Atomic Structure

SOLUTIONS

Exercise-I (Conceptual Questions)

1. Ans. (3)

Rutherford's α scattering experiment proves that atom has Nucleus.

2. Ans. (1)

${}_{27}A^{57}$ ${}_{30}B^{57}$

$n_B = 57-30 = 27$

3. Ans. (1)

${}_{6}C^{14}$ ${}_{7}N^{15}$ ${}_{9}F^{17}$

n = 14 – 6 = 8 n = 15 – 7 = 8 n = 17 – 9 = 8

4. Ans. (3)

$CN^{-} \to 6 + 8 = 14e^{-}$ ✓

$OH^{-} \to 8 + 2 = 10e^{-}$

$CH_3^{+} \to 6 + 2 = 8e^{-}$

$N_2 \to 7 + 7 = 14e^{-}$ ✓

$CO \to 6 + 8 = 14e^{-}$ ✓

5. Ans. (2)

${}_{Z}^{A}X^{3-}$

no. of e^{-} = Z + 3 = 10

Z = 7

${}_{7}^{14}X^{-3} \to$ no. of neutrons = 14 – 7 = 7

no. of neutrons in X_2 = 7 + 7 = 14

6. Ans. (2)

Isotones $\to$ n same

${}_{14}^{30}Si \Rightarrow 30 - 14 = 16$

${}_{15}^{31}P \Rightarrow 31 - 15 = 16$

${}_{16}^{32}S \Rightarrow 32 - 16 = 16$

7. Ans. (1)

(i) same Z $\to$ Isotopes

(ii) same A (p+n) $\to$ Isobars

(iii) same n $\to$ Isotones

(iv) same n – p $\to$ Isodiaphers

(v) same Z $\to$ Isotopes.

8. Ans. (3)

Deuterium ${}_{1}H^{2}$ p $\to$ 1

e $\to$ 1

n $\to$ 1

9. Ans. (2)

Average Atomic weight

$$= \frac{85\times75+87\times25}{75+25}$$

$$= \frac{6375+2175}{100} = \frac{8550}{100} = 85.5$$

10. Ans. (1)

$$\text{Specific charge} = \frac{\text{Charge (e)}}{\text{mass (m)}}$$

$$\frac{S.C._p}{S.C._\alpha} = \frac{e_p/m_p}{e_\alpha/m_\alpha} = \frac{1/1}{2/4} = \frac{2}{1}$$

11. Ans. (3)

${}_{13}Al^{27} \to$

a	b	c
p	e	n

c : b : a

14 : 13 : 13

12. Ans. (4)

Let Percentage of ${}^{20}Ne$ = x%

${}^{22}Ne$ = 100 – x %

Average atomic weight $\Rightarrow$ 20.2

$$= \frac{(20\times x)+22(100-x)}{100}$$

2x = 180

x = 90

${}^{20}Ne$ = 90%

${}^{22}Ne$ = 10% $\to$ heavier Isotope.

13. Ans. (3)

${}_{89}^{231}\gamma \to$ p 89, e 89, n 142

p, n, e

89 142 89

14. Ans. (3)

${}_{6}^{13}C \to 7 - 6 = 1$ ${}_{8}^{17}O \to 9 - 8 = 1$

Same (n – p) Isodiaphers

15. Ans. (3)

	D^{+}	He^{+}	H^{+}	He^{2+}
	$[{}_{1}H^{2}]^{+1}$	$[{}_{2}He^{4}]^{+1}$	$[{}_{1}H^{1}]^{+1}$	$[{}_{2}He^{4}]^{2+}$
$\frac{e}{m}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{1}$	$\frac{2}{4} = \frac{1}{2}$

Maximum e/m ration is of H^{+}.

16. Ans. (3)

Same number of (n–p) $\Rightarrow$ Isotones

${}^{77}_{32}Ge \Rightarrow 76 - 32 = 44$ = no. of n

no. of n of ${}^{77}_{33}As \Rightarrow 77 - 33 = 44$

no. of n of ${}^{78}_{34}Se \Rightarrow 78 - 34 = 44$

17. Ans. (3)

${}^{14}_{7}N \to P$	n	A
7	7	14
$\frac{7}{2}$	7	10.5

$\left.\begin{matrix}14\\10.5\end{matrix}\right\} 14 - 10.5 = 3.5$

% change = $\frac{3.5}{14} \times 100 = 25\%$ Reduces.

18. Ans. (4)

$\nu = \frac{c}{\lambda} \Rightarrow \lambda = \frac{c}{\nu} = \frac{3\times10^{8}}{8\times10^{15}}$

$= 0.375 \times 10^{-7}$m

$= 3.75 \times 10^{-8}$m

19. Ans. (3)

$E = h\nu$

$E = 6.626 \times 10^{-34} \times 5.01 \times 10^{14}$

Thus the energy of 1 mole

$E = 33.19 \times 10^{-20} \times 6.023 \times 10^{23} = 200$ KJ/mole

20. Ans. (4)

$mvr = \frac{2h}{2\pi}$ = x (given) [for H–atom]

$mvr = \frac{2h}{2\pi}$ = [for Ist exited state of Li^{+2} Ion]

$\boxed{mvr = x}$

21. Ans. (3)

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

$vr = \frac{nh}{2\pi m}$

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

22. Ans. (1)

$r = 0.529 \times \frac{n^2}{Z}$ A°

$n^2 = \frac{4.761\times1}{0.529} = 9$

n = 3

23. Ans. (1)

$r_H = 0.053 \text{ nm} = 0.053 \times \frac{(1)^2}{1}$

$r_{Li^{+2}} = 0.053 \times \frac{(3)^2}{3}$

$r_{Li^{+2}} = 0.0159$ nm

24. Ans. (3)

Ist orbit : IInd orbit : IIIrd orbit

$0.529 \times \frac{(1)^2}{Z} : 0.529 \times \frac{(2)^2}{Z} : 0.529 \times \frac{(3)^2}{Z}$

1 : 4 : 9

25. Ans. (2)

$r_2 : r_5$

$0.529 \times \frac{(2)^2}{3} : 0.529 \times \frac{(5)^2}{3}$

4 : 25

26. Ans. (4)

L : K	N : L
$(2)^2 : (1)^2$	$(4)^2 : (2)^2$
4 : 1	4 : 1

27. Ans. (4)

$v = 2.188 \times 10^6 \times \frac{z}{n}$ m/s

$= 2.188 \times 10^6 \times \frac{4}{4}$ ms^{-1}

$= 2.188 \times 10^3 \times$ Kms^{-1}

28. Ans. (4)

$r_{H_{(1)}} = 0.53$ A°

$r_{H_{(2)}} = 0.53 \times \frac{(2)^2}{1}$

$= 0.53 \times \frac{4}{1} = 2.12$ Å

29. Ans. (1)

H	:	D
n = 1	:	n = 1
z = 1	:	z = 1
$0.529 \times \frac{1}{1}$	:	$0.529 \times \frac{1}{1}$

1 : 1

30. Ans. (2)

$V_1 \quad : \quad V_2 \quad : \quad V_3$

$$2.188\times10^6\times\frac{1}{1} : 2.188\times10^6\times\frac{1}{2} : 2.188\times10^6\times\frac{1}{3}$$

$$1 \quad : \quad \frac{1}{2} \quad : \quad \frac{1}{3}$$

31. Ans. (1)

For H–atom

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

For He^+ (Z=2)

$$\Rightarrow E_n = -13.6\times\frac{4}{n^2} = 4E_n$$

32. Ans. (4)

$$E_2 \quad = -13.6\times\frac{1}{(2)^2} = -328\text{kJ/mol}$$

$$E_4 \quad = -13.6\times\frac{1}{(4)^2}$$

$$E_4 \quad = -328\times\frac{1}{4} = -82\text{kJ/mol}$$

33. Ans. (1)

$$\frac{E_1}{E_3}\Rightarrow\frac{-13.6\times\left(\frac{1}{1^2}\right)}{-13.6\times\left(\frac{1}{3^2}\right)} = \frac{-13.6}{E_3}$$

$$E_3 \quad = -13.6\times\frac{1}{9}$$

$$E_3 \quad = \quad -1.51\text{eV}$$

34. Ans. (3)

As we know T.E. = –K.E.

T.E. : – K.E.

1 : – 1

35. Ans. (3)

P.E. = 2E

P.E. = 4E [Double of Total Energy]

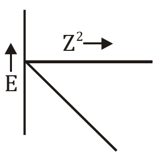
$$E \quad = \quad \frac{P.E.}{4} = \frac{-27.2\text{ev}}{4} = -6.8\text{eV}$$

36. Ans. (4)

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

$\Downarrow \qquad \Downarrow$

$y = \quad -mx$



37. Ans. (1)

As we know K.E. $\propto \frac{1}{r}$

So going from K–shell to N–shell radius increases so we can say K.E. decreases

38. Ans. (1)

e^- jumps from higher to lower energy realises & lower to higher energy absorbed.

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

$$\frac{c}{\lambda} = R_H cz^2\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right] \text{--}$$

$$\nu = R_H cz^2\left[\frac{1}{1}-\frac{1}{4}\right] = \frac{3R_H cz^2}{4} \text{ [minimum]}$$

39. Ans. (4)

I.E. = 313.8 $\quad [n_1 = 1, n_2 = \infty]$

Energy in II[nd] exited state

$$E = -313.8\times\frac{1}{3^2} = -34.86 \simeq -35 \text{ kcal/mol}$$

40. Ans. (1)

In transition, closer to nucleus will require largest amount of energy, i.e. n = 1 to n = 2.

41. Ans. (2)

$$E = \frac{P.E.}{2} = \frac{-3.02}{2} = -1.51$$

$$-1.51 = -13.6\times\frac{(1)^2}{(n)^2}$$

$$n^2 = \frac{13.6}{1.51}\simeq 9$$

n = 3 [II[nd] exited state]

42. Ans. (4)

In transition, away from, lowest frequency radiation will be emitted.

43. Ans. (4)

I[st] exited state (n=2)

II[nd] exited state (n=3)

$$\frac{E_2}{E_3} = \frac{-13.6\times\frac{(1)^2}{(2)^2}}{-13.6\times\frac{(1)^2}{(3)^2}} = \frac{\frac{1}{4}}{\frac{1}{9}} = \frac{9}{4}$$

44. Ans. (3)

$E_n = -313.6/n^2 = -34.84$

$n^2 = \frac{313.6}{34.84} \simeq 9$

$n = 3$

45. Ans. (1)

$\frac{\text{P.E.}}{2} = \text{T.E}$

P.E. = 2 T.E.

$\frac{\text{P.E.}}{\text{T.E}} = \frac{2}{1} = 2$

46. Ans. (1)

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

$E \propto \frac{-1}{n^2}$

$n \uparrow \quad E \uparrow$

Energy order $E, > E_2 > E_3$ is not true real order will be $E_3 > E_2 > E_1$

47. Ans. (1)

$E_2 - E_1 = 10.2$ev

$E_3 - E_2 = 1.89$ev

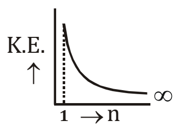
$E_4 - E_3 = 0.66$ev

$[E_2 - E_1] > [E_3 - E_2] > [E_4 - E_3]$

48. Ans. (3)

$\text{K. E.} = \frac{kZe^2}{2r}$

$\text{K. E.} \propto \frac{1}{n}$



K. E. $\uparrow$ then n $\downarrow$

49. Ans. (1)

First excitation potential of H

$E_2 - E_1 = 10.2$eV

50. Ans. (3)

M shell [n = 4]

$E_2 = -13.6 \times \frac{(1)^2}{(2)^2}$ First exited state (n = 2)

$E_2 = -13.6 \times \frac{1}{4}$

$E_2 = -3.4$eV

51. Ans. (4)

Second exited state [n = 3]

$\text{I. E.} = 13.6 \times \frac{1}{n^2} = 13.6 \times \frac{1}{9} = 1.51\text{eV}$

52. Ans. (4)

$E_2 = -13.6 \times \frac{(1)^2}{(2)^2}$

$= -3.4$eV

3.4 or less

53. Ans. (1)

$E_2 - E_1 = -13.6 \times (1)^2 \left[\frac{1}{4} - \frac{1}{1}\right]$

$E_2 - E_1 = 13.6 \left[\frac{3}{4}\right]$

54. Ans. (1)

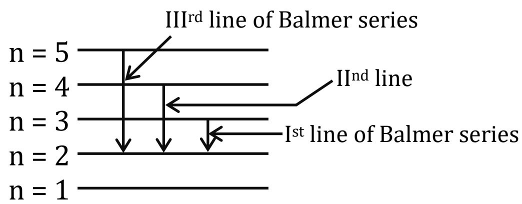
I. P. of He^+ Ion is equivalent to K.E. of first orbit.

Singly Ionized He^+ Contain only 1 electron & also e^- present in I[st] orbit hence this energy is equal to K.E. I[st] orbit.

55. Ans. (4)

He^+ is expected to be similar to Li^{+2} because number of electrons are similar.

56. Ans. (1)



$\boxed{\text{N = 5 to n = 2}}$

57. Ans. (3)

Energy difference maximum then wavelength will be lower.

$n_4 \longrightarrow n_1$

58. Ans. (4)

Lyman (n = 1) have highest energy in hydrogen spectrum.

$E \propto \frac{1}{n^2}$

$n \uparrow . E \downarrow$

59. Ans. (3)

$$\frac{\nu_L}{\nu_B} = \frac{RZ^2\left[\frac{1}{1}-\frac{1}{4}\right]}{RZ^2\left[\frac{1}{4}-\frac{1}{4}\right]}$$

$$\frac{\nu_L}{\nu_B} = \frac{\frac{3}{4}}{\frac{5}{36}}$$

$$\frac{\nu_L}{\nu_B} = \frac{3\times36}{5\times4} = \frac{27}{5} = 5.4$$

60. Ans. (4)

$n_1 = 1, \quad n_2 = 2$

$E_{2\to1} = h\nu_{2\to1} = 13.6 \times \left[\frac{1}{4}-\frac{1}{1}\right]$

$= 13.6 \times \frac{3}{4} = 10.2ev$

$\Delta E \propto \nu \propto \frac{1}{\lambda}$

61. Ans. (1)

$Mg^{+2} \to 10e^-$

$Al^{+3} \to 10e^-$

Same number of electrons.

62. Ans. (2)

$$\frac{\frac{1}{\lambda_L}}{\frac{1}{\lambda_B}} = \frac{(RZ^2)\left[\frac{1}{1^2}-\frac{1}{\infty^2}\right]}{(RZ^2)\left[\frac{1}{2^2}-\frac{1}{\infty^2}\right]}$$

$$= \frac{\lambda_L}{\lambda_B} = \frac{1}{4} = 0.25$$

63. Ans. (4)

H atom $\frac{1}{\lambda_1} = R(1)^2\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$

He^+ atom $\frac{1}{\lambda_2} = R(2)^2\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$

$$\frac{\lambda_1}{\lambda_2} = \frac{R\times4\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]}{R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]}$$

$$\frac{\lambda_1}{\lambda_2} = \frac{4}{1}$$

$$\lambda_2 = \frac{\lambda_1}{4}$$

64. Ans. (2)

$\nu_{maxL} = cRZ^2\left[\frac{1}{1^2}-\frac{1}{\infty^2}\right] = cRZ^2$

$\nu_{maxB} = cRZ^2\left[\frac{1}{4^2}-\frac{1}{\infty^2}\right] = \frac{cRZ^2}{16}$

$$\frac{\nu_{max\,L}}{\nu_{maxB}} = \frac{cRZ^2}{\frac{cRZ^2}{16}} = \frac{16}{1}$$

65. Ans. (1)

$$\lambda_{Li^{+2}} = \frac{1}{R(3)^2\left[\frac{1}{1^2}-\frac{1}{2^2}\right]} = \frac{1}{9R\left(\frac{3}{4}\right)}$$

$$\lambda_D = \frac{1}{R(1)^2\left[\frac{1}{1^2}-\frac{1}{2^2}\right]} = \frac{1}{\left(\frac{3}{4}\right)R}$$

$$\frac{\lambda_{Li^{+2}}}{\lambda_D} = \frac{R\left(\frac{3}{4}\right)}{9R\left(\frac{3}{4}\right)} = \frac{1}{9}$$

66. Ans. (2)

Visible $\to$ Balmer series

Infra red $\to$ Pashend, bracket, Pfund, Humphrey

U.V. light $\to$ Lyman series.

Atom can not emit γ–rays.

67. Ans. (3)

Lyman [2 to 1] $\to$ H $\to$ 10.2ev

Balmer [4 to 2] $\to$ 10.2ev

$\Delta E = -13.6 \times Z^2\left[\frac{1}{n_2^2}-\frac{1}{n_1^2}\right]$

$10.2 = -13.6 \times 2^2\left[\frac{1}{4^2}-\frac{1}{2^2}\right]$

$Z^2 = 4 \Rightarrow Z = 2\ (He^+)$

68. Ans. (3)

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

$\nu = 3 \times 10^8 \times 1.1 \times 10^7 \times (1)^2\left[\frac{1}{2^2}-\frac{1}{\infty^2}\right]$

$\nu = 8.22 \times 10^{14}\ sec^{-1}$

69. Ans. (1)

$\bar{\nu} = Rz^2\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$

$\bar{\nu} = R(1)^2\left[\frac{1}{4}-\frac{1}{9}\right]$

$\bar{\nu} = \frac{5R}{36}cm^{-1}$

70. Ans. (4)

I^{st} Lyman series [2 to 1] $\rightarrow \lambda = 10.2ev$ $[E_2 - E_1]$

He^+ $(n_2 \rightarrow n_1) \rightarrow \lambda = \Delta E = 10.2ev$

$(E_{n_2} - E_{n_1})_Z = (E_{n_2} - E_{n_1})_H \times Z^2$

$(10.2)He^+ = (E_{n_2} - E_{n_1})_H \times (2)^2$

$\Rightarrow (E_{n_2} - E_{n_1})_H = \frac{10.2}{4} = 2.55ev$

So $n_2 = 4$ & $n_1 = 2$

71. Ans. (1)

$n_2 = 6$ to $n_1 = 3$

Total spectral lines = $\frac{(n_2-n_1)(n_2-n_1+1)}{2}$

$= \frac{(6-3)(6-3+1)}{2} = 6$

72. Ans. (3)

Let n = 7

Total spectral lines = $\frac{(n_2-n_1)(n_2-n_1+1)}{2}$

$= \frac{(7-1)(7-1+1)}{2} = \frac{6\times7}{2} = 21$

73. Ans. (3)

1, 2, 3 $\rightarrow$ Coming to energy level A but 4, 5, 6 $\rightarrow$ are not coming to energy level A So they will not appear in the absorption spectrum.

74. Ans. (1)

U.V. region $\rightarrow$ Lyman series $\rightarrow$ 3

I^{st} Line $\rightarrow 2 \rightarrow 1$

II^{nd} Line $\rightarrow 3 \rightarrow 1$

III^{rd} Line $\rightarrow 4 \rightarrow 1$

$n_2 = 4$

$4 \rightarrow 3 \rightarrow$ Total lines = 1 (in paschen series)

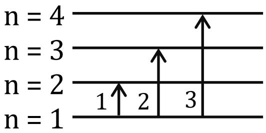
75. Ans. (4)

Total spectral Lines = $\frac{(n_2-n_1)(n_2-n_1+1)}{2}$

$= n_2 = 4, n_1 = 1$

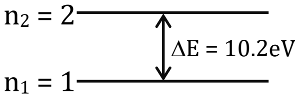
T. S. Lines = $\frac{(4-1)(4-1+1)}{2} = 6$

76. Ans. (1)



Absorption always take place from ground state. So Total 3 absorption lines.

77. Ans. (1)



$E_2 - E_1 = 10.2eV$

e^- will reach in 2^{nd} orbit it we supply min. 10.2eV energy. So here no spectral line will be formed as energy supplied according to question is 9.9eV

78. Ans. (3)

$\nu = \frac{C}{\lambda} = \frac{3\times10^8}{1285\times10^9}$

Also $\nu = 3.39\times10^{15}\left[\frac{1}{3^2}-\frac{1}{n^2}\right]$

$\frac{1}{n^2} = \frac{1}{9} - \frac{3\times10^8}{1285\times10^{-9}} \times \frac{1}{3.29\times10^{15}}$

$n^2 = 25 \Rightarrow n = 5$

79. Ans. (3)

K. E. = $2.8 \times 10^{-23}J$

$m_e = 9.1 \times 10^{-31}$ kg

$\lambda = \frac{h}{\sqrt{2m_e\ KE}}$

$= \frac{6.6\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times2.8\times10^{-23}}}$

$\lambda = 9.28 \times 10^{-8}m$

80. Ans. (2)

$2\pi r_n = n\lambda$

$2\pi\ 0.529\frac{n^2}{Z} = n\lambda$

$\lambda = 2\pi\ 0.529\times\frac{n}{Z}$

Z = 1, n = 3

$\lambda = 9.96 \times 10^{-8}cm$

81. Ans. (3)

n = 4, λ = 4 A°

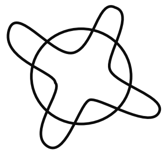
Circumference = $2\pi r = n\lambda$

Circumference = $n\lambda$

Circumference = 4 × 4 A°

Circumference = 16 A°

82. Ans. (1)



Orbit is 4 so number of wave is also 4.

83. Ans. (1)

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

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{v_2}{v_1}} = \sqrt{\frac{50}{200}} = \frac{1}{2}$$

84. Ans. (1)

$2\pi r = n\lambda$

Circumference = $2\pi r$

$= n\lambda$

85. Ans. (1)

m = +2

ℓ = +2

n = +3

number of wave made by Bohr electron is 3.

86. Ans. (1)

$\Delta Pe = 32 \times 10^5$

$\Delta X_e = \Delta X_{He}$

ΔP_{He} = ?

$$\frac{\Delta Pe}{P_{He}} = \frac{\Delta X_{He}}{\Delta X_e} \Rightarrow \frac{32\times10^5}{\Delta P_{He}} = \frac{1}{1}$$

$\Delta P_{He} = 32 \times 10^5$

87. Ans. (3)

$m_e = 9.1 \times 10^{-28}$

$h = 6.6 \times 10^{-27}$ gcm^2/sec.

Δv = 0.011% of 3×10^4

= 3.3cm/sec.

$$\Delta x = \frac{h}{4\pi m\Delta v} = \frac{6.6\times10^{-27}}{4\pi\times9.1\times10^{-28}\times3.3}$$

= 0.1748cm

88. Ans. (4)

Motor car and stationary Particles (2 and 3 both)

As we know it is not valid for macroscopic particles & stationary particles.

89. Ans. (1)

$$\lambda = \frac{h}{P} \Rightarrow P = \frac{h}{\lambda}$$

λ = 1 Å = 10^{-8}cm

$$P = \frac{6.6252\times10^{-27}\,\text{erg/s}}{1\times10^{-8}\,\text{cm}}$$

P = 6.6252×10^{-19} gcm/sec.

90. Ans. (4)

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

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

SO_2 has maximum mass so it will have least de-Broglie wavelength.

91. Ans. (1)

n = 3, l = 2, m = 2

i.e. $3d_{x^2-y^2}$ so 1 orbital is possible.

92. Ans. (4)

Number of possible orbitals = n^2

n = 3

So number of orbitals = 3^2 = 9

93. Ans. (1)

2d $\quad$ ℓ should be less than n

n = 2

ℓ = 2

94. Ans. (3)

(1) 2s

(2) 3s

(3) 2p

(4) 1s

s orbital has 0 nodal plans so [3] is ans.

95. Ans. (2)

2s $\rightarrow$ n = 2

ℓ = 0

$n - \ell - 1 = 2 - 0 - 1 = 1$

96. Ans. (1)

Number of orbitals $= 2\ell + 1$

$= 2\,[5] + 1$

$= 10 + 1 = 11$

97. Ans. (3)

n, ℓ, m $\Rightarrow$ 3 are required to specify the position of electron.

98. Ans. (1)

$4d \rightarrow \quad n = 4$

$\ell = 2$

$m = -2, -1, 0, +1, +2$

$s = \frac{+1}{2}, \frac{-1}{2}$

99. Ans. (4)

$n = 3$

$\ell = 0$ to $n - 1$

$\ell = 0$ to 2

$\ell = 0, 1, 2$

100. Ans. (1)

$s < p < d < f$

101. Ans. (2)

$n = 5, m = 2$

$\ell = 0 \rightarrow m = 0$

$\ell = 1 \rightarrow m = -1, 0 +1$

$\ell = 2, 3, 4 \rightarrow m = +2$ possible

102. Ans. (1)

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

103. Ans. (3)

$n = 6, m = 0, \ell = 1$

$6\,P_z \Rightarrow 2e^-$(maximum)

104. Ans. (3)

n = 4, total no. of orbitals will be $n^2 = 4^2 = 16$

105. Ans. (4)

$n = 3, \ell = 2, m = +2, s = +\frac{1}{2}$

1 electron

106. Ans. (1)

$\Psi_{n\ell m} = \Psi_{420}$

$4d_{z^2}$

107. Ans. (2)

$4d \rightarrow \quad n = 4$

$\ell = 2$

$m = -2, -1, 0, +1, +2$

$s = \frac{+1}{2}, \frac{-1}{2}$

$\ell = 1$ is not possible----

108. Ans. (2)

2K, 8L, 11M, 2N $\qquad 23e^-$

Z = 23

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

$8e^-s$

109. Ans. (3)

$\ell = 3 \rightarrow f$

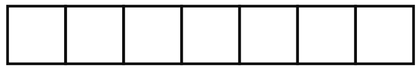
(1) 3p, 3

(2) 4f, 14

(3) 5f, 7 number of orbital

(4) 3d, 5

110. Ans. (4)



nf–orbital has $2e^-$ with Opposite spin.

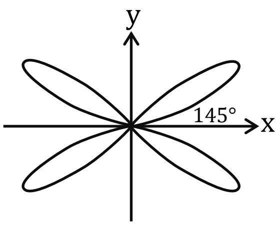
111. Ans. (3)

$3P_y \qquad n = 3$

$\ell = 1$

$m = -1$ or $+1$----

112. Ans. (3)



At an angle of 45° from x & y axis

113. Ans. (3)

Angular nodal planer $= \ell$

$= 2$

d–orbital.

114. Ans. (4)

$\ell = 0 \Rightarrow$ s–orbital

s-orbital shape is symmetrical around the nucleus.

115. Ans. (4)

$$\sum_{\ell=0}^{\ell=n-1} 2(2\ell+1)$$

or

maximum $e^- = 2n^2$

let $n = 1 \Rightarrow$ maximum $2e^-$

Put $n = 1$ in all option we get $2e^-$

116. Ans. (2)

Acc. to pauli's exclusion Principle all 4 quantum number should be different for different electrons.

$\boxed{\uparrow\downarrow}\quad \boxed{\uparrow\uparrow}\quad \boxed{\uparrow}\boxed{}\boxed{}$

$1s^2$	$2s^2$	$2p^1$
$n = 2$	$n = 2$	
$\ell = 0$	$\ell = 0$	
$m = 2$	$m = 2$	
$s = +1/2$	$s = +1/2$	

117. Ans. (1)

Acc. to hund's rule paring of electrons in orbitals belonging to same subshell does not takes place until each orbital has got on electron each with same spin.

$[He]\ \underset{2s}{\boxed{\uparrow\downarrow}}\quad \underset{2p}{\boxed{\uparrow}\boxed{\uparrow}\boxed{}}$

118. Ans. (3)

$N \rightarrow \underset{1s^2}{\boxed{\uparrow\downarrow}}\quad \underset{2s^2}{\boxed{\uparrow\downarrow}}\quad \underset{2p^3}{\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}}$

$\downarrow$

Hund's principle

119. Ans. (4)

3d $n + \ell = 3 + 2 = 5$

5p $n + \ell = 5 + 1 = 6$

4s $n + \ell = 4 + 0 = 4$

6d $n + \ell = 6 + 2 = 8$

$n + \ell \uparrow$ the maximum energy.

120. Ans. (1)

$n + \ell = 7$

$7 + 0 = 7 \Rightarrow 7s$ $\quad n > \ell$

$6 + 1 = 7 \Rightarrow 6p$ $\quad n > \ell$

$5 + 2 = 7 \Rightarrow 5d$ $\quad n > \ell \Rightarrow$ 4 Subshell

$4 + 3 = 7 \Rightarrow 4f$ $\quad n > \ell$

$3 + 4 = 7$ $\quad n > \ell$

$2 + 5 = 7$ $\quad n > \ell$

$1 + 6 = 7$ $\quad n > \ell$

121. Ans. (1)

$\boxed{\uparrow\downarrow}\quad \boxed{\uparrow\downarrow}\quad \boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}$

122. Ans. (1)

$d^9 \Rightarrow \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow}$

Total spin $= \frac{1}{2} \times$ (number of unpaired electrons)

$= \frac{1}{2} \times 1 = \frac{1}{2}$

123. Ans. (4)

In case of H-atom n = 3

all options have value n = 3 so neither absorption nor emission takes place.

124. Ans. (3)

${}_{24}Cr \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

$\underset{1s^2}{\boxed{\uparrow\downarrow}}\ \underset{2s^2}{\boxed{\uparrow\downarrow}}\ \underset{2p^6}{\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}}\ \underset{3s^2}{\boxed{\uparrow\downarrow}}\ \underset{3p^6}{\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}}$

$\underset{3d^5}{\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}}\ \underset{4s^1}{\boxed{\uparrow\downarrow}}$

Total orbital with paired $e^- = 15$

125. Ans. (2)

${}_{11}Na \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^1$

$3s^1 \Rightarrow\ n = 3, \ell = 0, m = 0$

$s = +\frac{1}{2}, -\frac{1}{2}$

126. Ans. (3)

${}_{24}Cr \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

$4s^1 \Rightarrow\ n = 4, \ell = 0, m = 0$

$s = +\frac{1}{2}, -\frac{1}{2}$

127. Ans. (4)

$3p \Rightarrow\ n = 3, \ell = 1, m = -1, 0, +1$

$s = +\frac{1}{2}, -\frac{1}{2}$

128. Ans. (1)

$Cr^{+2} \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^\circ$

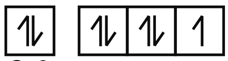
$\underset{3d^4}{\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{}}$

Total 4 unpaired electrons.

129. Ans. (3)

Z = 17

$_{17}Cl \Rightarrow 1s^2\ 2s^2\ 2p^6\ \underbrace{3s^2\ 3p^5}$



$3s^2$ $3p^5$

Total 3 orbitals.

130. Ans. (2)

$[Ar]\ 3d^5$

Actual number of e^-s = 23 + 3 = 26

131. Ans. (3)

$_{29}Cu \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^{10}$

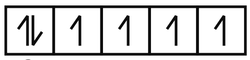
$_{24}Cr \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

$_{30}Zn \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$

$_{19}K \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$

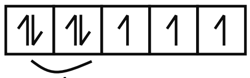
132. Ans. (2)

$_{26}Fe^{+2} \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^6$



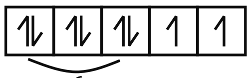
2

$_{27}Co^{+2} \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^7$



4

$_{28}Ni^{+2} \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^8$



6

Total = 2 + 4 + 6 = $12e^-$

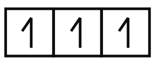
133. Ans. (3)

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

n = 4, ℓ = 0, m = 0

$s = +\frac{1}{2}, -\frac{1}{2}$

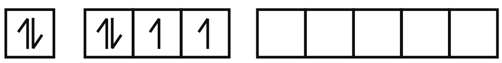
134. Ans. (1)

 maximum 3 unpaired e^-

$3p^3$

$15e^- \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

135. Ans. (3)



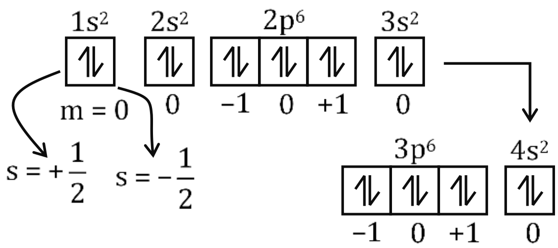
It shows ground state configuration

136. Ans. (1)

2K, 8L, 8M, 2N

Number of e^- is 20

Z = 20



6 electrons $\Rightarrow$ m = 0

$S = +\frac{1}{2}$

Exercise-II (Previous Year Questions)

1. Ans. (1)

n = 3, ℓ = 1, m_ℓ = 0 $\Rightarrow$ 1 orbital

2. Ans. (4)

λ = 45nm = 45×10^{-9}m

h = 6.63×10^{-34} J.s

c = 3×10^8 m/s

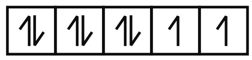
$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3\times10^{8}}{45\times10^{-9}}$

E = 0.442×10^{-17} J

E = 4.42×10^{-18} J

3. Ans. (2)

$_{28}Ni^{2+}\ 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^8$



$3d^8 \rightarrow$ 2 unpaired electrons

Magnetic moment $\Rightarrow \sqrt{n(n+2)}$

$= \sqrt{2(2+2)} = \sqrt{8}$ = 2.83 B.M.

4. Ans. (3)

ClO_3^- and SO_3^{-2} are isoelectronic and isostructural.

5. Ans. (1)

$_{26}Fe^{+2} \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^6$

$\Rightarrow$ 6 d- electrons

$_{17}Cl \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5 \Rightarrow 6 + 5 = 11$ electrons.

p-electrons in Cl

6. Ans. (4)

$_{28}Ni^{+2} \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^8$

$\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}$

Number of unpaired e^- s = 2

Magnetic moment $\Rightarrow \sqrt{n(n+2)}$

$= \sqrt{2(2+2)} = \sqrt{8}$ = 2.84 BM.

7. Ans. (4)

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

for d-orbital ℓ = 2, $\dfrac{h}{2\pi} = \hbar$

The Orbital angular momentum

= $\sqrt{2(2+1)}\ \hbar$

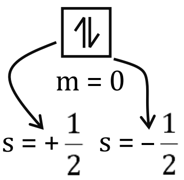
= $\sqrt{6}\ \hbar$

8. Ans. (2)

$_{22}Ti \Rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^2$

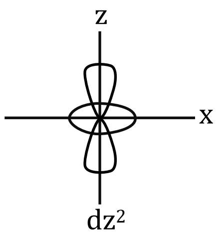
3s 3p 4s 3d

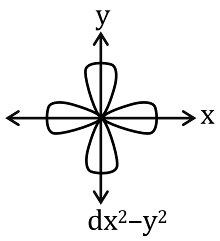
9. Ans. (4)



Spin quantum number (5)

10. Ans. (1)





Both have e^- density along the axis

11. Ans. (3)

n = 3, ℓ = 1

3p maximum 2 electrons are possible in 1 orbital

12. Ans. (3)

$1s < 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = 4f <$ ---

13. Ans. (3)

$N \rightarrow \boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow}\boxed{\uparrow}\boxed{\downarrow}$

This is wrong statement

$\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\ \boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$

14. Ans. (2)

In Hydrogen atom spectrum Balmer series Transitions falls in visible region.

15. Ans. (3)

4 f

Orbital angular node (e) = 3

Total node = n – ℓ – 1 + ℓ

= n = 1

= 4 – 1 = 3

16. Ans. (2)

$mvr_n = \dfrac{nh}{2\pi}$

$P = \dfrac{nh}{2\pi r_n}$ ...(1)

$\lambda = \dfrac{h}{p} \Rightarrow \lambda = \dfrac{n}{2\pi r_n}$

we know $r_n = 52.9n^2$

$r_2 = 52.9(2)^2 = 211.6$ pm

so $\lambda = \dfrac{2\pi(211.6)}{2}$ = 211.6 π pm

17. Ans. (2)

$^{175}_{71}Lu \Rightarrow p \rightarrow 71$

$e \rightarrow 71$

n = 175 – 71 = 104

p	n	e
71	104	71

18. Ans. (1)

3s angular nodes ℓ = 0

Radial nodes n – ℓ – 1

= 3 – 0 – 1 = 2

19. Ans. (1)

$E = \dfrac{hc}{\lambda} = h\nu$

So $\dfrac{c}{\lambda} = \nu \Rightarrow \lambda = \dfrac{c}{\nu}$

$\lambda = \dfrac{3\times10^8}{1368\times10^3} = 219.3m$

20. Ans. (3)

d_{xy}, d_{y^2}, d_{zx} & $d_{x^2-y^2}$ these 4 orbitals has similar shape but d_{z^2} has different shape.

21. Ans. (4)

$r_n \propto \frac{n^2}{z}$

$\frac{r_3(Li^{+2})}{r_2(He^+)} = \frac{(3)^2}{3} \times \frac{2}{(2)^2}$

$\frac{r_3(Li^{+2})}{105.8} = \frac{3}{2}$

$r_3(Li^{+2}) = \frac{3}{2} \times 105.8 = 158.7$ pm

22. Ans. (4)

(a) $n = 2, \ell = 1 \Rightarrow 2p \Rightarrow$ (iii)
(b) $n = 3, \ell = 2 \Rightarrow 3d \Rightarrow$ (iv)
(c) $n = 3, \ell = 0 \Rightarrow 3s \Rightarrow$ (ii)
(a) $n = 2, \ell = 0 \Rightarrow 2s \Rightarrow$ (i)

23. Ans. (4)

$\lambda = 300$ nm $= 300 \times 10^{-9}$m

$E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34})(3\times10^{8})}{300\times10^{-9}}$

$= 6.626 \times 10^{-9}$ J

for 1 mole $\Rightarrow 6.626 \times 10^{-9} \times 6.023 \times 10^{23}$
$= 3.99 \times 10^{5}$ J/mole

K.E. $= 1.68 \times 10^{5}$ J/mole

$h\nu_0 = h\nu - K.E.$

$h\nu_0 = 3.99 \times 10^{5} - 1.68\ 10^{5}$
$= 2.31 \times 10^{5}$ J/mole

minimum energy $= 2.31 \times 10^{5}$ J/mole^{-1}

24. Ans. (3)

It is statement based question.
Statements B, C & E are correct.
(B) Mass of the electron is 9.10939×10^{-31} kg
(C) All the isotopes of given elements show same chemical properties.
(E) Dalton's atomic theory, regarded the atom as an ultimate particle of matter.

25. Ans. (4)

Number of permissible values of magnetic quantum number for a given value of azimuthal quantum $(\ell) \Rightarrow n_m = 2\ell + 1$

$\Rightarrow \ell = \frac{n_m - 1}{2}$

26. Ans. (2)

$m_\ell \rightarrow$ orientation of orbital

$m_s \rightarrow$ orientation of spin of e^-

$\ell \rightarrow$ shape of orbital

$n \rightarrow$ size of orbital

27. Ans. (1)

$E \propto \frac{Z^2}{n^2}$

$\frac{E_1}{E_2} = \frac{Z_1^2}{n_1^2} \times \frac{n_2^2}{Z_2^2}$

$He^+ \rightarrow n_1 = 1$ & $Z_1 = 2$

$Be^{+3} \rightarrow n_2 = 2$ & $Z_2 = 4$

$\frac{E_1}{E_2} = \frac{2^2}{1^2} \times \frac{2^2}{4^2} = 1$

$E_1 = E_2$

28. Ans. (2)

$\uparrow(n+\ell) \uparrow$Energy so correct one is

I > III > II > IV

29. Ans. (3)

Both statement I and statement II are true.

Exercise-III (Analytical Questions)

1. Ans. (1)

Azimuthal quantum number $(\ell) \Rightarrow$ represents subshell also determines the shape of orbital.
Number of orbitals in subshell $= (2\ell + 1)$

2. Ans. (1)

n, ℓ, m can be same for two electrons. But s value should be different.

eg.  $n = 2, \ell = 0, m = 0, s = +\frac{1}{2}$ & $-\frac{1}{2}$

2s

3. Ans. (3)

$\rightarrow$ Energy order.

1s < 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = 4f ----

(I) Incorrect.

$(n + \ell) \Rightarrow$ same then less n will have less energy. (II) Correct

4. Ans. (1)

→ Energy of stationary state e^- ⇒ $E_n = R_H \left[\frac{-1}{n^2}\right]$ (I)correct

→ If electron is present in n^{th} orbit then it feel more attraction compare to electron present at infinity distance. So energy is less for n^{th} orbit of electron.

5. Ans. (1)

Cathode ray can travel in straight line in absence of electric or magnetic field. Also Characteristics does not depend upon the nature of gas because Characteristics particles are electrons.

6. Ans. (1)

As per the Thomson model of atom. b, c are correct.

7. Ans. (1)

For neutral atom

→ number of electrons = number of protons.

→ positive charge of nucleus is due to protons.

8. Ans. (1)

9. Ans. (1)

10. Ans. (1)

11. Ans. (4)