.

114. (b) $n = 2$ than no. of orbitals $= n^2$, $2^2 = 4$

118. (b) For both *A* & *B* electrons $s = -1/2$ & $+1/2$ respectively, $n = 3, l = 0, m = 0$

119. (a) According to Aufbau's rule.

120. (a) Possible number of subshells would be (6*s*, 5*p*, 4*d*).

121. (d) For f orbital $l = 3$.

123. (b) 4*d*-orbital have highest energy in given data.

125. (d) If $m = -3, l = 3$ and $n = 4$.

127. (b) $N_7^{14} = 1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$.

128. (c) *m* can't be greater than *l*.

130. (b) $n = 1$ and $m = 1$ not possible for *s*-orbitals.

131. (a) $Fe_{26} = [Ar]3d^6 4s^2$

$Fe^{3+} = [Ar]3d^5 4s^0$.

132. (c) Maximum number of electron

$= 2n^2 (\text{where } n = 4) = 2 \times 4^2 = 32$.

133. (d) When 2*p* orbital is completely filled then electron enter in the 3*s*. The capacity of 2*p* orbital containing e^- is 6. So $1s^2, 2s^2 2p^2 3s^1$ is a wrong electronic configuration the write is $1s^2 2s^2 2p^3$.

134. (b) This electronic configuration is *Cr* (chromium element) in the ground state

$= 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

137. (c) No. of electron are same (18) in Cl^- and Ar.

138. (c) For *s*-subshell $l = 0$ then should be $m = 0$.

139. (c) 19th electron of chromium is $4s^1$

$n = 4, l = 0, m = 0, s = +\frac{1}{2}$

140. (c) The value of *m* is – *l to* l including zero so for *l* = 3, *m* would be –3, –2, –1, 0, +1, +2, +3.

141. (c) $l = 1$ is for p orbital.

142. (d) Magnetic quantum number of sodium $(3s^1)$ final electron is *m* = 0.

143. (c) Generally azimuthal quantum number defines angular momentum.

146. (d) $m = (2l + 1)$ for *d* orbital $l = 2$ $m = (2 \times 2 + 1) = 5$.

147. (a) The atomic number of chlorine is 17 its configuration is $1s^2 2s^2 2p^6 3s^2 3p^5$

148. (c)

n	l	m_1	m_2
3	2	1	0

This set (c) is not possible because spin quantum number values $= \pm\frac{1}{2}$.

149. (b) The ground state of neon is $1s^2 2s^2 2p^6$ on excitation an electron from $2p$ jumps to $3s$ orbital. The excited neon configuration is $1s^2 2s^2 2p^5 3s^1$.

152. (a)

	s	*p*	*d*	*f*	*g*	*h*
l =	0	1	2	3	4	5

Number of orbitals $= 5 \times 2 + 1 = 11$

153. (a) It is the ground state configuration of chromium.

155. (b) $n = 4 \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^2, 4p^6, 4d^{10}, 4f^{14}$

So $l = (n - 1) = 4 - 1 = 3$ which is *f* orbit contain 7 orbital.

156. (d) 2*p* have contain maximum 6 electron out of which there are 3 are of + 1/2 spin and 3 are of – 1/2 spin

157. (a) For 4*f* orbital electron, $n = 4$

$l = 3$ (Because 0, 1, 2, 3)

s, *p*, *d*, *f*

m = + 3, + 2, +1, 0, – 1, – 2, – 3

s = +1/2

158. (b) ${}_{24}Cr \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$
$l=1$ $l=1$ $l=2$

(We know that for *p* the value of $l = 1$ and for *d*, $l = 2$)

For $l = 1$ total number of electron = 12

For $l = 2$ total number of electron = 5.

159. (c) Atomic number of potassium is 19 and hence electronic configuration will be $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1$

Hence for $4s^1$ electron value of Quantum number are

Principal quantum number $n = 4$

Azimuthal quantum number $l = 0$

Magnetic quantum number $m = 0$

Spin quantum number $s = +1/2$

160. (d) According to Hund's rule electron first fill in unpaired form in vacant orbital then fill in paired form to stabilized the molecule by which $1s^2, 2s^2, 2p_x^2$ is not possible. According to Hund's rule. Because $2p_x, p_y, p_z$ have the same energy level so electron first fill in unpaired form not in paired form so it should be $1s^2, 2s^2, 2p_x^1, 2p_y^1$.

161. (c) It is governed by Aufbau principle.

162. (d) The electronic configuration of atomic number

$24 = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$

163. (b) The maximum number of electron in any orbital is 2.

164. (c) According to pauli principle 2 electron does not have the same value of all four quantum number. They have maximum same value are 3.

165. (a) Number of orbitals $= n^2 = 4^2 = 16$.

166. (d) We know from the Aufbau principle, that $2p$ orbital will be filled before $3s$ orbital. Therefore, the electronic configuration $1s^2, 2s^2, 2p^2, 3s^1$ is not possible.

167. (d) Each orbital may have two electrons with opposite spin.

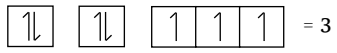
168. (d) Maximum no. of electrons in a subshell $= 2(2l+1)$ for f subshell, $l = 3$ so 14 electrons accommodated in f-subshell.

169. (b) Each orbital has atleast two electron.

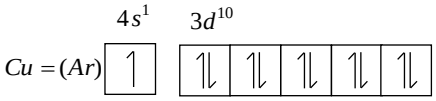
170. (a) Nucleus of 20 protons atom having 20 electrons.

174. (b) For $m = 0$, electron must be in s-orbital.

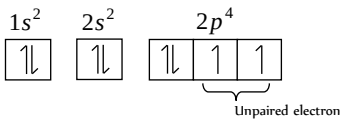
176. (c) In this type of electronic configuration the number of unpaired electrons are 3.



177. (a) Atomic number of *Cu is* 29 so number of unpaired electrons is 1



178. (b) $O_8 =$

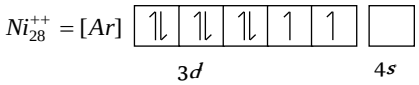


181. (c) $Be_4 = 1s^2, 2s^2 =$ (Ground state)

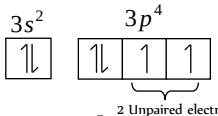
Number of unpaired electrons in the ground state of Beryllium atom is zero.

182. (b) Two unpaired electrons are present in

$Ni^{++}(z = 28)$ cation



183. (c) $O_2 = 1s^2\ 2s^2\ 2p^6 3s^2\ 3p^4$

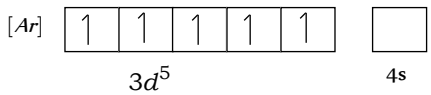


184. (c) $Cr_{24} = (Ar)3d^5\ 4s^1$ but $Cr_{24}^{3+} = (Ar)3d^3\ 4s^0$

185. (a) $Zn_{30} = [Ar]3d^{10}\ 4s^2$

$Zn^{++} = [Ar]3d^{10}\ 4s^0$

186. (d) Mn^{+2} ion will have five (maximum) unpaired electrons

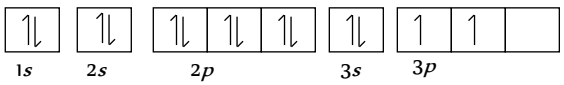


187. (c) Fe^{3+} ion will have five (maximum) unpaired electrons.

190. (c) Due to full filled d-orbital Cl^- has spherical symmetry.

191. (b) Atomic number 14 leaving 2 unpaired electron

$_{14}Si = 1s^2 2s^2 2p^6 3s^2 3p^2$



192. (a) Shell = *K, L, M* $= 1s^2\ \ 2s^2 2p^6\ \ 3s^2 3p^4$

Hence the number of s electron is 6 in that element.

193. (d) $C_6 = 1s^2, 2s^2 2p^2$ (Ground state)

$= 1s^2\ 2s^1\ 2P_x^1\ 2p_y^1\ 2p_z^1$ (Excited state)

In excited state no. of unpaired electron is 4.

194. (b) Max. no. of electrons in N-shell $(n = 4)$

$= 2n^2 = 2 \times 4^2 = 32$.

195. (d) $_{26}Fe = [Ar]3d^6, 4s^2$

$Fe^{2+} = [Ar]3d^6, 4s^0$

Number of d-electrons = 6

$_{17}Cl = [Ne]3s^2, 3p^5$

$Cl^- = [Ne]3s^2, 3p^6$

Number of p-electrons = 6.

196. (a) Electrons in the atom $= 18 + 4 + 3 = 25$ *i.e.* $Z = 25$.

197. (c) The atomic number of bromine is 35 and the electronic configuration of Br is

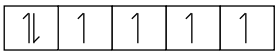
$Br_{35} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^2, 4p^5$

total electron present in p-orbitals of Br is –

$2p^6 + 3p^6 + 4p^5 = 17.$

198. (d) Fe^{2+} has $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6$ configuration with 4 unpaired electron.

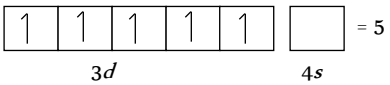
199. (b) $Fe^{2+}\ [Ar]3d^6\ 4s^0$



Fe^{2+} consist of maximum 4 unpaired electrons.

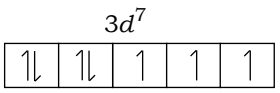
201. (a) Fe^{3+} $(z = 26)$

$Fe^{3+} = [Ar]3d^5\ 4s^0$



Total no. of unpaired electron=5

202. (b) $Co_{27} = [Ar]\ 3d^7 4s^2$



3 unpaired electron are present in cobalt metal.

203. (b) According to Hund's rule, the pairing of electrons will not occur in any orbital of a subshell unit and unless, all the available of it have one electron each.

Electronic configuration of

$_7N^{14} = 1s^2, 2s^2, 2p_x^{\ 1} 2p_y^{\ 1} 2p_z^{\ 1}$

Hence it has 3 unpaired electron in $2p$-orbital.

204. (c) $2s$ orbital have minimum energy and generally electron filling increases order of energy according to the Aufbau's principle.

205. (d) According to Pauli's exclusion principle no two electrons in the same atom can have all the set of four quantum numbers identical.

206. (b) The second principal shell contains four orbitals *viz* $2s, 2p_x, 2p_y$ and $2p_z$.

207. (b) Follow Hund's multiplicity rules.

208. (c) According to the Aufbau's principle, electron will be first enters in those orbital which have least energy. So decreasing order of energy is $5p > 4d > 5s$.

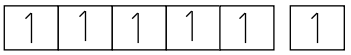
210. (b) No two electrons in an atom can have identical set of all the four quantum numbers.

212. (a) In particular shell, the energy of atomic orbital increases with the value of l.

214. (c) Aufbau principle explains the sequence of filling of orbitals in increasing order of energy.

215. (a) According to Aufbau principle electron are filling increasing order of energy. Therefore the electronic configuration $1s^2\ 2s^2\ 2p^6$ obeys Aufbau principle.

216. (d) Electronic configuration of the Cr_{24} is $[Ar]4s^1 3d^5$ or



= 6

217. (b) According to the Aufbau principle electron filling minimum to higher energy level.

219. (b) According to Aufbau principle electron are filled in various atomic orbital in the increasing order of energy

1*s* < 2*s* < 2*p* < 3*s* < 3*p* < 4*s* < 3*d* < 4*p* < 5*s* < 4*d* < 5*p* < 6*s* < 4*f* < 5*d* < 6*p* < 7*s*.

220. (d) According to Aufbau's rule.

222. (b) We know that for *d*-electron $l = 2$.

$$\mu = \sqrt{l(l+1)}\,\frac{h}{2\pi};\ \mu = \sqrt{2(2+1)}\,\frac{h}{2\pi}$$

$$\mu = \sqrt{2(2+1)}\,\frac{h}{2\pi};\ \mu = \sqrt{6}\,\frac{h}{2\pi}.$$

223. (a) Number of nodal centre for $2s$ orbitals $(n-1) = 2-1 = 1$.

224. (d) Since *s*-orbital have $l = 0$

Angular momentum = $\sqrt{l(l+1)} \times \frac{h}{2\pi} = 0 \times \frac{h}{2\pi} = 0$.

225. (d) Azimuthal quantum number (l) = 3 shows the presence of *f* orbit, which contain seven orbitals and each orbital have 2 electrons. Hence $7 \times 2 = 14$ electrons.

227. (b) According to Aufbau principle.

228. (a) Atomic number of deuterium = 1; ${}_1D^2 \rightarrow 1s^1$

Critical Thinking Questions

1. (a) F^- have the same number of electrons with the neon atom.

2. (d) No change by doubling mass of electrons however by reducing mass of neutron to half total atomic mass becomes $6+3$ instead of $6+6$. Thus reduced by 25%.

3. (d) $\frac{e}{m}$ for (i) neutron $= \frac{0}{1} = 0$

(ii) $\alpha-$ particle $= \frac{2}{4} = 0.5$

(iii) Proton $= \frac{1}{1} = 1$

(iv) electron $= \frac{1}{1/1837} = 1837$.

4. (a) Metal is ${}_{56}M^{2+}(2,8,14)$ than $n = A - Z$

$= 56 - 26 = 30$.

5. (d) $E = h\nu = h\frac{c}{\lambda}$ *i.e.* $E \propto \frac{1}{\lambda}$

$$\frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} = \frac{4000}{2000} = 2.$$

6. (c) Rutherford discovered nucleus.

7. (b) According to Bohr's model $\Delta E = E_1 - E_3$

$$= 2.179 \times 10^{-11} - \frac{2.179 \times 10^{11}}{9}$$

$$= \frac{8}{9} \times 2.179 \times 10^{-11} = 1.91 \times 10^{-11} = 0.191 \times 10^{-10}\ erg$$

Since electron is going from $n = 1$ to $n = 3$ hence energy is absorbed.

8. (d) Radius of nucleus $= 1.25 \times 10^{-13} \times A^{1/3}\ cm$

$= 1.25 \times 10^{-13} \times 64^{1/3} = 5 \times 10^{-13}\ cm$

Radius of atom = $1\text{Å} = 10^{-8}\ cm$.

$$\frac{\text{Volume of nucleus}}{\text{Volume of atom}} = \frac{(4/3)\pi(5 \times 10^{-13})^3}{(4/3)\pi(10^{-8})^3}$$

$= 1.25 \times 10^{-13}$.

9. (a) Values of energy in the excited state $= -\frac{13.6}{n^2}\ eV$

$= \frac{-13.6}{4} = -3.4\ eV$ in which $n = 2, 3, 4$ *etc.*

10. (c) $E_{1\ He^+} = E_{1\ H} \times z^2$

$-871.6 \times 10^{-20} = E_{1H} \times 4$

$E_{1\ H} = -217.9 \times 10^{-20}\ J$

11. (a) 42*g* of N_3^- ions have $16\,N_A$ valence electrons 4.2*g* of N_3^- ion have $= \frac{16\,N_A}{42} \times 4.2 = 1.6\,N_A$.

12. (d) I^{st} excited state means $n = 2$

$r = r_0 \times 2^2 = 0.53 \times 4 = 2.12$ Å

13. (d) Frequency $\nu = 12 \times 10^{14}\ s^{-1}$ and velocity of light $c = 3 \times 10^{10}\ cm\ s^{-1}$. We know that the wave number

$$\bar{\nu} = \frac{\nu}{c} = \frac{12 \times 10^{14}}{3 \times 10^{10}} = 4 \times 10^4\ cm^{-1}$$

14. (c) The last line in any series is called series limit. Series limit for Balmer series is 3646 Å.

15. (b) $E = \frac{-13.6}{n^2} = \frac{-13.6}{4} = -3.4\ eV$

We know that energy required for excitation $\Delta E = E_2 - E_1$

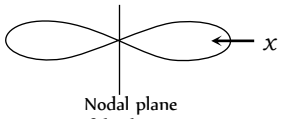
$= -3.4 - (-13.6) = 10.2\, eV$

Therefore energy required for excitation of electron per atom

$= \frac{10.2}{6.02 \times 10^{23}} = 1.69 \times 10^{-23}\, J$

17. (a) The number of nodal plane are present in a p_x is one or no. of nodal place = *l*

for p_x orbital *l* = 1



18. (b) In Balmer series of hydrogen atomic spectrum which electronic transition causes third line $O \rightarrow L$, $n_2 = 5 \rightarrow n_1 = 2$

20. (b) $\bar{\nu} = \frac{1}{\lambda} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$= \frac{1}{\lambda} = R_H\left[\frac{1}{3^2} - \frac{1}{n_2^2}\right] = n_2 = 3$ for Paschen series.

21. (a) $E \propto \left[\frac{1}{n_2^2} - \frac{1}{n_1^2}\right]$

23. (d) $\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{8 \times 10^{15}} = 3.75 \times 10^{-8}$

$= 3.75 \times 10^{-8} \times 10^9 nm = 4 \times 10^1 nm$.

Assertion & Reason

1. (d) The assertion is false but the reason is true exact position and exact momentum of an electron can never be determined as according to Hesenberg's uncertainity principle even with the help of electron microscope because when e^- beam of electron microscope strikes the target e^- of atom, the impact causes the change in velocity of e^- thus attempt to locate the e^- changes ultimately, the momentum & position of e^-.

$\Delta x.\Delta p \geq \frac{h}{4\pi} \approx 0.57\, ergs\,\text{sec}/gm.$

2. (d) Both assertion and reason are false. $2p_x$ and $2p_y$ orbitals are degenerate orbitals, i.e., they are of equal energy and hence no possibility of transition of electron.

3. (a) We know that principal quantum number represent the main energy level or energy shell. Since each energy level is associated with a definite amount of energy, this quantum number determines to a large extent te energy of an electron. It also determines the average distance of an electron around the nucleus. Therefore both Assertion and Reason are true and the Reason is a correct explanation of the Assertion.

4. (a) It is observed that a nucleus which is made up of even number of nucleons (No. of n & p) is more stable than nuclie which consist of odd number of nucleons. If number of neutron or proton is equal to some numbers *i.e.,* 2,8, 20, 50, 82 or 126 (which are called magic numbers), then these passes extra stability.

5. (c) The assertion that the isobars are the atoms of different elements having same mass number but different atomic number, is correct but reason is false because atomic mass is sum of number of neutron and protons which should be same for isobars.

6. (d) We know from the Pauli exclusion principle, that two electrons in the same atom can not have same value of all four quantum numbers. This means each electron in an atom has only one set of values for n, l, m and s. Therefore both the Assertion and Reason are false.

7. (e) We know that the line in Balmer series of hydrogen spectrum the highest wavelenght or lowest energy is between $n_1 = 2$ and $n_2 = 3$. And for Balmer series of hydrogen spectrum, the value of $n_1 = 2$ and $n_2 = 3,4,5$. Therefore the Assertion is false but the Reason is true.

8. (d) We know that Absorption spectrum is produced when white light is passed through a substance and transmitted light is analysed by a spectrograph. The dark spaces corresponds to the light radiation absorbed by the substance. And emission spectrum is produced by analysing the radiant energy emitted by an excited substance by a spectrograph. Thus discontinuous spectra consisting of a series of sharp lines and separated by dark bands are obtained. Therefore both the Assertion and Reason are false.

9. (a) We know that a resonance hybrid or the actual molecule is always more stable than any of its canonical structures which is also called hypothetical or imaginary structures. This stability is due to delocalization of electrons and is measured in terms of resonance energy or delocalization energy, it is defined as the difference in internal energy of the resonance hybrid and the most stable canonical structure. Therefore both the Assertion and Reason are true and the Reason is a correct explantion of the Assertion.

10. (e) We know that cathode rays cast shadows of solid objects placed in their path. During experiment performed on these rays, fluorescene (flash of light) is observed in the region, outside the shadow. This shows that cathode rays travel in straight lines. We also known that cathode rays penetrate through a thin sheet of metals but are stopped by thick sheets. Therefore both Assertion and Reason are false.

11. (b) We know that electrons are revolving around the nucleus at high speed in circular paths. The centrifugal force (which arises due to rotation of electrons) acting outwards, balances the electrostatic force of attraction (which arises due to attraction between electrons and nucleus). This prevent the electron from falling into the nucleus. We also know that Rutherford's model of atom is comparable to the "solar system". The nucleeus represent the sun whereas revolving electrons represent the planets revolving around the sun. Thus revolving electron are also called planetary electrons. Therefore both Assertion and Reason are true but Reason is not a correct explanation of Assertion.

12. (c) Assertion is true but Reason is false. Threshold frequency is a minimum frequency required for the emission of electrons from the metal surface.

13. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

Radius, $r = \frac{n^2h^2}{4\pi e^2 mZ} = \frac{n^2}{Z} \times 0.529 Å.r_n$ also increases indicating a greater separation between the orbit and the nucleus.

14. (d) Both assertion and Reason are false. Only s-orbital is spherically symmertrical. Shape of different d orbitals is as below.

15. (c) Assertion is true but reason is false. Spin angular momentum of the electron, a vector quantity, can have two orientations (represented by + and – sign) relative to a chosen axis. These two orientation are distinguished by the spin quantum number m_s equals to $+\frac{1}{2}$ or $-\frac{1}{2}$. These are called the two spin

states of the electron and are normaly represented by the two arrows $\uparrow$ (spin up) and $\downarrow$ (spin down) respectively.

16. (d) Both assertion and reason are false. Total number of orbitals associated with Principal quantum number $n = 3$ is 9. One $3s$ orbital + three $3p$ orbital + five $3d$ orbitals. $\therefore$ Therefore there are a total number of nine orbitals. Number of orbitals in a shell equals to n^2.

17. (c) Assertion is true but reason is false. The order $1s < 2s = 2p < 3s = 3p = 3d < ....$ is true for the energy of an electron in a hydrogen atom and is solely determined by Principal quantum number. For multielectron system energy also depends on azimuthal quantum number. The stability of an electron in a multi electron atom is the net result of the attraction between the electron and the uncleus and the repulsion between the electron and the rest of the electron present. Energies of different subshell (azimuthal quantum number) present within the same principal shell are found to be in order of $s < p < d < f$.

18. (e) Assertion is false but reason is true. Splitting of the spectral lines in the presence of a magnetic field is known as Zeeman effect or in electric field it is known as stark effect. The splitting of spectral lines is due to different orientations which the orbitals can have in the presence of magnetic field.

19. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

20. (e) Assertion is false but reason is true. Atomic orbital is designated by n, l and m_l while state of an electron in an atom is specified by four quantum numbrs n, l, m_l and m_s.

21. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. The difference between the energies of adjacent energy levels decreases as we move away from the nucleus. Thus in H atom

$$E_2 - E_1 > E_3 - E_2 > E_4 - E_3 .....$$

22. (d) Both assertion and reason are false. Cathode rays are stream of electrons. They are generated through gases at low pressure and high voltage.

23. (d) Both assertion and reason are false. In case of isoelectronic, i.e., ions, having the same number of electrons and different nuclear charge, the size decreases with increase in atomic number.

Ion	At. No.	No. of electrons	Ionic radii
Na^+	11	10	0.95Å
Mg^{2+}	12	10	0.65Å
Al^{3+}	13	10	0.50Å