ATOMIC STRUCTURE

(MAIN)

FOUNDATION BUILDER (OBJECTIVE)

1. $_{3}Li^{6} + ? \longrightarrow {}_{2}He^{4} + {}_{1}H^{3}$

   By law of conservation of mass and change the missing particle in neutron $\left({}_{0}^{0}n^{1}\right)$

2. $\frac{e}{M}$ ratio lies in the sequence $n < \alpha < p < l$

Particle	Change	Mass
$\propto$	+ 2	+ 4
n	0	+ 1
p	+ 1	+ 1
e	− 1	$= 1/1837$

   $\left(e/m\right)$ order $\longrightarrow$ $n < \propto < P < e$

3. Atomic Number = No. of protons in atom

   By equation of change

   $-1\times 56 + 1\times x = -2$

   $\Rightarrow \quad x = 54$

4. Same number of neutrons hence, Isotones.

5. Cathode Ray are made of electrons hence, same change/mass ratio as of β particle.

6. From Muliken's oil drop experiment, it was found that change on oil droplets is qualified.

   Hence,

   q = ne . where $e = -1.6\times 10^{-19}$, n = 1, 2, 3…

   $\therefore \quad$ (B)

7. $f = \frac{1}{T} \Rightarrow f = 1/2\,Hz$

8. $VIBGYOR^{\text{highest wavelength}}_{\text{lowest frequency}}$

   $Energy \propto freq.$

   $\therefore$ (D) red

9. (c)

10. Wave number $\Rightarrow \bar{\upsilon} = \frac{1}{\lambda}$

   $\Rightarrow \quad \frac{1}{500\times 10^{-9}} \quad \Rightarrow \quad \frac{\overset{2}{\cancel{1000}}\times 10}{\cancel{500}}$

$\therefore$ (c)

11. $E = \frac{hc}{\lambda}, \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} = 2$

12. $\text{Frequency} = \frac{\text{velocity}}{\text{wavelength}} = \frac{3 \times 10^8}{5090 \times 10^3}$

13. $E = nh\nu$

$n = \frac{E}{h\nu}$

$= \frac{10^3}{6.626 \times 10^{-34} \times 880 \times 10^3} = 1.72 \times 10^{30}$

14. $E_{photon} = \frac{12400}{\lambda\left(\text{in}A^0\right)} = \frac{12400}{8900} = 1.393\,eV$

$1.393 \times 1.6 \times 10^{-19} \times x = 3.15 \times 10^{-14}$

$x = \frac{3.15}{1.393 \times 1.6} \times 10^5 \quad x = 1.41 \times 10^5$

$\therefore \quad (c)$

15. $E_{absorbed} \times \frac{50}{100} = E_{emitted\ out}$

$\frac{hc}{\lambda_{absorbed}} \times n_1 \times \frac{50}{100} = n_2 \times \frac{hc}{\lambda_{emitted}}$

$\frac{n_2}{n_1} = \frac{50}{100} \times \frac{\lambda_{emitted}}{\lambda_{absorbed}} = \frac{50}{100} \times \frac{5000}{4500} = \frac{5}{9} = 0.55$

16. As PE = - 2 KE

PE will change from $-2x$ to $-\frac{2x}{4}$

$= \quad -\frac{x}{2} + 2x = +\frac{3}{2}x$

17. $T_E = \frac{PE}{2}$, so first excited state

18. $TE = \frac{-13.6\ Z^2}{n^2} = \frac{-13.6 \times 16}{16} = -13.6$ and $TE = \frac{PE}{2}$

$\Rightarrow \quad PE = -27.2\ eV$

19. $TE = \frac{-13.6\ Z^2}{n^2} = \frac{-13.6 \times 1}{9} = -1.511$

$TE = \frac{PE}{2} \Rightarrow PE = -3.02 eV \qquad TE = -KE \Rightarrow KE = 1.51 eV$

20. $r = \frac{0.529n^2}{Z} A^0$

$r_{3rd} = \frac{0.529 \times 9}{2} = 2.3805 A^0$ $\quad$ $r_{4th} = \frac{0.529 \times 16}{2} = 4.232$

21. $r_x = \frac{0.529\ n^2}{Z}$, n = 4

$r_H = \frac{0.529n^2}{Z}$, n = 1, z = 1

$\Rightarrow \quad \frac{0.529 \times 16}{Z} < 0.529 \quad \Rightarrow Z > 16$

$R_x < r_H$

22. $v = 2.18 \times 10^6 \frac{Z}{n}$

$v \propto \frac{Z}{n} \qquad \frac{v_1}{v_2} = \frac{n_2}{n_1} = \frac{5}{3}$

$\therefore$ (B)

23. $r_2 = \frac{a_0 \times 4}{Z} = R \qquad r_3 = \frac{a_0 \times 9}{Z} = R$

$\Rightarrow \quad r_3 = \frac{9R}{4}$

24. Ground state of hydrogen atom = 0.529 Å

$r = \frac{0.529 \times n^2}{z} = \frac{0.529 \times (n)^2}{4} = 0.529 \qquad \Rightarrow \quad n = 2$

25. $V = \frac{2.18 \times 10^6 Z}{n}$, $v\ \alpha\ z$, $v\ \alpha\ \frac{1}{n}$

26. $\nu = \frac{V}{2\pi r} = \frac{2.18 \times 10^6 \times \frac{1}{2}}{2\pi \times 4 \times 0.529 \times 10^{-10}} = 8.13 \times 10^{14}\ s^{-1}$

27. $E = \frac{nhC}{\lambda} = nhc\bar{\upsilon}$

$10 = nhcx \qquad n = \frac{10}{hcx}$

28. $E = \frac{13.6Z^2}{n^2} = \frac{13.6 \times 1}{4} = 3.4$

29. $mvr = \frac{nh}{2\pi}$

$r = \frac{0.529n^2}{Z}$ mvr $\alpha \sqrt{r}$

Angular momentum $\alpha\sqrt{r}$

30. $\nu = \frac{V}{2\pi r} \propto \frac{Z^2}{n^3}$

$\nu_H = \frac{1}{27} = T$ $\nu_{He^+} = \frac{4}{8} = x$

$\frac{2}{27} = \frac{T}{x}$ $x = \frac{27}{2}T$

= B

31. $TE = \frac{-13.6Z^2}{n^2} eV$

$TE_{4,H} = \frac{-13.6}{16} eV = -KE = -E$ $TE_{Li^{2+}} = \frac{-13.6 \times 9}{1} = x$

$\frac{1}{144} = \frac{-E}{x}$

X = –144 E

32. $R_{H} \times 1^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = R_{H} \times 2^2 \left(\frac{1}{n_1^{12}} - \frac{1}{n_2^{12}}\right)$

$\Rightarrow$ $1 \times \left(\frac{1}{1} - \frac{1}{25}\right) = 4 \times \left(\frac{1}{1} - \frac{1}{n_2^2}\right)$

$\Rightarrow$ $\frac{\cancel{24}^{6}}{25} = \cancel{4} \times \frac{n_2^2 - 1}{n_2^2}$ $\Rightarrow$ $6n_2^2 = 25n_2^2 - 25$

$\Rightarrow$ $19n_2^2 = 25$ $\Rightarrow$ $n_2^2 = \frac{25}{15} = 1$

$\therefore$ (b)

33. $f = \frac{KZe^2}{r^2}$

$= \frac{KZe^2}{\left(\frac{0.529n^2}{Z}\right)^2} \propto \frac{Z^3}{n^4}$ $f_{Li^{2+}} = \frac{27}{16} = f$

$f_H = \frac{1}{1} = x$ $\frac{27}{16} = \frac{f}{x}$

X = 16f/27

34. $a = \frac{V^2}{r}$

$= \frac{\frac{(2.18 \times 10^6)^2 Z^2}{n^2}}{\frac{0.529n^2}{Z}}$ $\propto \frac{z^3}{n^4}$

$a_{1,He^+} \propto \frac{8}{1}$ $\qquad$ $a_{2,Be^{3+}} \propto \frac{64}{16}$

$\Rightarrow \quad a_{2,Be^{3+}} = \frac{1}{2}\zeta$

35. Follow the expression

$r = \frac{n^2 \times 0.529}{Z}$

$\Rightarrow$ (d)

36. Follow the expression

$E = \frac{-13.6Z^2}{n^2}$

$\Rightarrow$ (a)

37. See theory

38. $2n_2 + 3n_1 = 18$

$2n_2 - 3n_1 = 6$

Solve this and we get

$n_1 = 2,\ n_2 = 6$

So, $\frac{(6-2)(6-2+1)}{2} = 10$

39. $n_1 + n_2 = 4$

$n_2 - n_1 = 2$

$\Rightarrow \ n_2 = 3,\ n_1 = 1$

$\bar{\upsilon} = \frac{1}{\lambda} = R_H \times 2^2\left(\frac{1}{1^2} - \frac{1}{3^2}\right)$

$= R_H \times 4\left(\frac{8}{9}\right)$

40. $\frac{1}{\lambda} = R_H Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$\nu = \frac{c}{\lambda} = cR_H Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$\nu = \frac{c}{\lambda} = cR_H Z^2\left(\frac{1}{n^2} - \frac{1}{(n+1)^2}\right) = cR_H Z^2\left(\frac{2n+1}{n^2(n+1)^2}\right)$

When n >>> 1 then (n +1) $\approx$ n and (2n + 1) $\approx$ 2n

$\nu = 2cR_H Z^2 \frac{n}{n^4} = \frac{2cR_H Z^2}{n^3}$

41. $\frac{1}{\lambda_{min}} = 3^2 \times R\left(\frac{1}{3^2} - 0\right) = R$

$\Rightarrow \lambda_{min} = \frac{1}{R}$

42. $\frac{1}{\lambda_{max}} = R_H \times (2)^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$

$$\frac{1}{\lambda_{max}} = R_H \times 4\left(\frac{1}{1} - \frac{1}{4}\right) \qquad \Rightarrow \lambda_{max} = \frac{1}{3R_H}$$

43. $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) = R\left(\frac{1}{1^2} - \frac{1}{n^2}\right)$

$$n = \left[\frac{\lambda R}{\lambda R - 1}\right]^{\frac{1}{2}}$$

44. $E = E_1 + E_2$

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$$

$$\lambda = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

45. $\frac{1}{\lambda} = R_H Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$$\frac{1}{2170 \times 10^{-9}} = R_H\left(\frac{1}{n^2} - \frac{1}{7^2}\right) \qquad \Rightarrow n = 4$$

46. $\frac{n(n-1)}{2} = 15$

$n = 6$

$$\frac{1}{\lambda} = R_H Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

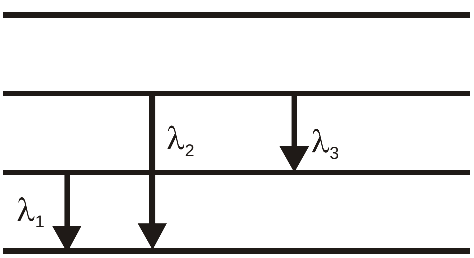
$$\frac{1}{\lambda} = 109677\left(\frac{1}{1^2} - \frac{1}{6^2}\right)$$

$= 937.3$ Å

47. $\frac{n(n-1)}{2} = 6$

$n = 4$, so excited state is 3^{rd}

48.



$1/\lambda_2 = 1/\lambda_1 + 1/\lambda_3$

$\lambda_2 = \lambda_1\lambda_3/ (\lambda_1 + \lambda_3)$

49. $\frac{1}{\lambda_L} = R_H\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) \Rightarrow \frac{1}{x} = R_H$

$$\frac{1}{\lambda_B} = R_H \times 4\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{1}{\lambda_B} = \frac{1}{x} \times \frac{5}{9}$$

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

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

$\Delta x = \Delta p$

$(\Delta p)^2 = \frac{h}{4\pi}$, $\Delta p = \sqrt{\frac{h}{4\pi}}$

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

$\Delta V = \frac{1}{2m}\sqrt{\frac{h}{\pi}}$

51. mass = 100×10^3 kg

V = 23.76 km s/hr = $23.76 \times \frac{5}{18}$ m/s

h = 6.6×10^{-34}

$\lambda = \frac{h}{mV} = \frac{6.626 \times 10^{-34}}{100 \times 10^3 \times 23.76 \times \frac{5}{18}} \simeq 10^{-39}$ m

52. $KE = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{h}{m\lambda}\right)^2 \quad \left(\begin{array}{l}\lambda = \frac{h}{mv} \\ v = \frac{h}{m\lambda}\end{array}\right)$

$= \frac{1}{2}\frac{mh^2}{m^2\lambda^2} = \frac{1}{2}\frac{h^2}{m\lambda^2}$

$KE \propto \frac{1}{m}$

53. $2\pi r = n\lambda$

$\lambda = \frac{2\pi r}{n} \quad \Rightarrow \lambda = \frac{2\pi \times 3^2 x}{3} = 6\pi x$

54. $\left.\begin{array}{l} m = 200g \\ v = 10\ ms^{-1}\end{array}\right\} \Delta V = \frac{0.1}{100} \times 10$

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

$\Delta x = \frac{h}{4\pi m\Delta v} = \frac{6.626 \times 10^{-34}}{4\pi \times \frac{200}{1000} \times \frac{0.1}{100} \times 10}$

55. Follow theory

56. (Follow theory)

57. $\nu = 3.5 \times 10 Hz$

$\nu_0 = 1.5 \times 10^{15} Hz$

h = 6.6×10^{-34}

KE = $h\nu - h\nu_0$

$KE = 6.6 \times 10^{-34}(3.5 \times 10^{15} - 1.5 \times 10^{15}) = 1.32\times10^{-18}$ J

58. $KE = h\nu - h\nu_0$

$$\frac{1}{2}mv^2 = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$

$$v^2 = \frac{2hc}{m}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$

$$v = \sqrt{\frac{2hc}{m}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)}$$

$$v = \sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$$

59. See theory

60. Orbital angular momentum = $\sqrt{l(l+1)}\,\frac{h}{2\pi} = \sqrt{6}\times\frac{h}{2\pi}$

61. $\lambda = \frac{h}{mV}$

62. See theory

63. See theory

64. $\sqrt{l(l+1)}\,\frac{h}{2\pi}$

65 to 74. See theory

75. n = 3, l = 3, m = 0, s = –1/2

Not possible

76. Follow n + l rule

77. Follow theory

78. Follow n + l rule

79. A g subshell will have 9 orbitals so there will be 18 electrons

80. 26(Iron) follow electronic configuration

81. (D) is not possible because ‘P’ sub shell cannot have more than 7 electrons.

82. $Mn = 3d^5\, 4s^2$

$Ti = 3d^2\, 4s^2$

$V = 3d^3\, 4s^2$

$Al = 3s^2\, 3p^1$

83. $\sqrt{n(n+2)}$ $Fe = 3d^6\, 4s^2$

n = 5

$\sqrt{5(5+2)}$

84. $s=\pm\frac{1}{2}\times5=\frac{5}{2}$

85. See configuration.

86. Same as 92

87. See Theory

88. $\mu=\sqrt{n(n+2)}$

$2.83=\sqrt{n(n+2)}$

89. Same as 98

90. $\mu=\sqrt{n(n+2)}$

$1.73=\sqrt{n(n+2)}$

N = 1

91. $\mu=\sqrt{n(n+2)}$

Write the electric configuration for both fe and Co and after removal of 3 electron from cobalt the unpaired in $Fe^{+3}=5$ and $Co^{+3}=4$

GET EQUIPPED TO MAINS

1. **(C)**

$E_{1,Li^{2+}}=\frac{9}{4}E_{1,He^{+}}=\frac{9}{4}\times19.6\times10^{-18}$

$=4.41\times10^{-17}$ J

2. **(D)**

$n\ell$: $1s^2 2s^2 2p^6 3s^2 3p^1$

$\Rightarrow$ outermost e^- : $n=3$, $\ell=1$

3. **(A)**

$E=\frac{hc}{\lambda}\Rightarrow\frac{E_1}{E_2}=2$

4. **(B)**

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

$\ell=1\Rightarrow$ p subshell $\Rightarrow 12e^-$

$\ell=2\Rightarrow$ d subshell $\Rightarrow 10e^-$

5. **(D)**

Orbital angular momentum $\alpha\sqrt{\ell(\ell+1)}$

$\Rightarrow$ same ℓ value has same orbital angular momentum.

6. **(B)**

By $(n+\ell)$ rule

7. **(B)**

$r_3He^+ = \frac{n^2}{Z}a_0 = \frac{3^2}{2}a_0 = 4.5a_0$

8. **(C)**

$\nu = \frac{C}{\lambda} = \frac{3\times10^8}{500\times10^{-9}} = 6\times10^{14}$ Hz

9. **(D)**

$\frac{1}{\lambda} = 9\times15200 = 136800$

10. **(D)**

11. **(A)**

Atomic no. $= 25 \quad \Rightarrow$ Mn

12. **(C)**

2^{nd} series $\Rightarrow$ Balmer

4^{th} Line in Balmer $\Rightarrow 6\to2$

13. **(A)**

Paschal Lines : $5\to3$

$4\to3$

14. **(B)**

15. **(A)**

$E = \frac{1240}{242}\times1.6\times10^{-19}\times6.022\times10^{23}\times\frac{1}{1000}$

16. **(C)**

m cannot be greater then ℓ

17. **(A)**

18. **(D)**

19. **(A)**

$\frac{1}{\lambda} = R\left(\frac{1}{4}-\frac{1}{9}\right) = \frac{5R}{36}$

20. **(D)**

$$r = \frac{n^2}{Z} a_0$$

21. **(A)**

$1s^2 2s^2 2p^4$

No. of unpaired electron $= 2$

$\Rightarrow$ total spin $= 1$

Magnetic moment $= \sqrt{2 \times 4} = \sqrt{8}$

22. **(B)**

No. of angular nodes $= 2$

23. **(A)**

$$E = x\left(\frac{1}{4} - \frac{1}{9}\right) = \frac{5x}{36}$$

24. **(B)**

25. **(C)**

$$\text{Orbital angular momentum} = \sqrt{2 \times 3}\,\frac{\pi}{2\pi}$$

$$= \sqrt{6}\,\frac{h}{2\pi}$$

26. **(B)**

No. of radical nodes $= n - \ell - 1$

$= 2 - 1 - 1 = 0$

27. **(B)**

$$p = \frac{6.6 \times 10^{-34}}{0.1 \times 10^{-9}} = 66 \times 10^{-25}$$

28. **(D)**

29. **(D)**

$$\frac{nh}{2\pi} = \frac{2h}{\pi} = n = 4$$

$$\frac{1}{\lambda} = R\left(\frac{1}{9} - \frac{1}{16}\right)$$

$$\lambda = \frac{144}{7R}$$

30. **(B)**

Min. $\lambda \Rightarrow$ Max. E

31. **(C)**

$$\frac{1}{\lambda} = R\left(\frac{1}{4} - \frac{1}{n^2}\right)$$

$$\lambda = \frac{4n^2}{R\left(n^2 - 4\right)} \Rightarrow R = \frac{4}{R}$$

32. **(a)**

$E_{C\to A} = E_{C\to B} + E_{B\to A}$

$= \frac{1240}{364.6} + \frac{1240}{121.5}$ eV

$= 3.4 + 10.2 \qquad = 13.6\,\text{eV}$

$= 13.6 = \frac{1240}{\lambda} \qquad \Rightarrow \lambda = 91.17\,\text{nm}$

33. **(a)**

Minimum $= 1 \qquad 4 \to 1$

Maximum $= 4 \qquad 4 \to 3 \to 2 \to 1\ \&\ 4 \to 1$

$\frac{\Delta n(\Delta n + 1)}{2} \to$ only if sufficiently large number of atoms are present

34. **(d)**

Shortest wavelength implies maximum energy

$\therefore \frac{n(n-1)}{2} = 15$

$\Rightarrow \frac{1}{\lambda_{6\to 1}} = R_H (1)^2 \left(\frac{1}{1} - \frac{1}{36}\right)$

$\frac{1}{\lambda} = \frac{35R}{36} \qquad \therefore \lambda = \frac{36}{35R}$

35. **(c)**

Total orbitals $= 3\ell + 1$

$= 3 \times 2 + 1$

$= 7$

e^- in 1 orbital still $= 2$

Since it has only 2 types of spin

36. **(b)**

$L = \frac{nh}{2\lambda}$

37. **(b)**

$235 + 1 = 196 + x + 3$

$\Rightarrow x = 90 - 3 = 87$

38. **(c)**

Radial $= 1 \to$ spherical

Angular $3 - 1 - 1 = 1$

39. **(a)**

$S \to$ spherical (non-directional)

40. $E_{111\to 1} = 2E - E = \frac{hc}{\lambda}$

$$E_{11\to1} = \frac{4E}{3} - E = \frac{hc}{\lambda'}$$

$$\Rightarrow \frac{E}{3} = \frac{hc}{\lambda'}$$

$$\Rightarrow \lambda' = 3\lambda$$