ATOMIC STRUCTURE

(ADVANCED)

FOUNDATION BUILDER (OBJECTIVE)

1. **(A)**

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

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

2. **(D)**

$\frac{e}{M}$ 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. **(D)**

Atomic Number = No. of protons in atom

By equation of change

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

$\Rightarrow \quad x = 54$

4. **(D)**

Same number of neutrons hence, Isotones.

5. **(B)**

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

6. **(B)**

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…

$\therefore$ (B)

7. **(B)**

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

8. **(D)**

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

Energy $\propto$ freq.

$\therefore$ (D) red

9. **(C)**

10. **(C)**

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

$$\Rightarrow \quad \frac{1}{500\times10^{-9}} \quad \Rightarrow \quad \frac{\overset{2}{\cancel{1000}}\times10}{\cancel{500}}$$

11. **(B)**

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

12. **(B)**

$$\text{Frequency} = \frac{\text{velocity}}{\text{wavelength}} = \frac{3\times10^8}{5090\times10^3}$$

13. **(B)**

$$E = nh\nu$$

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

$$= \frac{10^3}{6.626\times10^{-34}\times880\times10^3} = 1.72\times10^{30}$$

14. **(C)**

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

$$1.393\times1.6\times10^{-19}\times x = 3.15\times10^{-14}$$

$$x = \frac{3.15}{1.393\times1.6}\times10^5 \qquad x = 1.41\times10^5$$

$\therefore$ (c)

15. **(A)**

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

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

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

16. **(A)**

As PE = - 2 KE

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

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

17. **(A)**

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

18. **(D)**

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

$\Rightarrow$ PE = - 27.2 eV

19. **(B)**

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

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

20. **(C)**

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

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

21. **(D)**

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

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

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

$R_x < r_H$

22. **(B)**

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

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

$\therefore$ (B)

23. **(D)**

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

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

24. **(B)**

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. **(D)**

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

26. **(D)**

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

27. **(C)**

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

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

28. **(C)**

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

29. **(D)**

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

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

Angular momentum $\alpha \sqrt{r}$

30. **(B)**

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

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

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

= B

31. **(A)**

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

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

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

X = –144 E

32. **(B)**

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

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

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

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

$\therefore$ (b)

33. **(D)**

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

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

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

X = 16f/27

34. **(C)**

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

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

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

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

35. **(D)**

Follow the expression

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

$\Rightarrow$ (D)

36. **(A)**

Follow the expression

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

$\Rightarrow$ (A)

37. **(B)**

See theory

38. **(A)**

$2n_2 + 3n_1 = 18$

$2n_2 - 3n_1 = 6$

Solve this and we get

$n_1 = 2,\ n_2 = 6$

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

39. **(B)**

$n_1 + n_2 = 4$

$n_2 - n_1 = 2$

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

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

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

40. **(A)**

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

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

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

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. **(C)**

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

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

42. **(B)**

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

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

43. **(B)**

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

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

44. **(B)**

$E = E_1 + E_2$

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

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

45. **(C)**

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

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

46. **(A)**

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

$n = 6$

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

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

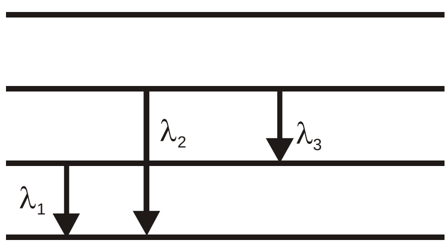
$= 937.3$ Å

47. **(A)**

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

n = 4, so excited state is 3rd

48. **(B)**



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

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

49. **(A)**

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

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

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

50. **(C)**

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

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

$$\Delta x = \Delta p$$

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

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

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

51. **(C)**

Mass = 100×10^3 kg

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

h = $6.\ 6 \times 10^{-34}$

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

52. **(C)**

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{h}{m\lambda}\right)^2 \left(\begin{matrix}\lambda = \frac{h}{mv} \\ v = \frac{h}{m\lambda}\end{matrix}\right)$$

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

$$KE \; \alpha \; \frac{1}{m}$$

53. **(B)**

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

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

54. **(D)**

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

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

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

55. **(A)**
Follow theory

56. **(C)**
Follow theory

57. **(A)**

$\nu = 3.5 \times 10Hz$

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

$h = 6.6 \times 10^{-34}$

$KE = h\nu - h\nu_0$

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

58. **(C)**

$KE = h\nu - h\nu_0$

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

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

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

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

59. **(D)**

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

$$\frac{\lambda_A}{\lambda_B} = \frac{v_B}{v_A}$$

When $\lambda_B = 2\lambda_A$, then $V_A = 2V_B$

$$KE = \frac{1}{2}mv^2$$

$$\frac{T_A}{T_B} = \frac{V_A^2}{V_B^2}$$

$$\frac{T_A}{T_B} = \frac{4}{1}$$

Also $T_A - T_B = 1.50$

$\therefore \quad T_B = 0.50$

$T_A = T_B + 1.5$

$= 0.50 + 1.50$

$= 2$

Also, $4.25 = W_A + T_A$

$4.20 = W_B + T_B$

$W_A = 4.25 - 2 = 2.25$

$W_B = 4.20 - 0.50 = 3.70$

60. **(B)**

$$K_A = E_A - 2 \quad K_B = E_B - 4$$

$$\lambda_A = \frac{h}{\sqrt{2mK_A}}, \lambda_B = \frac{h}{\sqrt{2mK_B}}$$

$$\frac{\cancel{h}}{\sqrt{\cancel{2m}\,K_B}} = 2\frac{\cancel{h}}{\sqrt{\cancel{2m}\,K_A}}$$

$$\frac{1}{K_B} = \frac{4}{K_A}$$

$$E_A - 2 = 4E_B - 16 \qquad E_A - 2 = 4E_A + 2 - 16$$

$$3E_A = 12 \Rightarrow E_A = 4$$

$$\Rightarrow \quad E_B = 4.5$$

61. **(A)**

See theory

62. **(A)**

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

63. **(A)**

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

64. **(C)**
See theory

65. **(D)**
See theory

66. **(B)**

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

67. **(B)**
See theory

68. **(A)**
See theory

69. **(D)**
See theory

70. **(D)**
See theory

71. **(C)**
See theory

72. **(D)**
See theory

73. **(B)**
See theory

74. **(C)**
See theory

75. **(A)**
See theory

76. **(A)**
See theory

77. **(D)**
n = 3, l = 3, m = 0, s = –1/2
Not possible

78. **(C)**
Follow n + l rule

79. **(D)**
Follow theory

80. **(A)**
Follow n + *l* rule

81. **(D)**
A g subshell will have 9 orbitals so there will be 18 electrons

82. **(C)**
Angular part cannot be 0 so no angular node , Hence s orbital. Two radial node means 3s

83. **(D)**
See theory

84. **(C)**
n = 5

85. **(C)**
See the graphs

86. **(D)**
Follow n – l – l

87. **(C)**
Increasing Z will decrease radius

88. **(C)**

$$\Psi_{3s} = \frac{1}{9\sqrt{3}}\left(\frac{1}{a_0}\right)^{3/2}(6 - 6\sigma + \sigma^2)e^{-\frac{\sigma}{2}}\text{; where } r = \frac{2r.Z}{3a_0}$$

The maximum red all distance of node from nucleus will be $r = \frac{3}{2}\frac{(\sqrt{3}+3)}{Z}a_0$

Radial node occurs where probability of finding $e^- = 0$

$\therefore \quad \Psi^2 = 0$ or $\Psi = 0$

$\therefore \quad 6 - 6\sigma + \sigma^2 = 0$ or $\sigma = 3 \pm \sqrt{3} = \frac{2rZ}{3a_0} \Rightarrow r = \frac{3}{2}\frac{3+\sqrt{3}}{z}a_0$

89. **(C)**

Probability of finding e^{-} is zero implies mat $\Psi^2 = 0$ or $\Psi = 0$

$(\sigma - 1) = 0,\ \sigma = 1 \Rightarrow r = \frac{a_0}{2z}$

$(\sigma^2 - 8\sigma + 12) = 0$

$(\sigma - 6)\ (\sigma - 2) = 0$

$\sigma = 6,\ \Rightarrow\ r = \frac{6a_0}{2Z} = \frac{3a_0}{Z}$

$R = 2,\ \Rightarrow r = \frac{a_0}{Z}$

90. **(C)**

26(Iron) follow electronic configuration

91. **(D)**

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

92. **(A)**

$Mn = 3d^5\ 4s^2$

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

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

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

93. **(A)**

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

n = 5

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

94. **(C)**

$s = \pm\frac{1}{2} \times 5 = \frac{5}{2}$

95. **(A)**

See configuration.

96. **(D)**

Same as 92

97. **(C)**

See Theory

98. **(B)**

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

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

99. **(C)**

Same as 98

100. **(D)**

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

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

N = 1

101. **(B)**

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

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

FOUNDATION BUILDER (SUBJECTIVE)

1. $E = \frac{nhc}{\lambda}$

$600 = \frac{6.626\times10^{-34}\times3\times10^{8}\times2\times10^{22}}{\lambda}$

$600 = \frac{39.759\times10^{4}}{\lambda}$

$\lambda = 6630\,\text{nm}$

2. $E = \frac{hc}{\lambda} = \frac{19.878\times10^{-26}}{4.995\times10^{-7}}$

$= 3.979\times10^{-19}$ J

$3.979\times10^{-19}\,J = 1\,\text{photon}$

$10^{3}\,J = 0.251\times10^{22}$ photons

$\underline{0.25\times10^{22}}$

6.022×10^{23}

0.0416×10^{-1}

4.16×10^{-3}

3. $QE = \frac{\text{moles dissociated}}{\text{moles of photons abscrbed}}$

$2 = \frac{0.01}{\text{moles of photons absorbed}}$

$0.005\times6.022\times10^{23}$

$5\times10^{-3}\times6.022\times10^{23}$

30.11×10^{20}

4. Energy given to I_2 molecule $=\frac{hc}{\lambda}=\frac{6.626\times10^{-34}\times3\times10^{8}}{450\times10^{-10}}$

$$=4.417\times10^{-19}\text{ J}$$

Also energy used for breaking up of I_2 molecules

$$=\frac{240\times10^{3}}{6.022\times10^{23}}=3.948\times10^{-19}\text{ J}$$

$\therefore$ Energy used in importing KE to two I atoms = [4.417 – 3.984]

$$KE/\text{Iodine atom}=\left[4.417-\frac{3.984}{2}\right]\times10^{-19}$$

$$=0.216\times10^{-19}\text{ J}$$

5.

(a) $\frac{1}{\lambda}=R_H\left(\frac{1}{2^2}-\frac{1}{3^2}\right)=109677\left(\frac{1}{4}-\frac{1}{9}\right)$

$$=\frac{109677\times5}{36}=6564\overset{0}{A}$$

(b) $\frac{1}{\lambda}=R_H\left(\frac{1}{4^2}-\frac{1}{5^2}\right)=109677\left(\frac{1}{16}-\frac{1}{25}\right)$

$$=\frac{109677\times9}{400}=40523\overset{0}{A}$$

(c) $\frac{1}{\lambda}=R_H\left(\frac{1}{9^2}-\frac{1}{10^2}\right)=109677\left(\frac{1}{81}-\frac{1}{100}\right)$

6. **Lyman Series**

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

$$\frac{1}{\lambda}=\frac{109678\times3}{4}$$

$$\lambda=1015\overset{0}{A}$$

Balmer Series

$$\frac{1}{\lambda}=109678\left(\frac{1}{2^2}-\frac{1}{3^2}\right)$$

$$=109678\left(\frac{1}{4}-\frac{1}{9}\right)$$

$$=\frac{109678\times5}{36}$$

$$\lambda=6564\overset{0}{A}$$

Paschen Series

$$\frac{1}{\lambda}=109078\left(\frac{1}{3^2}-\frac{1}{4^2}\right)$$

$$=\frac{109678\times 7}{144}=18756\overset{0}{A}$$

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

$$\frac{1}{\lambda}=109678\times 3^2\left(\frac{1}{1^2}-\frac{1}{3^2}\right)$$

$$=109678\times 9\left(\frac{1}{1}-\frac{1}{9}\right)$$

$$=\frac{109678\times 9\times 8}{9}=113.9\overset{0}{A}\ \text{or 11.39 nm}$$

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

$$\frac{1}{2170}=1.09677\times 10^7\left(\frac{1}{n_1^{\ 2}}-\frac{1}{7^2}\right)$$

Solve $n_1=4$

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

$$\frac{1}{\lambda}=109678\left(\frac{1}{1^2}-\frac{1}{2^2}\right)$$

$$=\frac{109678\times 3}{4}$$

$$\lambda=1215\overset{0}{A}$$

10. Energy given to H atom = $\dfrac{6.626\times 10^{-34}\times 3\times 10^8}{1028\times 10^{-10}}$

$$=1.933\times 10^{-18}\,J=12.07\,eV$$

∴ Energy of the H atom offer excitation = – 13.6 + 12.07

∴ $$E_n=\frac{E_1}{n^2}$$

$$n^2=\frac{-13.6}{-1.53}\approx 9 \qquad n = 3$$

Thus electron in H atom is excited to 3rd orbit

I induced $\lambda_1=\dfrac{hc}{E_3-E_1}$

$E_1=-13.6\,eV$, $E_3=-1.53\,eV$

$$\lambda_1=\frac{6.026\times 10^{-34}\times 3\times 10^8}{(-1.53+13.6)\times 1.602\times 10^{-19}}=1028\times 10^{-10}\,m=1028\overset{0}{A}$$

$\therefore$ II Induced $\lambda_2 = \dfrac{hc}{E_2 - E_1}$

$E_1 = -13.6\,eV \qquad E_2 = \dfrac{-13.6}{4}\,eV$

$$\lambda_2 = \frac{6.626\times10^{-34}\times3\times10^{8}}{\left(\frac{-13.6}{4}+13.6\right)\times1.602\times10^{-19}} = 1216\times10^{-10}\,m = 1216\,\overset{0}{A}$$

$\therefore$ III Induced $\lambda_3 = \dfrac{hc}{E_3 - E_2}$

$E_1 = -13.6\,eV,\ E_2 = \dfrac{-13.6}{4}\,eV,\ E_3 = \dfrac{-13.6}{9}\,eV$

$$\lambda_3 = \frac{6.626\times10^{-34}\times3\times10^{8}}{\left(\frac{-13.6}{9}+\frac{13.6}{4}\right)\times1.662\times10^{-19}}$$

$= 6568\times10^{10}\,m = 6568\,\overset{0}{A}$

11. For visible line spectrum, i.e Balmer series $n_1 = 2$

Also for minimum energy transition. $n_2 = 3$

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

$$= 1.1\times10^{7}\left[\frac{1}{4}-\frac{1}{9}\right] = \frac{1.1\times10^{7}\times5}{36}$$

$\lambda = 6.55\times10^{-7}$ meter

$$E = \frac{hc}{\lambda} = \frac{6.626\times10^{-34}\times3\times10^{8}}{6.55\times10^{-7}} = 3.03\times10^{-19}\text{ Joules}$$

Energy released = $E\times N_A$

$= 3.03\times10^{-19}\times6.022\times10^{23}$

$= 18.25\times10^{4}\,J$

= 182.5 kJ

12. $\dfrac{1}{\lambda} = R_H\left(\dfrac{1}{1^2}-\dfrac{1}{6^2}\right)$

$= \dfrac{109677\times35}{36}$

$= 937.8\,\overset{0}{A}$

13. Threshold wavelength $\left(\lambda^0 = 230nm = 230\times10^{-9}m\right)$

$E_\rho = 13.6\left(1-\dfrac{1}{9}\right) = 12.09\,eV$

$$KE_{max} = 12.09\times1.6\times10^{-19} - \frac{6.626\times10^{-34}\times3}{230\times10^{-9}}$$

$=1.07\times10^{-18}$ J

14. $\overline{U}=1.096\times10^{7}\left[1-n^{2}\right]$ where n = 2

Maximum wavelength means. Minimum Energy (minimum tranish)

$\overline{U}=1.096\times10^{7}\left(1-2^{-2}\right]$

Maximum wavelength = $1215\overset{0}{A}$ or 1.216×10^{-7} meters

Minimum wavelength means maximum energy (max to)

$\overline{U}=1.096\times10^{7}\left(1-\infty^{-2}\right]$

0.912×10^{-7} meter

Series will be ultraviolet region

15. for He^{+}, $\frac{1}{\lambda}=R_H Z^2\left[\frac{1}{2^2}-\frac{1}{4^2}\right]$

For H $\frac{1}{\lambda}=R_H\left[\frac{1}{{n_1}^2}-\frac{1}{{n_2}^2}\right]$

Since λ is same

$$z^2\left[\frac{1}{2^2}-\frac{1}{4^2}\right]=\left[\frac{1}{{n_1}^2}-\frac{1}{{n_2}^2}\right]$$

$$\left[\frac{1}{1^2}-\frac{1}{2^2}\right]=\left[\frac{1}{{n_1}^2}-\frac{1}{{n_1}^2}\right]$$

$n_1=1$ and $n_2=2$

16. shortest wavelength [largest energy] max transition

$\frac{1}{\lambda}=\overline{U}=R_H\left[\frac{1}{2^2}-\frac{1}{\infty^2}\right]$

= 109677/4 $=27419\,cm^{-1}$

17. $V=\frac{2.18\times10^{6}Z}{n}$

$V\propto\frac{1}{n}$ $V=\frac{2.18\times10^{6}\times1}{2}=1.09\times10^{6}\,m/sec$

$T=\frac{2\pi r}{V}$

18. i) $E=\frac{-13.6Z^2}{n^2}=-\frac{13.6\times1}{9}=-1.51eV$

ii) $r=\frac{0.529\ n^2}{z}=0.529\times9=4.761\overset{0}{A}$

iii) $\frac{1}{\lambda}=R_H\left(\frac{1}{1^2}-\frac{1}{3^2}\right]$

$\frac{1}{\lambda}=109677\times1\left(\frac{8}{9}\right)$

$=1025\overset{0}{A}$ or 1.032×10^{-7} m

iv) $v = \frac{C}{\lambda} = \frac{3\times10^{8}}{1.032\times10^{-7}}\ \ 2.90\times15$

19. $r = \frac{0.529\,n^2}{Z}$

$r_I = 0.529\,\overset{0}{A}$

$r_{II} = 0.529\times4 = 2.116\,\overset{0}{A}$

$r_{III} = 0.529\times9 = 4.761\,\overset{0}{A}$

$r_I\ He^+ = \frac{0.529\times1}{2} = 0.2645\,\overset{0}{A}$

$r_{II}\ He^+ = \frac{0.529\times4}{2} = 1.058\,\overset{0}{A}$

$r_{III}\ He^+ = 0.529\times9 = 2.38\,\overset{0}{A}$

20. $E = \frac{313.6\times Z^2}{n^2} = \frac{313\times1}{16} = 19.6\,\text{Kcal}$

21.

$\frac{-13.6}{16}$ ______________ 4

$\frac{-13.6}{9}$ ______________ 3

$\frac{-13.6}{4}$ ______________ 2

– 13. 6 ______________ 1

$E_3 - E_1 = -1.51-(-13.6)$ = 12.09 eV

22. $E_n = \frac{-2.17\times10^{-12}}{n^2}\text{erg}$

$E_2 = -\frac{21.7\times10^{-12}}{4} = -5.425\times10^{-12}\ \text{erg}$

For removal of electron $E_2 = \frac{hc}{\lambda}$ E_2 should be given to remove electron i.e. + ve

$\lambda = \frac{6.626\times10^{-27}\times3\times10^{10}}{5.425\times10^{-12}} = 3663.6\times10^{-8}\ \text{cm} = 3663.6\,\overset{0}{A}$

So the longest wavelength = $3663-6\,\overset{0}{A}$

23. $E_1\ \text{for}\ Li^{2+} = \frac{E_1\,\text{for}\,H\times Z^2}{n^2} = \frac{13.6\times9}{4} = 30.6\,\text{eV}$

$E_1\ \text{for}\ Be^{3+} = \frac{E_1\,\text{for}\,H\times Z^2}{n^2} = \frac{13.6\times16}{4} = 54.4\,\text{eV}$

24. Energy of one photon = $\frac{hc}{\lambda}$

$$=\frac{6.626\times10^{-34}\times3\times10^{8}}{4500\times10^{-10}}\,J$$

$$=4.42\times10^{-19}\,J$$

Energy emitted by bulb $=150\times\frac{8}{100}\ J/sec\left(watt=\frac{J}{sec}\right)$

$\therefore\quad n\times4.42\times10^{-19}=150\times\frac{8}{100}$

$n=27.2\times10^{18}$

25. E_3 for H = -2.41×10^{-12} erg

E_2 for H = -5.42×10^{-12} erg

$\therefore$ for a jump from III to II shell

$$\Delta E=E_3-E_2=\frac{hc}{\lambda}$$

$$\lambda=\frac{hc}{E_3-E_2}=\frac{6.626\times10^{-27}\times3\times10^{10}}{-2.41\times10^{-12}+5.42\times10^{-12}}$$

$$=6602.9\times10^{-8}\,cm=6603\,\overset{0}{A}$$

26. $V=\frac{2.18\times10^{6}\times Z}{n}=\frac{2.18\times10^{6}}{3}$

$=0.726\times10^{6}$

27. $v=\frac{V}{2\pi r}=\frac{2.18\times10^{6}}{2\times2\times3.14\times0.529\times4\times10^{-10}}$

$=0.0819\times10^{16}\times10^{-8}\quad=0.0819\times10^{8}$

28. E_1 for H = – 13 .6 eV

E_2 for H = $-\frac{13.6}{22}=-\frac{13.6}{4}=-3.4\,eV$

$E_1-E_2=-3.4-(-13.6)=+10.2\,eV$

Difference in two level = 10.2 eV

Also for transition of H like atom

$\lambda=3\times10^{-8}\,m$

$\frac{1}{\lambda}=R_H\times Z^2$ ________

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

$R_H=109677\,cm^{-1}=109677\times10^{2}\,m^{-1}$

$$\therefore\quad\frac{1}{3\times10^{-8}}=109677\times10^{2}\times2^{2}\left(\frac{3}{4}\right)$$

$Z^2 = 4 \qquad Z = 2\ He^+$

29. The no of waves made by a bohr is equal to orbit no.

30. $E = hv$

$3.97\times10^{-19} = hv$

$v = \frac{3.97\times10^{-19}}{6.626\times10^{-34}} \qquad v = 0.599\times10^{15}$

31. copper surface $= \left(w = 4.5\,eV = \frac{hc}{\lambda^0}\right) 4.5\times1.6\times10^{-19} = \frac{6.626\times10^{-34}\times3\times10^8}{\lambda^0}$

$7.2\times10^{-19} = \frac{19.878\times10^{-26}}{\lambda^0} \quad = 2.76\times10^{-7}\ m$

Similarly for sodium and cerium surface.

32. Energy of photon = work function + KE

Energy of photon = work function + eV_0

e = electronic charge $\qquad V_0$ = slopping potential

eV_0 = energy required to stop the ejection to electron

$E_{photon} = \frac{hc}{\lambda} = \frac{6.626\times10^{-34}\times3\times10^8}{253.7\times10^{-9}} = 7.834\times10$

$= \frac{7.834\times10^{-19}}{1.602\times10^{-19}} \qquad eV = 4.89\,eV$

Work function = 4.65 eV

33. Binding energy of electron = $180.69\,kJ\,mol^{-1}$

Binding energy of one electron = $\frac{180.69\times10^3}{6.022\times10^{23}} J$

$= 30.00\ 49\times10^{-20}$

Binding energy $= hv^0$

$V^0 = \frac{30.0049\times10^{-20}}{6.626\times10^{-34}} = 4.52\times10^{14}\ sec^{-1}$

34. $K.E._{min} = 2eV \qquad (\text{When } \lambda = \lambda_0)$

$K.E._{max} = 2 + \frac{12400}{\lambda(\overset{o}{A})} - \frac{12400}{\lambda_0(\overset{o}{A})} eV \qquad (\text{if } \lambda < \lambda_0)$

$K.E._{max} = 2 + \frac{1240}{400} - \frac{1240}{660}$

$= 2 + \frac{1240\times260}{400\times660}$

$= 2 + 1.22$

$K.E._{max} = 3.22\ eV$

35. Energy of photon liberated from He^+ during emission of first line of lymon sense.

$$E = 13.6\, 2^2\left(\frac{1}{h_1^{\,2}} - \frac{1}{h_2^{\,2}}\right) = 13.6\times 4\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$$

$$= \frac{13.6\times 4\times 3}{4} = 40.8\,eV$$

This energy is used in liberating electron from H atom from ground state.

Therefore,

$$40.8\,eV = E_1 \text{ of } H + KE^-\left(\frac{1}{2}mv^2\right)$$

$$40.8\,eV = 13.6 + KE$$

KE = 40.8 – 13.6 = 27. eV

$$= 27.2\times 1.602\times 10^{-12}$$

$$= 43.57\times 10^{-12}$$

36. $\rho = \dfrac{6.626\times 10^{-34}\times 3\times 10^{8}}{360\times 10^{-10}}$

$$= 5.52\times 10^{-18} \text{ Joules}$$

kE = hv – hvo

$$= 5.52\times 10^{-18} - 7.52\times 10^{-19}$$

$$= 47.68\times 10^{-19} \text{ Joules}$$

37. $\lambda = \dfrac{h}{mv}$

$$= \frac{6.626\times 10^{-34}}{\frac{100}{1000}\times 100} = 0.6626\times 10^{-34}, 6.626\times 10^{-35}$$

38. $kE = \dfrac{1}{2}mv^2 = 4.55\times 10^{-25}\,J$

$$4^2 = \frac{4.55\times 10^{-25}\times 2}{9.108\times 10^{-31}}$$

$$4 = 10^3\,m\,sec^{-1}$$

$$\lambda = \frac{h}{mv} = \frac{6.629\times 10^{-34}}{9.108\times 10^{-31}\times 10^{3}}$$

$$= 7.27\times 10^{-7} \text{ meter}$$

39. $\underset{\left(\text{in}\,\overset{0}{A}\right)}{\lambda} = \left[\dfrac{150}{V}\right]^{1/2}$

$$\lambda = \sqrt{\frac{150}{v}}$$

$$\lambda = \sqrt{\frac{150}{100}} \qquad = 1.227\,\overset{0}{A}$$

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

$= \frac{6.626\times10^{-34}}{9.108\times10^{-31}\times\frac{3\times10^{8}\times1}{20}}$

$= 4.899\times10^{-11}$ m

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

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

$= \frac{6.626\times10^{-34}}{4\times3.14\times9.108\times10^{-31}\times10^{-10}}$

$= 5.8\times10^{5}\ \text{m sec}^{-1}$

42. $\Delta v = 3\times10^{7}\times0.02 = 6\times10^{5}$

$\Delta x = \frac{6.6\times10^{-34}}{4\times3.14\times1.67\times10^{-27}\times6\times10^{5}}$

43. for an electron

$\frac{1}{2}mv^{2} = eV$

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

Thus, $\frac{1}{2}m\frac{h^{2}}{m^{2}\lambda^{2}} = eV$

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

$= \frac{1\times6.626\times10^{-34}}{2\times9.108\times10^{-31}\times\left(1.54\times10^{-10}\right)^{2}\times1.602\times10^{-19}}$

= 63.3 volt

44. Due to Hund's Rule

45. A d subshell can have maximum 10 electrons

46. $\left.\begin{array}{l} S^{2} = \text{dimagnetic} \\ = 1s^{2}\ 2s^{2}\ 2p^{6}\ 3s^{2}\ 3p^{6} \end{array}\right]$ magnetic moment = 0

Co^{3+} = Paramagnetic

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

$\mu = \sqrt{n\left(n+2\right)}$

$\sqrt{4(4+2)}$ = 4.8913 BM

47. $\Psi_{2s} = \frac{1}{2\sqrt{2\pi}}\left[\frac{1}{a_0}\right]^{1/2}\left[2-\frac{r}{a_0}\right]e^{-r/2a_0}$

AT $r = r_0$, radial node is formed

For radial node at $r = r_0$, $\psi_{2s}^2 = 0$ this is possible only when $\left[2-\frac{r}{a_0}\right] = 0$

$2 = \frac{r_0}{a_0}$ $\quad r_0 = 2q_0$

GET EQUIPPED TO JEE - Main

1. **(C)**

$E_{1,Li^{2+}} = \frac{9}{4}E_{1,He^{+}} = \frac{9}{4}\times 19.6\times 10^{-18}$

$= 4.41\times 10^{-17}$ 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 $\Rightarrow 12\,e^-$

$\ell = 2 \Rightarrow$ 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)**

$r_3 He^+ = \frac{n^2}{Z}a_0 = \frac{3^2}{2}a_0 = 4.5\,a_0$

8. **(C)**

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

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 $\Rightarrow 6 \to 2$

13. **(A)**

Paschal Lines : $5 \to 3$

$4 \to 3$

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 $= \sqrt{2\times4} = \sqrt{8}$

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)**

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

$= 3.4 + 10.2$ $= 13.6\,eV$

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

33. **(A)**

Minimum $= 1$ $4 \to 1$

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

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

34. **(D)**

Shortest wavelength implies maximum energy

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

$\Rightarrow \frac{1}{\lambda_{6\to1}} = R_H (1)^2 \left(\frac{1}{1} - \frac{1}{36}\right)$

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

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. **(D)**

$E_{111\to1} = 2E - E = \frac{hc}{\lambda}$

$$E_{11\to 1} = \frac{4E}{3} - E = \frac{hc}{\lambda'}$$

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

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

GET EQUIPPED TO JEE - Advanced

❖ ONLY ONE OPTION CORRECT

1. **(D)**

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

$$\frac{1}{\lambda} = 1069n \times 4\left(\frac{1}{3^2} - \frac{1}{\infty^2}\right)$$

$$\lambda = \boxed{2051Å}$$

2. **(B)**

$$T = \frac{3\pi r}{V} = 2\pi \times \frac{\frac{0.529n^2}{z}}{\frac{2.18 \times 10^6 z}{n}}$$

$$T \propto \frac{n^3}{z^2}$$

3. **(C)**

$\frac{-13.6}{16}$ ____________________ 4

$\frac{-13.6}{9}$ ____________________ 3

$\frac{-13.6}{4}$ ____________________ 2

13.6 ____________________ 4

$E_4 - E_2 = 2.55eV$

4. **(A)**

5. **(A)**

$$\lambda = \frac{h}{\sqrt{2\ KE.m}}$$

$$\lambda = \frac{6.626 \times 10^{34}}{\sqrt{2 \times 6.8 \times 1.6 \times 10^{-19} \times 9.106 \times 10^{31}}}$$

Total is 20.4 out of which 136 goes for ionization. So rest is 6.8 which goes for KE

$\boxed{= 4.7\ Å}$

6. **(D)**

$$\Delta x + \Delta P = \frac{h}{4\pi}$$

$$\Delta P = \frac{h}{4\pi\Delta x} = \frac{6.626 \times 10^{-34}}{4 \times 3.14 \times 1 \times 10^{-9}}$$

$= 0.527 \times 10^{-25}$

$= \boxed{5.2 \times 10^{-26}}$

7. **(C)**

$$\frac{1}{\lambda} = R_H Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right), \ \frac{1}{\lambda} = 109677 \times 4\left(\frac{1}{2^2} - \frac{1}{\infty}\right)$$

$\lambda = 911 Å$

$$\lambda = \frac{h}{mc} = \frac{6.628 \times 10^{-34}}{3 \times 10^8 m}$$

8. **(D)**

By looking at wavelength increasing for can say it belongs to visible range

$E_p = \frac{1242}{486.4} = 2.55$ eV $\Rightarrow$ 4th orbit to 2nd orbit

9. **(B)**

$$r = \frac{0.529 \times 4}{Z}$$

$$= \frac{0.529 \times 4}{3} = 0.705 Å$$

10. **(A)**

$WF = E_p - K_{max}$

$$= 4 \times 10^{-20} - \frac{(6.626 \times 10^{-34})^2}{2 \times 9.11 \times 10^{-31} \times (59 \times 10^{-10})}$$

$= 3.313 \times 10^{-20}$J

11. **(C)**

$$\frac{hc}{\lambda} = \frac{hc}{8208} - \frac{hc}{22800}$$

$\lambda = 12825 Å$

12. **(C)**

$$\lambda_1 = \sqrt{\frac{150}{100}} Å \qquad \ldots(1)$$

$\lambda_2 = \sqrt{\frac{150}{81}}\text{Å}$ ...(2)

$\lambda_3 = \sqrt{\frac{150}{49}}\text{Å}$ ...(3)

From (1), (2) and (3)

$\frac{\lambda_3 - \lambda_2}{\lambda_1} = \frac{20}{03}$

13. **(A)**

No. of node = 1

14. **(D)**

$9_0 = 0$ is electron is in nucleus $e^{-r/90} = 0$

15. **(B)**

$R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = R \times 2^2\left[\frac{1}{4^2} - \frac{1}{6^2}\right]$

$\bar{\upsilon}_{He^+}(6 \to 4) = \bar{\upsilon}_H(3 \to 2)$

16. **(A)**

P.E. = - 2 K.E.

$\Rightarrow \quad \text{P.E.} = -mv^2$

17. **(B)**

$\lambda = \frac{h}{mv}, \text{ K.E.} = \frac{1}{2}mv^2$

$\lambda = \frac{h}{\sqrt{2m\,\text{K.E.}}}$

$\lambda = \frac{6.6 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 4.55 \times 10^{-25}}} = 7.27 \times 10^{-7}\,\text{m}$

18. **(C)**

Type of orbitals filled in 4^{th} period = 4s, 3d, 4p

Total no. of orbitals possible = 1 + 5 + 3 = 9

Total no. of elements = 9 × 3 = 27

19. **(C)**

No. of orbitals $= 2l + 1$

20. **(A)**

$\frac{E_{1H}}{E_{2Be}} = \frac{1/1}{(4)^2/(2)^2} = \frac{4}{16} = 1:4$

21. **(D)**

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

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

$$\frac{1}{\lambda} = R_H \times 16\left(\frac{1}{1^2} - \frac{1}{2^2}\right) \frac{R_H \times 16 \times 3}{4} = R_H \times 12$$

(D) (Be^{3+})

22. **(D)**

$$\overline{U} = R_H\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = 152000$$

$$\overline{U} = R_H \times 9\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{R_H \times 9 \times 5}{364}$$

= 137096.25

23. **(B)**

$$KE_1 = h\nu_1 - h\nu^0$$

$$KE_2 = h\nu_2 - h\nu^0$$

$$\frac{1}{k} = \frac{\nu_1 - \nu_0}{\nu_2 - \nu_0}$$

$$\nu_0 = \frac{k\nu_1 - \nu_2}{k - 1}$$

24. **(D)**

$-(n^{th}) + (n + 1)^{th} = (n - 1)^{th}$

$(n + 1)^2 - (n)^2 = (n - 1)^2$

$2n + 1 = n^2 - 2n + 1$

$N^2 - 4n = 0 \Rightarrow n = 4$

25. **(D)**

Acceleration on $\propto \frac{z^3}{n^4}$

$$\frac{\text{initial acceleration}}{\text{final acceleration}} = \frac{z_1^3}{z_2^3} \times \frac{n_2^4}{n_1^4}$$

$$= \frac{2^4}{3^4} = \frac{16}{81}$$

26. **(A)**

The probability on the surface of sphere is same.

27. **(D)**

$$\Delta x\ \Delta p \geq \frac{h}{4\pi}$$

$$\Delta x \geq \frac{h}{4\pi\Delta\pi} = \frac{6.62\times10^{-34}}{4\times3.14\times10^{-20}}$$
$$= 5.27\times10^{-15}\,m$$

28. **(B)**
Refer theory

29. **(A)**
No. of waves = orbit no.

30. **(B)**
Refer theory

31. **(C)**
$\Delta n = 5 - 1 = 4$

No. of spectral line $= \frac{\Delta n(\Delta n + 1)}{2}$

$= \frac{4\times5}{2} = 10$

32. **(D)**
On increasing no. of photons, no. of photo electrons increase but K.E. remains same.

33. **(A)**
$U = +2\times \text{Total Energy}$

34. **(A)**
$\lambda = \frac{h}{\sqrt{2mqV}}$

$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{q_2}{q_1}} = \sqrt{\frac{2}{1}}$

$\lambda_1 > \lambda_2$

❖ MORE THAN ONE OPTION CORRECT

1. **(C)**
Refer theory

2. (**ABC)**
Refer theory

3. (**ABD)**
Refer theory

4. **(AB)**
Refer theory

5. **(BCD)**
Refer theory

6. **(ABD)**
If $\ell = 2$ then $m = -2, -1, 0, 1, 2$

7. **(BC)**
It is applicable for moving microscopic particles.

8. **(C)**
Both are same one of them in ground state & other in excited state.

9. **(AD)**
2^{nd} orbit have 2 sub energy level (S & P)
M energy level (3^{rd} orbit) can accommodate 18 electron only.

10. **(ABD)**
If m = –2, then it should be d orbital.

11. **(ABC)**
Refer theory

12. **(ABC)**
Refer theory

13. **(A)**
For 3d, n = 3, $\ell = 2$, m = –2 to +2, $s = \pm\frac{1}{2}$

14. **(BC)**
Refer theory

15. **(ABCD)**
Refer theory

16. **(AB)**

$$\Delta x\ \Delta p \geq \frac{h}{4\pi}$$

$$\Delta x\left(F\Delta t\right) \geq \frac{h}{4\pi}$$

$$\Delta E \Delta t \geq \frac{h}{4\pi}$$

17. **(ABD)**
Refer theory

18. **(BCD)**
Photon doesn't carry any charge.

19. **(ABC)**
Shielding effect is not possible in H atom because it is unielectronic.

20. **(AD)**
White light can't be deflected by magnet & it consist different wavelength photons.

21. **(ABC)**
Refer theory

22. **(ABC)**
Refer theory

23. **(AC)**
Refer theory

❖ COMPREHENSION TYPE

Comprehension – 1

1. **(B)**

Orbital angular momentum $= \sqrt{\ell(\ell+1)}\dfrac{h}{2\pi}$

$$= \sqrt{1(1+1)}\frac{h}{2\pi} = \frac{h}{\sqrt{2}\pi}$$

2. **(A)**
Refer theory

3. **(A)**
s orbitals are non-directional.

4. **(D)**
No. of protons = 6
No. of electrons = 6
No. of neutrons = 14 – 6 = 8

5. **(D)**
As $n\uparrow$ energy difference between consecutive orbit decreasis.

6. **(A)**

No. of drops $= \dfrac{6.39\times10^{-19}}{1.6\times10^{-19}} = 4$

Comprehension – 2

1. **(C)**

No. of waves in one revolution = orbit no.

2. **(D)**

Circumference $= 2\pi r$

$$= 2\times 3.14\times 0.529\times 10^{-10}\times \frac{3^2}{1}$$

$$= 3\times 10^{-9}\,\text{m}$$

3. **(A)**

$$\lambda = \frac{2\pi r}{n} = \frac{3\times 10^{-9}}{3} = 10^{-9}\,\text{m}$$

4. **(B)**

$$E = -21.8\times 10^{-19}\times \frac{z^2}{n^2}\,\text{J}$$

$$E = -21.8\times 10^{-12}\times \frac{z^2}{n^2}\,\text{erg}$$

$$E = -21.8\times 10^{-12}\times \frac{1}{9}\,\text{erg}$$

$$E = 2.42\times 10^{-12}\,\text{erg}$$

P.E. = 2 × total energy

$$= -4.84\times 10^{-12}\,\text{erg}$$

5. **(A)**

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

$$mv = \frac{nh}{2\pi r} = \frac{3\times 6.62\times 10^{-34}}{3\times 10^{-9}} = 6.62\times 10^{-25}$$

Comprehension – 3

1. **(B)**

$$\lambda = \frac{h}{mv} \Rightarrow v = \frac{h}{m\lambda}$$

$$v = \frac{6.62\times 10^{-34}}{9.1\times 10^{-31}\times 5200\times 10^{-10}} = 1400\ \text{m/s}$$

2. **(A)**

$$\lambda = \sqrt{\frac{150}{V}} \Rightarrow V = \frac{150}{\lambda^2} = \frac{150}{(1.54)^2} = 63.3\,\text{V}$$

3. **(B)**

Binding energy $= 250\ \text{KJ / mol}$

$$= \frac{250\times10^{3}}{6.02\times10^{23}}\ \text{J/atom}$$

$$v_0 = \frac{\text{B.E.}}{h} = \frac{250\times10^{3}}{6.02\times10^{23}\times6.62\times10^{-34}} = 6\times10^{14}\ \text{sec}^{-1}$$

4. **(D)**

$$\Delta X\ \Delta P \ge \frac{h}{4\pi}$$

$$(\Delta X)^2 \ge \frac{h}{4\pi} \qquad (\Delta X = \Delta P)$$

$$\Delta X = \Delta P \ge \sqrt{\frac{h}{4\pi}}$$

$$\Delta V = \frac{1}{m}\sqrt{\frac{4}{4\pi}} = \sqrt{\frac{h}{4\pi m^2}}$$

$$\frac{h}{m} = \lambda V$$

$$\Delta V = \sqrt{\frac{\lambda V}{4\pi m}}$$

$$\hbar = \sqrt{\frac{\hbar}{2\pi}}$$

$$\Delta V = \sqrt{\frac{\hbar}{2m^2}}$$

5. **(C)**

Refer theory

6. **(C)**

$$\lambda = \frac{6.62\times0^{-34}\times3600}{0.2\times5} = 2.38\times10^{-30}\ \text{m}$$

Comprehension – 4

1. **(C)**

No. of electrons in $p^{3-} = 15+3 = 18$

No. of electrons in $Cl^{-} = 17+1 = 18$

2. **(D)**

	3d						4s
$Cr = [Ar]$	↿	↿	↿	↿	↿		↿

3. **(B)**

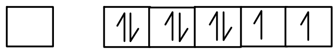
For Al, no. of S electrons = 2 + 2 +2 = 6

No. of P electrons = 6 +1 = 7

For Mg, no. of S electrons = 6 = no. of P electrons

4. **(B)**

4s 3d

Ni^{2+} = Ar 

n = 2

$$\mu = \sqrt{2(2+2)} = \sqrt{8} \text{ B.M.}$$

5. **(D)**

No. of radial nodes in 2P = 0

No. of angular nodes in 2P = 1

6. **(D)**

$\Delta n = 5 - 2 = 3$

Max. no. of spectral line $= \frac{3(3+1)}{2} = 6$

7. **(A)**

For H atoms, energy only depends upon n.

8. **(B)**

No. of valence electron in $NH_4^+ = 5 - 1 + 4 = 8$

❖ MATRIX MATCH

1. **(A) $\rightarrow$ Q; (B) $\rightarrow$ S; (C) $\rightarrow$ R; (D) $\rightarrow$ P**

$$\frac{U_{1,2}}{K_{1,1}} = \frac{-4 \times 6.8 \times \frac{z^2}{n^2}}{13.6 \times \frac{z^2}{n^2}} = \frac{-4 \times 6.8 \times \frac{4}{1}}{13.6 \times 1} = -\frac{8}{1}$$

$$\frac{r_{2,1}}{r_{1,2}} = \frac{0.529 \times \frac{4}{1}}{0.529 \times \frac{1}{2}} = \frac{8}{1}$$

$$\frac{V_{1,2}}{V_{2,4}} = \frac{2.18 \times 10^8 \times \frac{2}{1}}{2.18 \times 10^8 \times \frac{4}{2}} = 1$$

$$\frac{T_{1,2}}{T_{2,2}} = \frac{\frac{1^3}{2^2}}{\frac{2^3}{2^2}} = \frac{1}{8}$$

2. **(A) $\rightarrow$ Q; (B) $\rightarrow$ R; (C) $\rightarrow$ S; (D) $\rightarrow$ P**

No. of radial node of 5s = 5 – 1 = 4

No. of angular node of $3d_{yz} = 2$

No. of angular node of $4d_{xy} = 2$

No. of radial node of $4d_{xy} = 1$

No. of angular node of $3p = 1$

3. **(A) $\rightarrow$ S; (B) $\rightarrow$ R; (C) $\rightarrow$ P; (D) $\rightarrow$ Q**

Refer theory

4. **(A) $\rightarrow$ S; (B) $\rightarrow$ P; (C) $\rightarrow$ Q; (D) $\rightarrow$ R**

Refer theory

5. **(A) $\rightarrow$ P; (B) $\rightarrow$ P, Q, S; (C) $\rightarrow$ Q, S; (D) $\rightarrow$ P, R**

Refer theory

6. **(A) $\rightarrow$ P, Q, R; (B) $\rightarrow$ R; (C) $\rightarrow$ P, R, S; (D) $\rightarrow$ P, Q, R**

m = –1 can be for p, d & f

$\ell = 2$ only for d

$n = 3$ has s, d & f

s subshell doesn't have angular nodes

7. **(A) $\rightarrow$ P, S; (B) $\rightarrow$ P, R; (C) $\rightarrow$ Q, R; (D) $\rightarrow$ S**

Refer theory

EXPERTISE ATTAINERS

1. $K.E._{max} = E - \phi$

$E = K.E. + \phi = 0.73 + 1.82$

$= 2.55$ eV

2.55 eV is the difference of energy of 2^{nd} & 4^{th} orbit or hydrogen.

2. $\lambda\left(\overset{o}{A}\right) = \sqrt{\frac{150}{V}}$

$$V = \frac{150}{\lambda^2} = \frac{150}{500 \times 500} = 6 \times 10^{-4} \text{ Volt}$$

3. $$K.E._1 = \frac{12400}{\lambda_1} - \frac{12400}{\lambda_0} \quad ...(i)$$

$$K.E._2 = \frac{12400}{\lambda_2} - \frac{12400}{\lambda_0} \quad ...(ii)$$

$$K.E._2 = 2K.E._1$$

$$\frac{12400}{\lambda_2} - \frac{12400}{\lambda_0} = 2\left(\frac{12400}{\lambda_1} - \frac{12400}{\lambda_0}\right)$$

$$\frac{2}{\lambda_0}-\frac{1}{\lambda_0}=\frac{2}{\lambda_1}-\frac{1}{\lambda_2}=\frac{2\lambda_2-\lambda_1}{\lambda_1\lambda_2}$$

$$\frac{1}{\lambda_0}=\frac{2\lambda_2-\lambda_1}{\lambda_1\lambda_2}\Rightarrow\lambda_0=\frac{\lambda_1\lambda_2}{2\lambda_2-\lambda_1}$$

$$\lambda_0=2615.5\,\overset{o}{A}\Rightarrow\upsilon_0=\frac{3\times10^8}{2615.5\times10^{-10}}=1.148\times10^{15}\,\text{Hz}$$

4. K.E. of electron ejected $(\text{eV})=\dfrac{150}{\lambda^2\left(\overset{o}{A}\right)}$

$$=\frac{150}{4.7\times4.7}=6.79\text{ eV}$$

Energy of photon = K.E. of electron + Ionisation energy

$= 6.79+13.6=20.39$ eV

5. $\lambda=94.5$ nm to 130.0 nm

$=945\,\overset{o}{A}$ to $1300\,\overset{o}{A}$ ultraviolet (Lyman series)

$$\frac{1}{\lambda}=1.1\times10^7\left(\frac{1}{1^2}-\frac{1}{n^2}\right)$$

If $n=2$ then $\lambda=1215\,\overset{o}{A}$

If n = 5 then $\lambda=946.9\,\overset{o}{A}$

Hence lines fall in between are

$5\rightarrow1,\ 4\rightarrow1,\ 3\rightarrow1,\ 2\rightarrow1$

6. $2.6\times1.6\times10^{-19}=\dfrac{h\times3\times10^8}{2357\times10^{-10}}-h\upsilon_0$ ...(i)

$4.04\times1.6\times10^{-196}=\dfrac{h\times3\times10^3}{1849\times10^{-10}}-h\upsilon_0$ ...(ii)

Solving (i) & (ii)

$h=6.6\times10^{-34}$ & $\upsilon_0=6.42\times10^{14}$ Hz

7. $\Delta X\Delta P\geq\dfrac{h}{4\pi}$

$\Delta K=6\times10^{-6}$

$P=\sqrt{2mK}$

$$\frac{dP}{dK}=\frac{\sqrt{2m}}{2\sqrt{K}}$$

$$\frac{dP}{dK}=\sqrt{\frac{m}{2K}}\Rightarrow\frac{\Delta P}{\Delta K}=\sqrt{\frac{m}{2K}}$$

$$\Delta P=\sqrt{\frac{m}{2K}}\Delta K$$

$$\Delta X\left(\sqrt{\frac{m}{2K}}\Delta K\right)\geq\frac{h}{4\pi}$$

$$\Delta X\geq\frac{h}{4\pi}\sqrt{\frac{2K}{m}}\Delta K$$

$$\Delta X\geq\frac{h}{4\pi}\frac{\sqrt{2K}}{5.73\times10^{-21}}$$

$$\Delta X\Delta\upsilon\geq\frac{h}{4\pi m}$$

$$\Delta\upsilon\geq\frac{h}{4\pi m\Delta X}$$

$$\Delta\upsilon\geq\frac{6.29\times10^{9}}{\sqrt{2K}}$$

8. $\lambda_1=\sqrt{\frac{150}{V_1}}$ & $\lambda_2=\sqrt{\frac{150}{V_1+V_2}}$

$$\%\text{ change}=\frac{|\lambda_2-\lambda_1|}{\lambda_1}\times100=\frac{\sqrt{\frac{1}{V_1}}-\sqrt{\frac{1}{V_1+V_2}}}{\sqrt{\frac{1}{V_1}}}\times100$$

$$47.48=\left(1-\sqrt{\frac{V_1}{V_1+V_2}}\right)\times100$$

$$0.4748=1-\sqrt{\frac{V_1}{V_1+V_2}}$$

$$\sqrt{\frac{V_1}{V_1+V_2}}=1-0.4748=0.5252$$

$$\sqrt{\frac{V_1+V_2}{V_1}}=\frac{1}{0.5252}=1.9$$

$$\frac{V_1+V_2}{V_1}=3.61\Rightarrow\frac{V_2}{V_1}=2.61$$

$$\frac{V_1}{V_2}=0.383$$

9. $\Psi(\text{radial})=2\left(\frac{z}{a_0}\right)^{\frac{3}{2}}e^{-Zr/a_0}$

Probability $P=4\pi^2r^2\Psi^2$

$$P=16\pi^2r^2\left(\frac{z}{a_0}\right)^{3}e^{-2Zr/a_0}$$

For maximum probability

$$\frac{dP}{dr}=0$$

$$\frac{dP}{dr} = 16\pi^2\left(\frac{z}{a_0}\right)^3\left[2re^{\frac{-2Zr}{a_0}} - r^2\left(\frac{2z}{a_0}\right)e^{\frac{-2Zr}{a_0}}\right]$$

$$16\pi^2\left(\frac{z}{a_0}\right)^3 \times 2re^{-\frac{2Zr}{a_0}}\left[1-\frac{Zr}{a_0}\right] = 0$$

$$1-\frac{Zr}{a_0} = 0 \Rightarrow r = \frac{a_0}{z}$$

10. Total no. of atoms $= \frac{1.8}{1} \times 6.02 \times 10^{23}$

$= 1.083 \times 10^{24}$

No. of atoms in 2nd energy level $= \frac{15}{100}\left(1.083 \times 10^{24}\right)$

$= 1.624 \times 10^{23}$

No. of atoms in 3rd energy level $= \frac{27}{100}\left(1.083 \times 10^{24}\right)$

$= 2.924 \times 10^{23}$

Energy emitted $= \left[\left(1.624 \times 10^{23}\right) \times 10.2 \times 1.6 \times 10^{-19}\right] + \left[\left(2.924 \times 10^{23}\right) \times 12.09 \times 1.6 \times 10^{-19}\right]$

$= 83.06 \times 10^4 \text{ J} = 830.6 \text{ KJ}$

11. $-13.6 \times \frac{z^2}{n^2} = -3.4 \quad \Rightarrow n = 2$

Angular momentum $= \frac{nh}{2\pi} = \frac{h}{\pi}$

12. $E = \frac{nhc}{\lambda} \Rightarrow 3.15 \times 10^{-14} = \frac{n \times 2 \times 10^{-25}}{850 \times 10^{-9}}$

$$n = \frac{3.15 \times 10^{-14} \times 850 \times 10^{-9}}{2 \times 10^{-25}}$$

$n = 1.34 \times 10^5$

13. $\lambda_1 = 186.1 \text{ nm} = 486.1 \times 10^{-9} \text{ m}$

$\lambda_2 = 410.2 \text{ nm} = 410.2 \times 10^{-9} \text{ m}$

$$\bar{\upsilon} = \bar{\upsilon}_2 - \bar{\upsilon}_1 = \frac{1}{\lambda_2} - \frac{1}{\lambda_1} = 1.1 \times 10^7\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda_1} = 1.1 \times 10^7\left[\frac{1}{2^2} - \frac{1}{n_1^2}\right]$$

$$\frac{1}{486.1 \times 10^{-9} \times 1.1 \times 10^7} = \frac{1}{4} - \frac{1}{n_1^2}$$

$$\frac{1}{n_1^2} = \frac{1}{4} - \frac{1}{5.34} \Rightarrow n_1 = 4$$

$$\frac{1}{\lambda_2}=1.1\times10^7\left[\frac{1}{2^2}-\frac{1}{n_2^2}\right]$$

$$\frac{1}{410.2\times10^{-9}\times1.1\times10^7}=\frac{1}{4}-\frac{1}{n_2^2}$$

$$\frac{1}{n_2^2}=\frac{1}{4}-\frac{1}{4.51}\Rightarrow n_2=6$$

Hence transition is $6\rightarrow4$ (Bracket series)

$$\bar{\upsilon}=1.1\times10^7\left[\frac{1}{16}-\frac{1}{36}\right]=\frac{1.1\times10^7\times20}{16\times36}$$

$$\frac{1}{\lambda}=\frac{1.1\times10^7\times20}{16\times36}$$

$$\lambda=26.18\times10^{-7}\text{ m}$$

14. $$\frac{n_2}{n_1}=0.53$$

$$\frac{E_2}{E_1}=\frac{\frac{n_2hc}{\lambda_2}}{\frac{n_1hc}{\lambda_1}}=\frac{n_2\lambda_1}{n_1\lambda_2}$$

$$\frac{E_2}{E_1}=\frac{0.53\times4530}{5080}=0.472\text{ or }47.26\%$$

15. $$\frac{1}{\lambda}=1.1\times10^7\times4\left[\frac{1}{1^2}-\frac{1}{2^2}\right]=3.3\times10^7$$

$$\lambda=\frac{1}{3.3\times10^7}=3.03\times10^{-8}\text{ m}$$

$$R=4R_H\qquad(z=2)$$

$$r=0.529\times\frac{n^2}{z}=0.2645\,\overset{o}{A}$$

16. $$E_n-E_z=10.2+17=27.2\text{ eV}$$

$$-13.6\,z^2\left(\frac{1}{n^2}-\frac{1}{4}\right)=27.2\qquad\qquad ...(i)$$

$$E_n-E_3=4.25+5.95=10.2\text{ eV}$$

$$-13.6z^2\left(\frac{1}{n^2}-\frac{1}{9}\right)=10.2\text{ eV}\qquad\qquad ...(ii)$$

$(i)\div(ii)$

$$10.2\left(\frac{1}{n^2}-\frac{1}{4}\right)=27.2\left(\frac{1}{n^2}-\frac{1}{9}\right)$$

$$\frac{1}{n^2}-\frac{1}{4}=\frac{27.2}{10.2}\left(\frac{1}{n^2}-\frac{1}{9}\right)\Rightarrow n=6,$$

$$z=3$$

17. $1.89z^2=17\Rightarrow z^2=9\Rightarrow z=3$

Energy required for transition from

1^{st} to 3^{rd} = 12.09 z^2

$$=12.09\times9=108.81\,\text{eV}$$

$$\lambda=\frac{12400}{13.6\times9}=101.3\,\mathring{A}$$

$$\text{K.E.}=-\text{total energy}$$

$$=13.6\times9=122.4\text{ eV}$$

18. $\lambda=400\text{ nm},\ \phi=2.2\text{ eV}$

$$\text{K.E.}=\left(\frac{1240}{400}-2.2\right)-\text{Energy loss during collision}$$

$$\text{K.E.}=0.9-0.9\times\frac{10}{100}-0.9\times\frac{10}{100}$$

$$\text{K.E.}=0.72\text{ eV}$$

Energy loss in each collision $=0.09$ eV

No. of collision possible $=\frac{0.9}{0.09}=10$

19. $$\frac{1}{2052\times10^{-10}}=1.1\times10^7 z^2\left[\frac{1}{n_1^2}-\frac{1}{\infty^2}\right]$$

$$\frac{z^2}{n_1^2}=\frac{1}{2052\times10^{-10}\times1.1\times10^7}=\frac{1}{2.25}\Rightarrow n_1=3$$

$$z=2$$

20. $$\Psi=\frac{2}{3}\left(\frac{Z}{3a_0}\right)^{\frac{3}{2}}\left(3-\frac{2Zr}{a_0}+\frac{2Z^2r^2}{9a_0}\right)e^{-Zr/3a_0}$$

Since wave function doesn't have θ & ϕ component hence it should be s orbital.

No. of angular nodes $=\ell=0$

No. of radial nodes = 2 (from equation)

It should be 3s orbital.

For radial nodes $\Psi=0$

$$3-\frac{2Zr}{a_0}+\frac{2Z^2r^2}{9a_0^2}=0$$

$$r=\frac{\frac{2Z}{a_0}\pm\sqrt{\frac{4Z^2}{a_0^2}-\frac{24}{9}\frac{Z^2}{a_0^2}}}{2\left(\frac{2Z^2}{9a_0^2}\right)}$$

$$r = \frac{\frac{2Z}{a_0} \pm \frac{2Z}{a_0}\sqrt{1-\frac{6}{9}}}{\frac{4Z^2}{9a_0^2}}$$

$$r = \frac{2Z}{a_0} \times \frac{9a_0{}^2}{4Z^2}\left[1 \pm \frac{1}{\sqrt{3}}\right]$$

$$r = \frac{9a_0}{2Z}\left(1 \pm \frac{1}{\sqrt{3}}\right)$$

21. Orbital frequency of rotating electron $\upsilon = \frac{\upsilon}{2\pi r}$

$$mr\upsilon = \frac{nh}{2\pi} \Rightarrow \upsilon = \frac{nh}{2\pi mr}$$

$$r = \frac{n^2h^2}{4\pi^2 mKe^2}$$

$$\upsilon = \frac{nh}{4\pi^2 mr^2}$$

$$\upsilon = \frac{nh}{4\pi^2 m} \times \frac{16\pi^4 m^2 K^2 e^4}{n^4 h^4}$$

$$\upsilon = \frac{4\pi^2 mK^2 e^4}{n^3 h^3}$$

$$\upsilon = \frac{4\pi^2 me^4}{n^3 h^3}\left(\frac{1}{4\pi \in_0}\right)^2$$

$$\upsilon = \frac{me^4}{4 \in_0^2 n^3 h^3}$$

Now consider two adjacent orbitals n, n + 1

$$E_n = -\frac{me^4}{8 \in_0{}^2 n^2 h^2} \;\; \& \;\; E_{n+1} = -\frac{me^4}{8 \in_0{}^2 (n+1)^2 h^2}$$

$$E_{n+1} - E_n = \frac{me^4}{8 \in_0{}^2 h^2}\left[\frac{1}{n^2} - \frac{1}{(n+1)^2}\right]$$

$$= \frac{me^4}{8 \in_0{}^2 h^2}\left[\frac{2n+1}{n^2(n+1)^2}\right]$$

$$n >> 1 \;\Rightarrow\; n+1 \approx n$$

$$E_{n+1} - E_n = h\upsilon = \frac{me^4}{8 \in_0{}^2 h^2} \times \frac{2n}{n^4} = \frac{me^4}{4 \in_0{}^2 h^2 n^3}$$

$$\upsilon = \frac{me^4}{4 \in_0{}^2 h^3 n^3}$$

22. $Li(g) \rightarrow Li^{3+}(g) + 3e^-$

$\Delta H = 2000 \text{ KJ / mole}$

$= I.E._{1} + I.E._{2} + I.E._{3}$

$Li(g) \rightarrow Li^{+}(g) + e^{-} : I.E._{1} = 520\ KJ/mole$

$Li^{+}(g) \rightarrow Li^{2+}(g) + e^{-} : I.E._{2} = x\ KJ/mole$

$Li^{2+}(g) \rightarrow Li^{3+}(g) + e^{-} : I.E._{3} = 21.8 \times 10^{-19} \times Z^{2} \times 6.02 \times 10^{23}\ J/mole$

$= 21.8 \times 6.02 \times 9 \times 10^{4}\ J/mole$

$= 11810\ KJ/mole$

$520 + x + 11810 = 20000$

$x = 7670\ KJ$

WINDOW TO JEE MAIN

1. **(A)**

$Mn^{2+} = [Ar]3d^{5}$

$n = 5 \Rightarrow \mu = \sqrt{5(5+2)} = -\sqrt{35}\ B.M.$

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

$Ti^{2+} = [Ar]3d^{2}$, $n = 2$

$Cr^{2+} = [Ar]3d^{4}$, $n = 4$

2. **(C)**

Refer theory

3. **(B)**

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

$n = 4,\ \ell = 0,\ m = 0,\ s = \pm\frac{1}{2}$

4. **(C)**

$E_{2} - E_{1} = -3.4 - (-13.6) = 10.2\ eV$

5. **(C)**

K.E. = 1000 eV = 1 KeV

6. **(A)**

Refer theory

7. **(A)**

$\lambda = \frac{6.62 \times 10^{-34}}{0.5 \times 100} = 1.32 \times 10^{-35}\ m$

8. **(B)**

No. of redial nodes = 5 – 2 – 1 = 2

9. **(D)**
Refer theory

10. **(D)**
Refer theory

11. **(C)**
Electrons enter into n = 3, $\ell = 2$ first because for same $(n+\ell)$ value, n value is lower for it.

12. **(C)**
If n = 4, $\ell < 4 \quad (\ell = 0 \text{ to } 3)$

13. **(C)**
n = 3, $\ell = 2$, n = + 2 represents single orbital of 3d, which can accommodate max. 2 electron.

14. **(A)**
No. of nodal plane $= \ell = 1$

15. **(C)**
Refer theory

16. **(B)**

$$\lambda = \frac{6.62\times10^{-34}}{10\times10^{-3}\times100} = 6.62\times10^{-34}\,\text{m}$$

17. **(D)**

Angular momentum in an orbit $= \dfrac{nh}{2\pi}$

$$= \frac{5h}{2\pi}$$

18. **(C)**

$$\Delta V = \frac{0.001}{100}\times300 = 3\times10^{-3}\ \text{m/s}$$

$$\Delta X \geq \frac{h}{4\pi m\Delta V} = \frac{6.62\times10^{-34}}{4\times3.14\times9.1\times10^{-31}\times3\times10^{-3}}$$

$$= 19.3\times10^{-3}\ \text{m}$$

19. **(C)**

For 4f, n = 4, $\ell = 3, m = -3$ to +3 & $\ell = \pm\dfrac{1}{2}$

20. **(D)**
Refer theory

21. **(C)**

For this system

$$\frac{1}{\lambda}=2R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda}=2R\left[\frac{1}{2^2}-\frac{1}{3^2}\right]=2R\times\frac{5}{36}$$

$$\lambda=\frac{18}{5R}$$

22. **(C)**

$(n+\ell)\uparrow$, higher energy

For $(n+\ell)$ having same value, n should be higher.

23. **(A)**

Ionisation enthalpy $=1.312\times10^{16}$ J/mol

$$=\frac{1.312\times10^{6}}{60.2\times10^{23}}\ \text{J/atom}$$

Energy required $=\dfrac{1.312\times10^{6}}{6.02\times10^{23}}\left[\dfrac{1}{1^2}-\dfrac{1}{2^2}\right]$

$$=\frac{1.312\times10^{6}}{6.02\times10^{23}}\times\frac{3}{4}=0.16\times10^{-17}\ \text{J/atom}$$

$$=9.84\times10^{5}\ \text{J/mol}$$

24. **(C)**

$$\Delta V=\frac{0.005}{100}\times600=3\times10^{-2}\ \text{m/s}$$

$$\Delta X=\frac{6.62\times10^{-34}}{4\times3.14\times9.1\times10^{-31}\times3\times10^{-2}}=1.92\times10^{-3}\ \text{m}$$

25. **(B)**

$$\lambda=\frac{6.63\times10^{-34}}{1.67\times10^{-27}\times10^{3}}=3.97\times10^{-10}\ \text{m}$$

$$=0.397\ \text{nm}$$

26. **(D)**

$$\text{Energy}=\frac{242\times10^{3}}{6.02\times10^{23}}\ \text{J/atom}$$

$$E=\frac{hC}{\lambda}\Rightarrow\lambda=\frac{hC}{E}=\frac{2\times10^{-25}\times6.02\times10^{23}}{242\times10^{3}}$$

$$\lambda=4.9\times10^{7}\,\text{m}=490\ \text{nm}$$

27. **(B)**

$$\text{I.E.} \propto \frac{z^2}{n^2}$$

$$\frac{\text{I.E. of } Li^{2+}}{\text{I.E. of } He^{+}} = \frac{9}{4} \Rightarrow \text{I.E. of } Li^{2+} = 4.41\ \text{J/mol}$$

28. **(C)**

Refer theory

29. **(B)**

$$\frac{1}{\lambda} + \frac{1}{680} = \frac{1}{355} \Rightarrow \frac{1}{\lambda} = \frac{1}{355} - \frac{1}{680}$$

$$\lambda = \frac{355 \times 680}{(680 - 355)} = 742.76\ \text{nm}$$

30. **(B)**

$(n + \ell) \uparrow$ energy $\uparrow$

For same $(n + \ell)$, $n \uparrow$ energy $\uparrow$

31. **(B)**

$$\lambda = \frac{6.63 \times 10^{-34}}{1000 \times 36 \times \frac{5}{18}}$$

$$\lambda = 6.63 \times 10^{-38}\ \text{m}$$

32. **(B)**

$n = 5,\ m = +1$ $\quad$ $(4 \text{ orbitals} = 8 \text{ electrons})$

$n = 2,\ \ell = 1,\ m = -1,\ s = -\frac{1}{2}$ $\quad$ (1 electron of 2p)

33. **(A)**

$$\bar{\upsilon} = \frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{5}{36}R$$

34. **(C)**

$n = 3,\ \ell = 2,\ m = +2$ $\quad$ (1 orbitals of 3d)

35. **(D)**

$$E = -2.178 \times 10^{-18} \times \frac{z^2}{n^2}\ \text{J}$$

$$\Delta E = \frac{2 \times 10^{-25}}{\lambda} = 2.178 \times 10^{-18} \times \left[\frac{1}{1} - \frac{1}{4}\right]$$

$$\lambda = \frac{2\times10^{-25}\times4}{3\times2.178\times10^{-18}} = 1.22\times10^{-7}\ \text{m}$$

36. **(C)**

Energy of $Li^{2+} = -13.6\times\frac{9}{n^2}\text{eV}$

If $n = 2$ then

$$\text{Energy} = -13.6\times\frac{9}{4}\text{eV}$$
$$= -30.6\ \text{eV}$$

37. **(C)**

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$$

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

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

38. **(D)**

$$\text{T.E.} = -\ \text{K.E.} = \frac{\text{P.E.}}{2} = -\frac{1}{2}\frac{e^2}{r}$$

39. **(A)**

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

$$\lambda = \frac{6.63\times10^{-34}}{6.63\times10^{-3}\times100}$$

$$\lambda = 10^{-33}\ \text{m}$$

40. **(D)**

$$\text{Energy} = 495.5\ \text{KJ/mol}$$
$$= \frac{495.5\times10^{3}}{6.022\times10^{23}}\ \text{J/atom}$$

$$\upsilon = \frac{E}{h} = \frac{495.5\times10^{3}}{6.022\times10^{23}\times6.626\times10^{-34}}$$

$$\upsilon = 1.24\times10^{25}\ s^{-1}$$

41. **(D)**

$$Rb = [Kr]5s^1$$

$$n = 5,\ \ell = 0,\ m = 0,\ s = \pm\frac{1}{2}$$

42. **(C)**

$E = -13.6 \times \frac{1}{n^2} eV$

If n = 2 then

$E = -3.4\ eV$

43. **(B)**

Refer theory

44. **(C)**

$\lambda = \frac{h}{\sqrt{2mqV}}$

$\frac{h}{\lambda} = \sqrt{2mqV} = \sqrt{2meV}$

45. **(D)**

No. of orbital $= n^2 = 25$

WINDOW TO JEE ADVANCED

❖ **Objective Questions – I (Only One Option Correct Type)**

1. **(C)**

Nucleus is discovered by him.

2. **(D)**

Maximum 2 electrons of opposite spin are occupied by an orbital.

3. **(A)**

Refer theory

4. **(A)**

Same as 1.

5. **(D)**

$\frac{e}{m}$ will be lowest for neutron & maximum for electron. $\frac{e}{m}$ value of α is half time $\frac{e}{m}$ value of proton.

$\frac{e}{m} : n < \alpha < p < e$

6. **(A)**

$[Kr]5s^1$

$n = 5,\ \ell = 0,\ m = 0,\ s = \pm\frac{1}{2}$

7. **(D)**
If electron is present in 1s then it can jumps to higher orbits by absorb photon of appropriate energy.

8. **(B)**
Refer theory

9. **(B)**
Refer theory

10. **(B)**
Refer theory

11. **(B)**
Refer theory

12. **(C)**
$m = -\ell \text{ to } +\ell$
if $\ell = 2$ then $m = -2$ to $+3$

13. **(D)**
$$E = \frac{hc}{\lambda}$$
$$\frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} = \frac{4000}{2000} = \frac{2}{1}$$

14. **(C)**
$$\Delta E = \frac{hc}{\lambda}$$

15. **(B)**
Refer theory

16. **(C)**
$F = 1s^2 2s^2 2p^5$

17. **(A)**
$[Ar] 4s^1 3d^5$

18. **(C)**
$[Ne] 3s^2 3p^5$
$n = 3, \ \ell = 1, \ m = \pm 1, 0$

19. **(C)**
Refer theory

20. **(D)**

Refer theory

21. **(B)**

$\ell = 0$

Orbital angular momentum $= \sqrt{\ell(\ell+1)}\frac{h}{2\pi} = 0$

22. **(D)**

$Mg^{2+} = [Ne]$

$Ti^{3+} = [Ar]3d^1, V^{3+} = [Ar]3d^2, Fe^{2+} = [Ar]3d^5$

23. **(B)**

Refer theory

24. **(A)**

For a orbital, $\ell = 2$

Orbital angular momentum $= \sqrt{2(2+1)}\frac{h}{2\pi}$

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

25. **(A)**

$E_n = -13.6 \times \frac{1}{n^2} eV$

$n = 2$

$E = -13.6 \times \frac{1}{4} = -3.4\ eV$

26. **(A)**

As $(n+\ell)\uparrow$, energy $\uparrow$

For same n, $\ell\uparrow$, energy $\uparrow$

27. **(B)**

It is configuration of Cr.

28. **(A)**

No. of nodal plane $= \ell = 1$

29. **(C)**

$\lambda = \frac{h}{m\upsilon} = \frac{6.62\times10^{-34}\times3600}{0.2\times5}$

$\lambda \approx 10^{-30}$ m

30. **(D)**

Refer theory

31. **(C)**
Refer theory

32. **(D)**
Refer theory

33. **(B)**

$$r = 0.529 \times \frac{n^2}{z} \overset{o}{A} = 0.529$$

$$\frac{n^2}{z} = 1 \Rightarrow n^2 = z$$

34. **(A)**
No. of radial nodes in $3s = n - \ell - 1$
$= 3 - 0 - 1 = 2$
No. of radial nodes in $2p = 2 - 1 - 1 = 0$

35. **(C)**

$$K.E. = \frac{1}{2}mv^2 = \frac{P^2}{2m}$$

$$mvr = \frac{nh}{2\pi} \Rightarrow mv = \frac{nh}{2\pi r} = P$$

$$K.E. = \frac{n^2h^2}{2m\left(4p^2r^2\right)} = \frac{4h^2}{2m\left(4\pi^2 a_0^2 16\right)}$$

$$K.E. = \frac{h^2}{32\pi^2 m a_0^2}$$

36. **(B)**

$$\left[Ar\right]4s^2 3d^{10} 4p^6 5s^1$$

$$n = 5,\ \ell = 0,\ m = 0,\ s = \pm\frac{1}{2}$$

37. **(B)**
Refer theory

❖ Objective Questions – II (More than One Option Correct Type)

1. **(BD)**
Isotope have same atomic number but different mass number.
Isotope have same no. of neutrons
$_{32}Ge^{76}$: no. of neutrons = 76 – 32 = 44
$_{33}As^{77}$: 77 – 33 = 44
$_{34}Se^{78}$: 78 – 34 = 44

2. **(AC)**
Refer theory

3. **(C)**
Refer theory

4. **(BD)**
No. of neutron & proton in ${}_1H^2 = 1+1 = 2$
No. of neutron & proton in ${}_1H^3 = 1+2 = 3$

5. **(AB)**
Nucleus contains protons & neutrons.

6. **(A)**
$$E_n = -13.6 \times \frac{1}{n^2} \, eV$$

7. **(ABC)**
Refer theory

8. **(AD)**
Refer theory

❖ Assertion and Reason

1. **(C)**
I.E., (Be) > I.E., (B) because it is easy to remove electron from P orbital compare to S.
Energy of 2P > Energy of 2S.

❖ Comprehension Based Questions

1. **(B)**
Li^{2+} is in a spherically symmetric state, i.e. in s orbital. It has one radial node hence it should be in 2s.
2. **(C)**
$$-13.6 \times \frac{1}{1} = -13.6 \times \frac{3^2}{n^2} \Rightarrow n = 3$$
S_2 has 3^{rd} orbit.
Now no. of radial nodes = 1
Hence it should be 3P.
$$E = -13.6 \times \frac{3}{4} = 2.25 E_1 (H)$$

3. **(B)**
Orbital angular momentum quantum.

❖ Match the Columns

1. **(A)$\rightarrow$r; (B)$\rightarrow$q; (C)$\rightarrow$p; (D)$\rightarrow$s**
$$\frac{V_n}{K_n} = -2$$
$$r \propto \frac{n^2}{z}, \; E \propto \frac{z^2}{n^2}$$

$r \propto E^{-1}$ for same z

$\ell = 0 \Rightarrow$ angular momentum $= \sqrt{0(0+1)}\dfrac{h}{2\pi} = 0$

$\dfrac{1}{r} \propto \dfrac{z}{n^2} \Rightarrow \dfrac{1}{r} \propto z'$

2. **(A)$\rightarrow$q; (B) $\rightarrow$ p, q, r, s; (C)$\rightarrow$p, q, r; (D)$\rightarrow$p, q, r**
Refer theory

❖ Fill in the Blanks

1. $m_H = m_P = 1.66 \times 10^{-27}\,kg$

2. Refer theory

3. An orbital can occupy max. 2 electrons of opposite spin.

4. Refer theory

5. Refer theory

6. Refer theory

7. Refer theory

8. Refer theory

9. $Cr = [Ar]4s^1 3d^5$

❖ True / False

1. **False**
$Cr \neq [Ar]4s^2 3d^4,\ Cr = [Ar]4s^1 3d^5$

2. **False**
Range of wavelength of γ rays $= 10^{-9}$ to 10^{-10} cm

3. **True**
$n + \ell$ for $3d = 3 + 2 = 5$
$n + \ell$ for 4s = 4 + 0 = 4
$(n + \ell)\uparrow$ energy $\uparrow$

4. **False**
$d_{x^2-y^2}$ has electrons in xy plane

5. **True**
Refer theory

❖ Integer Type Questions

1. **(9)**

$n = 3,\ m_s = -\frac{1}{2}$

3^{rd} orbit has 3s, 3p & 3d

Total no. of electron with $\left(S = -\frac{1}{2}\right)$ = o. of orbital = 9

2. **(4)**

Energy given $= \frac{1240}{300} = 4.1\,eV$

If energy given > work function

Then photoelectric effect occurs.

3. **(5)**

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

$v = \sqrt{\frac{3RT}{M}}$

$\frac{\lambda_1}{\lambda_2} = \frac{m_2}{m_1}\sqrt{\frac{T_2 m_1}{T_1 m_2}} = \sqrt{\frac{m_2 T_2}{m_1 T_1}}$

$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{20\times(727+273)}{4\times(273-73)}} = \sqrt{\frac{5\times1000}{200}} = 5$

4. **(6)**

$n = 4,\ m = -1, +1, .\ s = -\frac{1}{2}$

2 orbitals of p, 2 orbitals of d & 2 orbitals of f

= 6 orbitals

Total no. of electron with $-\frac{1}{2}$ spin quantum no. n these orbitals

= no. of orbitals = 6

5. **(3)**

For H^- (Multie $^-$)