3. $\dfrac{r_A}{r_N} = 10^5$

$\dfrac{V_A}{V_N} = \left(\dfrac{r_A}{r_N}\right)^3 = (10^5)^3 = 10^{15}$ $\qquad \dfrac{V_A}{V_N} = 10^{-15}$

4. $R = R_0 A^{1/3} = 1.33 \;\; 10^{-13} \;\; (64)^{1/3}$ cm

$= 5.32 \;\; 10^{-13} \;\; (64)^{1/3}$ cm

$\because$ 1 fm = 10^{-15} m $\approx$ 5 fm

10. $\lambda = \dfrac{C}{\nu} = \dfrac{3\times 10^8}{400 \times 10^6} = 0.75$ m

14. d = 20 nm

$r = \dfrac{20}{2} = 10$ nm =100 A

$\because r = 0.529 \;\; \dfrac{n^2}{Z}$ A $\qquad$ For H atom Z = 1

$100 = 0.529 \;\; n^2 \qquad n = 14$

15. $E_n = -13.6 \;\; \dfrac{Z^2}{n^2}$

$E_1(H) = -13.6 \;\; \dfrac{1}{1} = -13.6$ eV

$E_2(He^+) = -13.6 \;\; \dfrac{4}{4} = -13.6$ eV

$E_3(Li^{2+}) = -13.6 \;\; \dfrac{3^2}{3^2} = -13.6$ eV

$E_4(Be^{3+}) = -13.6 \;\; \dfrac{4^2}{4^2} = -13.6$ eV

$\therefore$ Ans B

16. E = –78.4 kcal/mol

$E_n = -313.6 \;\; \dfrac{Z^2}{n^2}$ kcal/mol

for H atom Z = 1 $\qquad -78.4 = 313.6 \;\; \dfrac{1}{n^2}$

$n^2 = \dfrac{313.6}{78.4} \qquad n = 2$

17. $V_n = 2.188 \;\; 10^6 \;\; \dfrac{Z}{n}$ m/sec.

$\dfrac{V_3(Li^{2+})}{V_1(H)} = \dfrac{Z_3/n_3}{Z_1/n_1} = \dfrac{3/3}{1/1} \qquad V(Li^{2+}) = V$

18. Let state (माना अवस्था) (1) = n_1

state (अवस्था) (2) = n_2

$r_1 - r_2 = 624\, r_0$

$0.529 \;\; \dfrac{n_1^2}{Z} - \dfrac{0.529 n_2^2}{Z} = 624 \;\; \dfrac{0.529 \times 1}{Z}$

$n_1^{\,2} - n_2^{\,2} = 624$

$n_1 = 25$

$n_2 = 1$

$25 \rightarrow 1$

19. (A) Energy of ground state (मूल अवस्था की ऊर्जा)

$He^+ = -13.6 \;\; 4$ eV $= -54.4 \;\; 4$ eV

(B) P.E. of Ist orbit of H-atom (हाइड्रोजन परमाणु के प्रथम कक्ष की P.E.)=2T.E.= $-2 \;\; 13.6$eV = –27.2eV

(C) Energy of II excited state(II उत्तेजित अवस्था की ऊर्जा)

$= -13.6 \;\; \dfrac{Z^2}{n^2} = -13.6 \;\; \dfrac{(2)^2}{(3)^2}$

$= -13.6 \;\; \dfrac{4}{9} = -6.04$ eV

(D) I.E.= $-E_1 = 21.8 \;\; 10^{-19} \;\; 4$J $= 8.7 \;\; 10^{-18}$J

20. $E_5 = -13.6 \;\; \dfrac{1}{(5)^2} = -\,0.54$ eV

22. Li^{+2} & He^+ both have same no. of electron so spectrum pattern will be similar.(Li^{+2} व He^+ दोनों समान इलेक्ट्रॉन रखते हैं इसलिए स्पेक्ट्रम समान होगा।)

23. $\lambda = \dfrac{h}{\sqrt{2mqV}} \qquad \lambda \propto \dfrac{1}{\sqrt{V}}$

$\dfrac{\lambda_1}{\lambda_2} = \sqrt{\dfrac{V_2}{V_1}} = \sqrt{\dfrac{200}{50}} = \dfrac{2}{1}$

24. $\Delta x.\Delta p = \dfrac{\lambda}{4\pi}$

put value $\qquad \Delta p = 1.0 \;\; 10^{-5}$ kg ms^{-1}

26. Orbital angular momentum (कक्षीय कोणिय संवेग)

$= \sqrt{\ell(\ell+1)}.\dfrac{h}{2\pi}$ $\qquad$ for $\ell = 0$

28. ${}_{25}Mn = 1s^2, 2s^2\, 2p^6, 3s^2\, 3p^6\, 3d^5, 4s^2$

$Mn^{+4} = 1s^2, 2s^2\, 2p^6, 3s^2\, 3p^6\, 3d^3, 4s^0$

29. ${}_{30}Zn^{2+} = 1s^2, 2s^2\, 2p^6, 3s^2\, 3p^6\, 3d^{10}$

(unpaired (अयुग्मित) $de^- = 0$)

${}_{26}Fe^{2+} = 1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^6$(unpaired $de^- = 4$)

${}_{28}Ni^{3+} = 1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^7$(unpaired $de^- = 3$)

${}_{29}Cu^{+} = 1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^9$(unpaired $de^- = 1$)

30. $d^7 = \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}$

Total spin (कुल चक्रण) $= +\dfrac{1}{2} + \dfrac{1}{2} + \dfrac{1}{2} = \dfrac{3}{2}$

31. $K = 2e^- = 1s^2$

$L = 8e^- = 2s^2\, 2p^4$

$M = 11e^- = 3s^2\, 3p^6\, 3d^3$

$N = 2e^- = 4s^2$

for d $e^- = 3$, $\ell = 2$

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

For last e^- n = 3, l = 1, m = ±1

35. (A) $v = 2.18 \quad 10^6 \quad \frac{Z}{n} \Rightarrow v \propto \frac{Z}{n}$ or $v \propto \frac{1}{n}$

(B) $f = \frac{v}{2\pi r}$ or $f = \frac{v}{r} \propto \frac{Z/n}{n^2/Z} \qquad f \propto \frac{Z^2}{n^3}$

(C) $r \propto n^2 / Z \qquad [T \propto \frac{n^3}{Z^2}] \qquad F = \frac{mV^2}{r}$

$F \propto \frac{v^2}{r} \propto \frac{(Z^2/n^2)}{n^2/Z} \qquad F \propto \frac{Z^3}{n^4}$

So ans (A,B,D)

37. Change in angular momentum = $(n_2 - n_1)$ h

(कोणीय संवेग में परिवर्तन)

$(n_2 - n_1)$ is an integer value ($(n_2 - n_1)$ एक पूर्णांक मान है)

so ans (B,C)

ATOMIC STRUCTURE — EXERCISE # 2

1. $E_n = \frac{13.6z^2}{n^2}$

as move away from the nucleus the energy increases, hence energy is maximum at infinite distance from the nucleus.

(नाभिक से दूर जाने पर ऊर्जा बढ़ती है अत: नाभिक से अनन्त दूरी पर ऊर्जा अधिकतम होगी।)

2. When electron jump higher level to lower level, it emit the photon lower level to higher level, It absorb photon. Hence '1s' only absorb photon because it is lowest energy level.

(जब इलेक्ट्रोन उच्च स्तर से निम्न स्तर की ओर आता है, तो फोटॉन मुक्त होते है तथा जब निम्न स्तर से उच्च स्तर की ओर जाता है तो फोटॉन अवशोषित होते है अत: '1s' केवल फोटॉन अवशोषित करता है क्योंकि यह निम्न ऊर्जा स्तर है।)

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

In balmer series, electron jumps higher energy level to 2nd energy level. Hence third line form when electron jump fifth energy level to 2 energy level. $5 \rightarrow 2$

(बामर श्रेणी में, इलेक्ट्रॉन उच्च ऊर्जा स्तर से 2nd ऊर्जा स्तर में आता है अत: तृतीयक रेखा प्राप्त होती है जब इलेक्ट्रॉन पांचवे ऊर्जा स्तर से द्वितीयक ऊर्जा स्तर में आता है। $5 \rightarrow 2$)

4. $_{37}Rb = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s^1$

n	ℓ	m	s
5	0	0	+1/2

5. Aufbau's principle : electron fills in orbital increasing order of energy level.

(ऑफबाऊ सिद्धांत : कक्षक में इलेक्ट्रानों को ऊर्जा स्तर के बढ़ते क्रम में भरा जाता है)

6. $^{70}_{30}Zn^{2+}$ = n = A – Z = 70 – 30 = 40

7. $n > \ell, m = -\ell$ to $+\ell$

n	ℓ	s
3	2	½

The value of cm is wrong

$\ell = 2$, m = –2, –1, 0, +1, +2

8. Hund's rule

9. Cr = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$; $Mn^+ = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

i.e. it represent both ground state and cationic form.

10. $Fe^{3+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$

↑	↑	↑	↑	↑

11. Schrodinger equation gives only n, l and m quantum number, spin quantum number is not related to schrodinger equation.

(श्रोंडिगर समीकरण से केवल n, l व m क्वाण्टम संख्या प्राप्त होती है, चक्रण क्वाण्टम संख्या श्रोंडिगर समीकरण से सम्बन्धित नहीं होती है।)

12. $h\nu = h\nu_0 + \frac{1}{2}mv^2$

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

K.E.= $hc\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)$

$\left(\frac{h^2}{2m\lambda_e^2}\right) = hc\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right) \qquad \left(\therefore \lambda = \frac{h}{\sqrt{2mK.E}}\right)$

$\lambda_e^2 = \frac{\lambda\,\lambda_0\,h}{[\lambda_0 - \lambda]\,2mc}$

$\lambda_e = \left[\frac{h\lambda\,\lambda_0}{2mc[\lambda_0 - \lambda]}\right]^{\frac{1}{2}}$

13. m_n = mass of neutron ; m_p = mass of proton

$\frac{m_n}{2} \qquad 2m_p$

atomic mass $\Rightarrow (m_n + m_p) \qquad [m_n \simeq m_p]$

$\Rightarrow (8 + 6) = 14\ m_p$

atomic mass $\Rightarrow (4 + 12) = 16\ m_p$

% increase $= \frac{16 - 14}{14} \times 100 = 14.28\ \%$

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

for shortest wave length $n_2 = \infty$, $n_1 = 2$

$\frac{1}{\lambda}=R_H\cancel{z}^2\left[\frac{1}{4}-\frac{1}{\infty}\right]$ $\lambda = \frac{4}{4R_H}=\frac{1}{R_H}=x$

for longest wave length of parchan series $n_2 = 4$, $n_1 = 3$

$\frac{1}{\lambda}=R_H\cancel{z}^2\left[\frac{1}{9}-\frac{1}{16}\right]$ $\frac{1}{\lambda}=R_Hx^2\left[\frac{7}{9\times16}\right]$

$\lambda=\frac{9\times16}{9\times7}\times\frac{1}{R_H}\Rightarrow \lambda=\frac{16}{7}x$

16. $(IE)_{Li^{2+}}=(IE)_H\times\cancel{z}^2$

$= 21.8 \quad 10^{-19} \quad 9$ J/atom

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

$\lambda = \frac{6.62\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times2.18\times10^{-9}\times9}}$

λ =1.17 A

17. $Fe^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$

⇅	↑	↑	↑	↑

unpaired electron (n) = 4

Magnatic moment (चुम्बकीय आघूर्ण)

$= \sqrt{n(n+2)}$ BM $= \sqrt{4(6)}=24$

orbital angular momentum (कक्षीय कोणीय संवेग) =

$\sqrt{\ell\times(\ell+1)}\hbar = \sqrt{2(3)}\hbar \Rightarrow \sqrt{6}\hbar$

18. $\lambda=\frac{h}{\sqrt{2ME}}$ $\lambda\propto\frac{1}{\sqrt{ME}}$

$\lambda_e\propto\frac{1}{\sqrt{M_e\times16E}}$; $\lambda_{p^+}=\frac{1}{\sqrt{M_p\times4E}}$

$\lambda_\propto\propto\frac{1}{\sqrt{4M_p\times4E}}$; hence $\lambda_e>\lambda_{p^+}=\lambda_\propto$

19. $Cu^+ = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$

all the electron are paried ; hence it is paramagnatic

(सभी इलेक्ट्रॉन युग्मित है अतः यह प्रतिचुम्बकीय होगा।)

20. $Li\ (g) \longrightarrow Li^+ + e^-$; $\Delta n = 520$

$Li^+\ (g) \longrightarrow Li^{+2} + e$; Δn = a KJ/mol.

$Li^{2+}\ (g) \longrightarrow Li^{2+} + e$; Δn = b KJ/mol.

b = $(IE_2)_{Li^+}$ = $(IE)_{Li^{2+}}$ = $(IE)_n$ $\quad\cancel{z}^2$ = 1313 $\quad$ 9

b = $(IE_2)_{Li^+}$ = 11817 KJ/mol

520 + a + 11817 = 19800

$(IE_2)_{Li^+}$ = a = 7463 KJ/mol

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

$\lambda=\frac{(n_2^2\,n_1^2)}{(n_2^2-n_1^2)}$

1st line of lymen series n_2= 2, n_1= 1

2nd line of lymen series n_2= 3, n_1= 1

3rd line of lymen series n_2= 4, n_1= 1

22. The anode ray/canal ray independent to the electrode material.

(एनोड किरणें या केनाल किरणें इलेक्ट्रॉड के पदार्थ पर निर्भर नहीं करती है)

23. Energy order decide from (n + ℓ) rule ;(n + ℓ) is minimum energy is minimum ; if (n + ℓ) value is equal, lower the value of 'n' lower the energy.

(ऊर्जा का क्रम (n + ℓ) नियम द्वारा ज्ञात किया जाता है ; (n + ℓ) का मान कम होने पर ऊर्जा न्यूनतम होती है ; यदि (n + ℓ) का मान समान हो तो, 'n' का न्यूनतम मान ही ऊर्जा का न्यूनतम मान होगा।) $\quad$ e3 > e2 > e4 > e1

24. $r_1=\frac{r_2}{n^2}$ $\quad r_1=\frac{r}{4}$; $r_3 = r_1 \quad n^2$

r_3 = r/4 $\quad$ 9 $\quad r_3$ = 2.25 R

25. $\lambda=\frac{h}{mv}=\frac{6.62\times10^{-34}\times3600}{0.2\times5}$

$\lambda = 2.38 \quad 10^{-30}$ metre

26. Acc to paulis an orbital accomdate maximum two electron, hence paulis exclusion principle voilates.

(पॉउली नियम के अनुसार कक्षक में अधिकतम दो इलेक्ट्रॉन हो सकते है अतः पॉउली अपवर्जन नियम का पालन नहीं होता है।)

27. For d_{yz}, xy and xz are nodal palne

node = (n – ℓ –1) = 6–2–1 ⇒ 3

29. $x \longrightarrow y + {}_2^4H_2$

$y \longrightarrow {}_8O^{18} + {}_1H^1$

$y = {}_9y^{19}$

$x = {}_{11}x^{23}$

Hence x = Na

Na present in 3rd period

No of neutron = 23 – 11 ⇒ 12

mole of Na = $\frac{4.6}{23}\Rightarrow 0.2$

Mole of neutron ⇒ 0.2 $\quad$ 12 ⇒ 2.4

30. $E=\frac{hc}{\lambda}\Rightarrow\frac{1240}{\lambda_{nm}}ev$ $\quad E=\frac{1240}{31}\Rightarrow 40$ eV

40 = 12.8 + K.E.

K.E. = 10 –12.8 = 27.2 eV

K.E. = 27.2 $\quad$ 1.6 $\quad 10^{-19}$

$27.2 \quad 1.6 \quad 10^{-19}=\frac{1}{2} \quad 9.1 \quad 10^{-31} \quad v^2$

v = 2.18 $\quad\sqrt{2}\quad 10^6$ m/s

31. Frequency = $\frac{1}{T} \propto \frac{v}{r} \propto \frac{Z/n}{n^2/Z}$

Frequency $= \frac{1}{T} \propto \frac{Z^2}{n^3}$ $T \propto \frac{n^3}{Z^2} = \frac{1/4}{8/1} \Rightarrow \frac{1}{32}$

32. Radial node (त्रिज्यीय नोड) = $(n - \ell - 1)$

Angular node (कोणीय नोड) = ℓ

4s, $5p_x$, 6_{dxy} having 3 radial node.

angular node in all 's' orbital in zero.

(सभी 's' कक्षकों में कोणीय नोड शून्य होते है।)

33. s-orbital is spherical hence it is non-directional.

(s-कक्षक गोलीय होते है अत: यह अदिशात्मक होते हैं।)

34. B.E. = I.E.

$(I.E.)_{\text{any atom}} = (I.E.)_H \quad Z^2$

$\frac{122.4}{13.6} = Z^2$

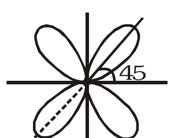
$Z^2 = 9 \qquad Z = 3$

$E_2 - E_1 = 122.4 - 30.6 = 91.8$ eV

35. $\Delta x = 2\Delta p \qquad \Delta x \,.2\Delta p = \frac{h}{4\pi}$

$2\,(\Delta p)^2 = \frac{h}{4\pi} \qquad (\Delta v)^2 = \frac{h}{8\pi m^2}$

$\Delta v = \frac{1}{2m}\sqrt{\frac{h}{2\pi}} \qquad \Delta v = \frac{1}{2m}\sqrt{\hbar}$

36. 

37. n =5 l = 0, 1, 2, 3, 4, s, p, d, f, g

38. From $(n + \ell)$ rule, same as Q.23

39. The value of $\ell = 0$ to $(n - 1)$

Number of electron for given value of $\ell = 2\,(2\ell+1)$

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

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

$\lambda^2 = \frac{h}{m} \Rightarrow \boxed{\lambda = \sqrt{\frac{h}{m}}}$

41. Acc to schrodinger model e^- behave as wave only.

(श्रोडिगर मॉडल के अनुसार e^- तरंग की तरह व्यवहार करते है।)

42. The maximum porbability of finding an electron is decribe the orbital, which is denote by Ψ^2.

(इलेक्ट्रॉन के पाये जाने की अधिकतम प्रायिकता की कक्षक के रूप में व्याख्या की जाती है। जिसे Ψ^2 से प्रदर्शित किया जाता है।)

43. $\lambda_m = \lambda_e \qquad \lambda = \frac{h}{mv}$

$\frac{h}{m_c v_c} = \frac{h}{m_n v_n} \qquad \frac{v_e}{v_n} = \frac{m_n}{m_c}$

45. (Ψ) it is a solution of schrodinger wave equation.

46. $2\pi r = n\lambda$ [acc to de-broglie theory]

47. $m_y = 0.25\ m_x$, $v_y = 0.75\ v_x$

$\lambda = \frac{h}{mv} \qquad \lambda_x = \frac{h}{m_x v_x}, \ \lambda_y = \frac{h}{m_y v_y}$

$\lambda_y = \frac{h}{0.25 M_x \times 0.75 v_x} \qquad \lambda_y = 5.33$ A

48. Orbital angular momentum (कक्षीय कोणीय संवेग) =

$\sqrt{\ell(\ell+1)}\,\hbar$

	s	p	d	f
ℓ =	0	1	2	3

48. $m = (2\ell + 1) \Rightarrow \ell = \frac{m-1}{2}$

50. $Mn^{4+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$

↑	↑	↑		

51. Acc to $(n + \ell)$ rule, after np, $(n + \ell)$ s always filled.

52. $Ni^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8$

↑↓	↑↓	↑↓	↑	↑

n = 2

magnatic moment (चुम्बकीय आघूर्ण) = $\sqrt{n(n+2)} \Rightarrow$

$\sqrt{2(4)} = 58 = 2.83$

53. $T \propto \frac{n^3}{Z^2} \qquad \frac{T_1}{T_2} = \frac{n_1^3}{n_2^3} = 1/8$

54. $E_\infty - E_1 = h\nu_1, \quad \Rightarrow E_1 \Rightarrow h\nu_1$

$E_2 - E_1 = h\nu_2$

$E_\infty - E_2 = h\nu_3, \quad \Rightarrow E_2 \Rightarrow h\nu_3$

$-h\nu_3 + h\nu_1 = h\nu_2$

$\boxed{\nu_2 = \nu_1 - \nu_3}$

$\boxed{\nu_3 = \nu_1 - \nu_2}$

55. $E_C - E_B = \frac{hc}{\lambda_1} \qquad \ldots$(i)

$E_B - E_A = \frac{hc}{\lambda_2} \qquad \ldots$(ii)

$E_C - E_A = \frac{hc}{\lambda_3} \qquad \ldots$(iii)

add equation (1) and (2)

$E_C - E_A = hc\left(\frac{1}{\lambda_1} + \frac{1}{\lambda_2}\right)$

put in equation (3)

$hc\left(\frac{1}{\lambda_1} + \frac{1}{\lambda_2}\right) = \frac{hc}{\lambda_3}$

$\frac{1}{\lambda_3} = \frac{\lambda_1 + \lambda_2}{\lambda_1 \lambda_2} \Rightarrow \boxed{\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}}$

56. $\Delta E = \dfrac{hc}{\lambda}$

$\Delta E = \dfrac{hc}{\lambda_1}$ (for H atom)

$\Delta E \quad z^2 = \dfrac{hc}{\lambda_2}$ (for He^+ atom)

$\dfrac{hc}{\lambda_1} \times 4 = \dfrac{hc}{\lambda_2} \Rightarrow \boxed{\lambda_2 = \dfrac{\lambda_1}{4}}$

57. First Excitation potential (प्रथम उत्तेजन विभव)

$= E_2 - E_1 \qquad \Rightarrow -4 + 16 \qquad \Rightarrow 12$ eV

58. $n_2=4, n_1=3$;

$n_2=5 \ n_1=4$;

$n_2=6 \ n_1=5$;

$n \rightarrow (n-1)(n \geq 4)$

59. $n_2 = 5, \quad n_1 = 1$

total number of stectrum line are

$\Sigma(5-1) \Rightarrow \Sigma 4$

$\Sigma 4 \Rightarrow 4 \quad + \quad 3 \quad + \quad 2 \quad + \quad 1$

lymer Balmer Pascher brackett

3 line in visible reigon.

ATOMIC STRUCTURE EXERCISE # 3

Comprehension # 1

1. $Cr = 1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^5\, 4s^1$

$Mn^+ = 1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^5\, 4s^1$

$Fe^{2+} = 1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^6$

$Co^{3+} = 1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^5$

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

$n(n+2) = 3$

$n + 2n = 3$

$n^2 + 2n - 3 = 0$

$(n+3)(n-1) = 0$

$n = 1$

Number of unpaired electron = 1

$V^{4+} \Rightarrow [Ar]\ 3s^1\ 4s^0$

3. $Fe^{3+} = [Ar]\ 3d^5$

$Ti^{3+} = [Ar]\ 3d^1$

$Co^{3+} = [Ar]\ 3d^6$

all are having unpaired electron hence paramagnetic & coloured.

4. $Fe = [Ar]\ 3d^6\ 4s^2$

↑↑	↑	↑	↑	↑		↑↓

Hund's and Pauli's principle is voileted. (हुण्ड तथा पॉउली नियम की पालना नहीं होती है)

5. Spin quantum number $(m_s) = -\dfrac{1}{2}, 0, +\dfrac{1}{2}$ that is one orbital accomodate maximum $3e^-$

(चक्रण क्वाण्टम संख्या अर्थात् $(m_s) = -\dfrac{1}{2}, 0, +\dfrac{1}{2}$ एक कक्षक में अधिकतम $3e^-$ होते हैं)

Number of element in any period = $3r^2$

$n = \dfrac{p+2}{2}$ (for even period no.)

$n = \dfrac{2+2}{2} = 2$

number of element $\Rightarrow 3 \quad 4 \Rightarrow 12$

6. for g - sub-shell

$n = 5$

$\ell = 0, 1, 2, 3, 4$

$\ell = 4$ {g - subshell}

number of electron= $2(2\ell + 1)$

$= 2 \quad 9 \Rightarrow 18$

number of orbital $= (2\ell + 1) \Rightarrow 9$

any orbital can have more two electron

ATOMIC STRUCTURE EXERCISE # 4[A]

1. Distance to be travelled from mars to earth $= 8 \quad 10^7$ km

(मंगल से पृथ्वी तक तय की गयी दूरी) $= 8 \quad 10^{10}$ m

$\because$ Velocity $= 3 \quad 10^8$ m/sec

$\therefore$ Time $= D/V = \dfrac{8 \times 10^{10}}{3 \times 10^8} = 2.66 \quad 10^2$ sec.

2. (a) $I.P. = \Delta E_{1=\infty} = E_\infty - E_1 = 0 - (-15.6) = 15.6$ l.v.

(b) $n = \infty \qquad n = 2$

$\Delta E = [0 - (-5.3)] = 5.3$ l.v.

$\Delta E = \dfrac{1240}{\lambda(nm)} \qquad \lambda = \dfrac{1240}{5.3} = 233.9$ nm

(c) $|\Delta E_{3\rightarrow1}| = |-3.08 - (-15.6)| = 15.6 - 3.08 = 12.52$ l.v.

$= \dfrac{1240}{\lambda} = \dfrac{12.52}{1240} = \dfrac{1}{\lambda}$ (n.m)

$\lambda = 1.808 \quad 10^7\ m^{-1}$

(d) (i) $E = -15.6 - (-6) = -15.6 + 6 = -9.6$

(ii) $E = -15.6 - (-11) = -15.6 + 11 = -4.6$

3. $1.6 \quad 10^{-19}$ J = 1 eV

$10^{-17} = \dfrac{10^{-17}}{1.6 \times 10^{-19}}$ eV $= 0.655 \quad 10^2$

$E = \dfrac{n\,hc}{\lambda} \qquad 0.625 \quad 10^2 = n\dfrac{1240}{550}$

$2.77 \quad 10 = n$

4. $330\ J = n(h\nu)$

$330\ J = n[6.62 \quad 10^{-34} \quad 5 \quad 10^{13}]$

$$\frac{330}{6.62\times10^{34}\times5\times10^{13}} = n \qquad 10^{22} = n$$

5. $E = \dfrac{hL}{\lambda}$ $\qquad n = \dfrac{3.15\times10^{-14}\times850\times10^{-9}}{6.62\times10^{-34}\times3\times10^{8}}$

$n = 134.8 \quad 10^{3} \quad n = 1.35 \quad 10^{5}$

6. $\lambda = 1093.6$ nm $\quad R_H = 1.09 \quad 10^{7}\ m^{-1}$

$= 1093.6 \quad 10^{-9}$ m. $\qquad n_2 = ?n_1 = 3$

$$\frac{10^{9}}{1093.6\times10^{7}\times1.09} = \frac{1}{9} - \frac{1}{n_2^2}$$

$$\frac{1}{n_2^2} = \frac{1}{9} = -0.83 \qquad \frac{1}{n_2^2} = \frac{9}{0.253}$$

$$n_2^2 = 36 \qquad \boxed{n_2 = 6}$$

7. $n_2 = 3 \qquad n_1 = 2$ $\qquad$ [first line]

$n_2 = 4 \qquad n_1 = 2$ $\qquad$ [second line]

$$\frac{1}{\lambda} = R_H\left[\frac{1}{4} - \frac{1}{9}\right]$$

$$\frac{1}{6565}\text{Å} = R_H\left[\frac{1}{4} - \frac{1}{9}\right]....(i)$$

$$\frac{1}{\lambda} = R_H\left[\frac{1}{4} - \frac{1}{16}\right]....(ii) \qquad \frac{(i)}{(ii)}$$

$$\frac{\lambda}{6565} = \frac{\frac{5}{36}}{\frac{3}{16}} = \frac{5\times16}{36\times3} \qquad \lambda = 4863\ \text{Å}$$

8. $3 \rightarrow 2$

$$\frac{1}{\lambda_1} = R_H\times Z^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R_H \quad 4\left[\frac{1}{4} - \frac{1}{9}\right] \quad ...(i)$$

$$2 \rightarrow 1 \quad \frac{1}{\lambda_2} = R_H\times4\left[\frac{1}{1} - \frac{1}{4}\right] \quad ... (ii)$$

$(\lambda_1 - \lambda_2) = 133.7$ nm $\qquad$ ... (iii)

we will solve the three equation and we will get

$R = 1.096 \quad 10^{7}\ m^{-1}$

9. $\Delta E = 13.6\left[\dfrac{1}{9} - \dfrac{1}{4}\right] \quad 96.3368$ kJ/mole

$= 13.6\left[\dfrac{4-9}{36}\right] \quad 96.368 = 182.074$

$= 1.827 \quad 10^{5}$ J/mole

10. $IE = \dfrac{hc}{\lambda} = \dfrac{1240}{85.4}$

$= \dfrac{1240}{85.4}\times96.368\,\text{kJ/mole} \approx 1399.25$ kJ/mol

11. Radius $= 16(RH) = 16 \quad 0.0529$

$16 \quad 0529 = 0.0529 \quad \dfrac{n^2}{Z}$

$16 = \dfrac{n^2}{1} \qquad \boxed{n = 4}$

T.E. $= -13.6 \quad \dfrac{n^2}{Z^2}$ l.v. $= 0.85$ l.v. $= -1.36 \quad 10^{-19}$J

12. $E_n = \dfrac{-21.7\times10^{-12}}{n^2}$ $\quad 1$ erg $= 10^{-7}$ Joule

$E_n = \dfrac{-21.7\times10^{-12}}{4}$

J.E. $= 0 - \left[\dfrac{-21.7\times10^{-12}}{4}\right] = \dfrac{21.7\times10^{-12}}{4}$

$= 5.425 \quad 10^{-12}$ ergs

(b) $5.425 \quad 10^{-12} = \dfrac{6.624\times10^{-34}\times10^{8}}{\lambda}$

$\lambda = \dfrac{6.624\times3\times10^{8}\times10^{12}}{5.425\times10^{34}} = 3.7 \quad 10^{-14}$ (nm)

$= 3.7 \quad 10^{-14} \quad 10^{9}$ cm $= 3.7 \quad 10^{-5}$ cm

13. $\underset{2\rightarrow1}{\Delta E} = \text{I.E.}\left[\dfrac{1}{4} - \dfrac{1}{1}\right]$

$2.17 \quad 10^{-11}$ erg/atom$\left[\dfrac{1}{4} - \dfrac{1}{1}\right] = \dfrac{hc}{\lambda(m)}$

$2.17 \quad 10^{-11} \quad 10^{-7}J\ \left[\dfrac{1}{4} - \dfrac{1}{1}\right] = \dfrac{6.626\times10^{-34}\times3\times10^{8}}{\lambda}$

$$\lambda = \frac{6.626\times10^{34}\times3\times10^{8}\times4}{2.17\times10^{-18}\times3} = \frac{6.626\times4\times10^{8}}{2.17}$$

$= 12.20 \quad 10^{-8}$ m

$1\ m \rightarrow 10^{10}$ Å

$6.10 \quad 10^{-8}m \rightarrow \dfrac{12.2\times10^{10}}{10^{8}} = 1220$ Å

14. $V_n = 2.18 \quad 10^{6} \quad \dfrac{Z}{n} = \dfrac{2.18\times10^{6}}{n}$

$$\frac{2.18\times10^{6}}{n} = \frac{1}{275}$$

$$\frac{2.18\times10^{6}}{n} = \frac{1}{3\times10^{8}} = \frac{1}{275}$$

$$\frac{2.18}{n(300)} = \frac{1}{275} \qquad \frac{1}{n} = \frac{300}{599.5}$$

$$n = \frac{599.5}{300} = \frac{1}{275} \qquad \frac{1}{n} = \frac{300}{599.5}$$

$n = 1.99 \simeq 2$

15. $Z = 3,\ n_1 = 1, \quad n_2 = 3$

$E_n = 13.6 \quad (Z^2)\left[\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right] = 13.6 \quad 9\left[\dfrac{1}{1} - \dfrac{1}{9}\right]$

$= 13.6 \quad 9 \quad \dfrac{8}{9} = 108.8$ eV

16.(i) $E_{n_2\to n_1} = 13.6\times Z^2\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$ = 13.6 $[1]^2\left[\frac{1}{1}-\frac{1}{4}\right]$

= 13.1 1 $\frac{3}{4}$ = 10.22 eV

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

$\frac{1}{3\times10^{-8}}$ = 1.09 10^7 $Z^2\left[\frac{1}{4}-\frac{1}{1}\right]$

$\frac{10^8}{3\times10^7\times1.09} = Z^2\times\frac{x-3}{4}$

$\frac{10\times4}{3\times1.09x-3}$ = Z^2 Z^2 = –4 Z = 2

17. 1.8 mole = (1.8 Na) atoms

27% = IIIrd energy level = 1.8 Na 0.27

15% = IInd energy level = 1.8 Na 0.15

ΔE = $\underset{3\to1}{\Delta E_1}+\underset{2\to1}{\Delta E_2}$ = 1.8 N_A 0.27 IE$\left[\frac{1}{9}-\frac{1}{1}\right]$ +

1.8 N_A 0.15 IE$\left[\frac{1}{4}-\frac{1}{1}\right]$ = 292.68 10^{21} atom

18. Number of atom in 3^{rd} orbit = 0.5 N_A

Number of atom in 2^{nd} orbit = 0.25 N_A

Total energy evolve=0.5 $N_A(E_3-E_1)$+0.25$N_A(E_2 - E_1)$

19. Angular momentum = $n\left(\frac{h}{2\pi}\right)$

$\left(\frac{hc}{\lambda}\right) = -3.4\,\text{eV}$ –3.4 = –13.6 $\frac{(1)^2}{n^2}$

$\frac{-3.4}{-13.6}=\frac{1}{n^2}$ $n^2 = \frac{3.4}{3.4}$

n^2 = 4 ⇒ n = 2

= $2\left(\frac{6.626\times10^{-34}\times7}{2\times22}\right)$ = $\frac{h}{\pi}$ or $\frac{6.62\times10^{-39}\times7}{2}$

20. 4.5 eV = $\frac{1240}{\lambda(\text{nm})}$ $\frac{1}{\lambda}=\frac{4.5}{1240}$

$\frac{1}{\lambda} = 0.0036\ \text{nm}^{-1}$ 1 nm → 10^{-9} m^{-1}

0.0036 nm^{-1} → 3.6 10^6 m^{-1}

21. $\frac{n(n-1)}{2}$ = 15 n^2 – n = 30

n^2 – n – 30 = 0 n = 6

$\frac{1}{\lambda Å}$ = $R_H\left[\frac{1}{1}-\frac{1}{36}\right]$

$\frac{1}{x}=\frac{1}{912}\times\frac{35}{36}$ = $\frac{35\times2496}{32832}$

$\boxed{\lambda = 932\,Å}$

22. V_2 = V_0 $\frac{1}{2}=\frac{V_0}{2}$

x = v t

x = $\frac{V_0}{2}\times10^{-8}$ sec = $\left(\frac{V_0\times10^{-8}}{2}\right)$m

2πr → 1 round

$\frac{V_0\times10^{-8}}{2}=\frac{V_0\times10^{-8}}{2}\times\frac{1}{2\pi r}$

r_2 = r_0 n^2 = $4r_0$

so, no. of revolutions (चक्करों की कुल संख्या)

= $\frac{V_0/2\times10^{-8}}{2\pi\times4r_0}$ = $\frac{V_0\times10^{-8}\times1}{2\times2\pi\times4r_0}$

= $\frac{2.18\times10^6\times10^{-18}}{2\times2\times3.14\times4\times0.529}$

= $\frac{2.18\times10^{-12}}{2.6\times10^{-21}}$ = 0.838 10^9 = $\boxed{8\times10^6}$

23. V = $\frac{\nu}{\lambda}$

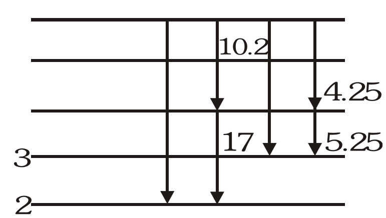
E of Ist Bohr orbit = –13.6

–13.6 = $\frac{6.626\times10^{-34}\times3\times10^8}{\lambda}$

or –13.6 = $\frac{1240}{\lambda(\text{in nm})}$

$\lambda = \frac{1240}{136}\times10$	V = $\frac{3\times10^8}{912\times10^{10}}$
λ = 91.17 (nm)	
= 912 Å	= $\frac{3}{912}\times10^{+R}$
	= 6530 10^{12} Hz

24.



$\Delta E_{2\to n}$ – (10.2 + 17) = 13.6 $2^2\left[\frac{1}{4}-\frac{1}{n^2}\right]$

$\Delta E_{3\to n}$ = 4.25 + 5.95 = 13.6 $Z^2\left[\frac{1}{9}-\frac{1}{n^2}\right]$

25. E = –2.18 $10^{-18}\frac{\cancel{Z}}{n^2}$g/atom

ΔE = (E_2 – E_1) = $\frac{1}{2}m\nu^2$

ν = 1.89 10^6 m/sec

ν = 1.89 10^8 cm/sec

26. $V_2 = V_0 \quad \frac{1}{2} = \frac{V_0}{2}$ $\qquad$ $r = r_0 \quad 4$

$N = \frac{(V_0/2)\times10^{-8}}{2\pi\times4r_0}$ $\qquad$ $\lambda_p = \frac{0.286}{\sqrt{V}}Å$

$\lambda_\infty = \frac{101}{\sqrt{V}}Å$

27. (a) $\frac{1}{\lambda} = \left(\frac{1}{\lambda_1}+\frac{1}{\lambda_2}\right) = r \quad 4 \left[\frac{1}{1^2}-\frac{1}{n^2}\right]$

(b) $\Delta E_{2\to4} = 2.7 = IE\left[\frac{1}{4}-\frac{1}{16}\right]$

$IE = 2.7 \quad \frac{16}{3}eV$

(c) $\Delta E^{max}_{4\to1} = IE\left[\frac{1}{k}-\frac{1}{1}\right]$

$\Delta E_{4\to3} = IE\left[\frac{1}{16}-\frac{1}{9}\right]$

29. B.E. = 180.69 kJ/mole $\Rightarrow$ w = $h\nu_0$

$\frac{180.69}{96.368}$ eV/atom = $h\nu_0$

$\frac{180.69}{96.368} \quad 1.6 \quad 10^{-19} = 6.6 \quad 10^{-34} \quad \nu_0$

$\nu_0 = 6.626 \quad 10^{-34}$

30. $E = \frac{1240}{240}eV$ $\qquad$ E = 5.167 eV

E = 497.9 kJ/mol

31. $h\nu_1 = h\nu_0 + 2E_1$ $\qquad$ $h\nu_2 = h\nu_0 + E_1$

$h\nu_1 - w_0 + 2E_1$ $\qquad$ $h\nu_2 - w_0 + E_1$

$2 = \frac{h\nu_1 - w_0}{h\nu_2 - w_0}$ $\qquad$ $2h\nu_2 - 2w_0 = h\nu_1 - w_0$

$h\,[2\nu_2 - \nu_1] = w_0$

$w_0 = 6.62 \quad 10^{-34}\,(2 \quad 10^{15} - 3.2 \quad 10^{15})$

$w_0 = 6.62 \quad 10^{-34} \quad 0.8 \quad 10^{15}$

$w_0 = 5.29 \quad 10^{-19}$ $\qquad$ $w_0 = 318.9$ kJ/mol

32. $\frac{hc}{\lambda_1} = w_0 + E_1$ $\qquad$ $\frac{hc}{\lambda_2} = w_0 + E_2$

$\frac{hc}{\lambda_1} - E_1 = w_0$ ....(i)

$\frac{hc}{\lambda_2} - E_2 = w_0$ ....(ii)

$\frac{hc}{\lambda_1} - E_1 = \frac{hc}{\lambda_2} - E_2$

33. $2000\ eV = \frac{hc}{\lambda} = \frac{1240}{\lambda(nm)}$

$\lambda = \frac{1240}{20000} = 62 \quad 10^{-3}$ nm = 0.62 Å

34. (KE) max = stopping potential (विराम विभव)

$\therefore$ stopping potential = 3.06 V

35. $U_{avg.} = \sqrt{\frac{8kJ}{\pi m}}$

$U_{avg.} = \sqrt{\frac{8\times1.38\times10^{-23}\times298}{3.14\times4\times1.67\times10^{-27}}}$

$U_{avg.} = 1.25 \quad 10^3$

$\lambda = \frac{h}{mV} \Rightarrow \frac{6.62\times10^{-34}}{4\times1.67\times10^{-27}\times1.25\times10^3}$

$\lambda = 0.79$ Å

36. $500 = \sqrt{\frac{150}{V}}$

$\therefore \frac{150}{250000} = V$ $\qquad$ $\therefore V = 6 \quad 10^{-4}$ volt

37. $\frac{1}{10}\times3\times10^8 = \Delta V = 3 \quad 10^7$

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

$\Delta x \quad 1.672 \quad 10^{-27}$ kg $\quad 3 \quad 10^7 = \frac{6.626\times10^{-34}}{4\times3.14} \Rightarrow$

$\Delta x = \frac{6.626\times10^{-34}\times100}{1.672\times10^{-27}\times3\times10^7\times4\times314}$

$\boxed{\Delta x = 1.05\times10^{-13}m}$

38. $1 \quad 10^{-10} = 6.6 \quad 10^{-34}$

$= \sqrt{2\times1.67\times10^{-27}\times1.6\times10^{-19}\times V}$

$\therefore 1 = 6.6 \quad 10^{-24} = \sqrt{5.344\times10^{-8}}$ eV

$\therefore 1 = 6.6 \quad 10^{-20} = \sqrt{5.344\times V}$

$\therefore \sqrt{5.344\times V} = 6.6 \quad 10^{-20}$

39. Cu = [Ar]. 4s, $3d^9$

or

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

no. of ex change pair $= \frac{n(n+1)}{2} = \frac{5\times4}{2} = 10$

$\frac{4\times3}{2} = 6$

Total exchanges = 10 + 6 = 16

41. E of light absorbed in one photon (एक फोटॉन में अवशोषित प्रकाश की E) = $\frac{hc}{\lambda_{absorbed}}$

Let n_1 photons are absorbed, therefore, (माना n_1 फोटॉन अवशोषित होते है)

Total energy absorbed(अवशोषित कुल ऊर्जा)= $\frac{n_1hc}{\lambda_{absorbed}}$

Now, E of light re-emitted out in one photon = $\frac{hc}{\lambda_{emitted}}$ (अब, एक फोटॉन में पुनः उत्सर्जित प्रकाश की E)

Let n_2 photons are re-emitted then, (माना n_2 फोटॉन पुनः उत्सर्जित होते है)

Total energy re-emitted out = $n_2 \quad \frac{hc}{\lambda_{emitted}}$

As given $\quad E_{absorbed} \quad \frac{47}{100} = E_{re\text{-}emitted\ out}$

$$\frac{hc}{\lambda_{absorbed}} \times n_1 \times \frac{47}{100} = n_2 \times \frac{hc}{\lambda_{emitted}}$$

$$\therefore \frac{n_1}{n_2} = \frac{47}{100} \times \frac{\lambda_{emitted}}{\lambda_{absorbed}} = \frac{47}{100} \times \frac{5080}{4530}$$

$$\therefore \frac{n_1}{n_2} = 0.527$$

42. $H_2 + Br_2 \xrightarrow{hv} 2HBr$

$Br_2 \xrightarrow{hv} 2Br$

BE = 192 kJ / mole

$$\frac{192}{93.368} \text{ eV/mole} = \frac{hv}{\lambda} \text{ or } \frac{192}{96.368} = \frac{1240}{\lambda(nm)}$$

λ = 6235 Å

43. $\frac{0.2\,n}{Na} = 0.01\,\text{mole} \qquad \frac{0.2 \times n}{1+128} = 0.01$

$\frac{0.2 \times n}{10 \times 127} = \frac{1}{100} \qquad 2 \quad n = \frac{127}{10}$

$$n = \frac{127}{10 \times 2} = \frac{12.7}{2} = 6$$

No. of protons $= \frac{6 \times 10^{22}}{2} = 3 \times 10^{22}$

44. $\frac{243}{96.368} = \frac{1240}{\lambda(nm)}$

$$\lambda = \frac{1240 \times 96.368}{243} = 491.75\ 10^{-9}\ m \approx 4.9 \quad 10^{-7} m$$

45. Energy required to break H–H bond

$= \frac{430.53 \times 10^3}{6.023 \times 10^{23}}$ J/molecule = 7.15 $\quad 10^{-19}$ J

Energy of photon used for this purpose $= \frac{hc}{\lambda}$

$= \frac{6.625 \times 10^{-34} \times 3.0 \times 10^8}{253.7 \times 10^{-9}} = 7.83 \quad 10^{-19}$ J

$\therefore$ Energy left after dissociation of bond = (7.83 – 7.15) $\quad 10^{-19}$

or $\quad$ Energy converted into K.E. = 0.68 $\quad 10^{-19}$J

$\therefore$ % of energy used in kinetic energy =

$$\frac{0.68 \times 10^{-19}}{7.83 \times 10^{-19}} \times 100 = 8.68\%$$

46. Energy given to I_2 molecule

$= \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4500 \times 10^{-10}} = 4.417 \quad 10^{-19}$ J

Also energy used for breaking up of I_2 molecule

$= \frac{240 \times 10^3}{6.023 \times 10^{23}} = 3.984 \quad 10^{-19}$ J

$\therefore$ Energy used in imparting kinetic energy to two I atoms

= [4.417 – 3.984] $\quad 10^{-19}$ J

$\therefore$ K.E./iodine atom = [(4.417 – 3.984)/2] $\quad 10^{-19}$

= 0.216 $\quad 10^{-19}$ J

48. $\lambda = \sqrt{\frac{150}{10^3 \times 100}} = 3.88 \quad 10^{-2}$ Å = 3.88 pm

49. $\lambda = \frac{6.6 \times 10^{-34}}{6 \times 10^{24} \times 3 \times 10^6}$

$= \frac{1 \times 1}{3} \times 10^{-65} = 3.68 \quad 10^{-65}$ m

50. ΔV = 30 $\quad 10^2$ cm/sec

λ = 5000 Å $\qquad$ m = 200 g

$\lambda = \frac{h}{mV} \qquad 500 = \frac{h}{m \times V}$

$P = mV = \frac{500}{6.626 \times 10^{-26}} = 30 \quad 10^2 \quad 200$

$\boxed{= 1.75 \times 10^{-29}}$

51. v = 40 m/sec $\qquad \Delta v$ = 0.01

$$\therefore \Delta x = \frac{h}{4\pi \times 9.1 \times 10^{-37} \times 99.99 \times 40}$$

$$= \frac{0.53 \times 100 \times 10^{-54}}{40 \times 99.99 \times 9.1 \times 10^{-37}}$$

$= \frac{0.53 \times 10^{-3} \times 100}{40 \times 9.1 \times 99.99} \qquad m.\Delta x.\Delta x = \frac{h}{4\pi}$

$$\Delta x = \frac{5.27 \times 10^{-34}}{9.1 \times 10^{-31} \times 40 \times 0.04 \times \frac{1}{100}} = 1.447 \quad 10^{-3} \quad 100$$

1. Given that λ_1 = 486.1 10^{-9} m = 486.1 10^{-7} cm

λ_2 = 410.2 10^{-9} m = 410.2 10^{-7} cm

and $\bar{v} = \bar{v}_2 - \bar{v}_1 = \left[\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right]$

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

$v = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ ....(i)

For line I of Balmer series

$\frac{1}{\lambda_1} = R_H\left[\frac{1}{2^2} - \frac{1}{n_1^2}\right]$ = 109678 $\left[\frac{1}{2^2} - \frac{1}{n_1^2}\right]$

or $\frac{1}{456.1 \times 10^{-7}}$ = 109678 $\left[\frac{1}{2^2} - \frac{1}{n_1^2}\right]$

$\therefore$ n_1 = 4

For line II of Balmer series ;

$\frac{1}{\lambda_1} = R_H\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$ = 109678 $\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$

or $\frac{1}{410.2 \times 10^{-7}}$ = 109678 $\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$

$\therefore$ n_2 = 6

Thus given electronic transition occurs from 6^{th} to 4^{th} shell. Also by eq. (i)

(अत: दिया गया इलेक्ट्रॉनिक संक्रमण 6^{th} से 4^{th} कोश में होगा।)

$\bar{v} = \frac{1}{\lambda} = 109678\left[\frac{1}{4^2} - \frac{1}{6^2}\right]$

$\therefore$ λ = 2.63 10^{-4} cm

2. E_{ext} = 2.18 10^{-19} $\left(1 - \frac{1}{9}\right)$ 6.023 10^{23} =

116.71 kJ/mol H

D.E. = 116.71   2.67 = 311.62 kJ/mol H_2

n = $\frac{PV}{RT} = \frac{1}{0.082 \times 300}$ = 0.04

$\Rightarrow$ T.E. = 0.04   311.62 + 0.08   116.71 = 21.8kJ

3. E(ev) = $\frac{1240}{\lambda(nm)}$

Energy of 1st photon = $\frac{1240}{108.5}$ = 11.428 eV

Energy of 2st photon = $\frac{1240}{30.4}$ =40.79 eV

En = 52.217– 54.4 = – 2.182 eV (E_1 = –54.4 eV)

–2.182 = $-\frac{13.6 \times 4}{n^2} \Rightarrow$ n = 5

4. Since we obtain 6 emission lines, it means electron comes from 4th orbit energy emitted is equal to, less than and more than 2.7 eV. So it can be like this :

(क्योंकि 6 उत्सर्जन रेखाऐं प्राप्त होती है अर्थात् इलेक्ट्रॉन 4th कक्षा से आता है। उत्सर्जित ऊर्जा 2.7 eV के बराबर, से कम तथा से अधिक होती है।)

$E_4 - E_2$ = 2.7 eV, $E_4 - E_3$ < 2.7 eV, $E_4 - E_1$ > 2.7 eV

(a) n = 2,

$(E_4 - E_2)^{atom} = (E_4 - E_2)^H$ Z^2

2.7 = 2.55 Z^2 = 1.029

(b) IP = 13.6 Z^2=13.6 $(1.029)^2$ = 14.4 eV

(c) Maximum energy emitted=E_4–E_1 = $(E_4 - E_1)^H$ Z^2

= 12.75 $(1.029)^2$

= 13.5eV

Minimum energy emitted=$E_4 - E_3$ =$(E_4 - E_3)^H$ Z^2

= .66 $(1.029)^2$ = 0.7eV

5. $\left.\begin{array}{l} n \rightarrow 2 \Delta E = 27.2eV(17 + 10.2) \\ n \rightarrow 3 \Delta E = 10.2eV(4.25+5.95.2) \end{array}\right\} E_3 - E_2 = 17eV$

17 eV = 1.89 $Z^2 \Rightarrow$ Z = 3

E_2 = –3.4   9 = –30.6 eV

$E_n - E_2$ = 27.2 eV

E_n = 27.2 + E_2 = –3.4 eV

E_n = – 3.4 = $-\frac{13.6 \times 3^2}{n^2} \Rightarrow n^2 = 36 \Rightarrow$ n = 6

6. λ = 975 Å

E= $\frac{\lambda c}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{975 \times 10^{10}}$ =2.03 10^{-18}J=12.75eV

So electron will excite to 4th energy level and when comeback number of emission line will be 6.

minimum energy emitted = $E_4 - E_3$ = 0.66 eV

(अत: इलेक्ट्रॉन 4th ऊर्जा स्तर तक उत्तेजित होगा तथा जब वापस आता है उत्सर्जन विभव की संख्या 6 होगी।)

$\lambda = \frac{hc}{E} = \frac{1.9878 \times 10^{-25}}{.66 \times 1.6 \times 10^{-19}}$ = 1.882 10^{-6} m = 18820 Å

7. (a) kE = qV = 2 1.6^{-19} 2 10^6 = 6.4 10^{-13}J

(b) At distance d = 5 10^{-14} m let K.E. is x J and

PE = $\frac{k\,q_1 q_2}{d} = \frac{9 \times 10^9 \times 2 \times 1.6 \times 10^{-19} \times 47 \times 1.6 \times 10^{-19}}{5 \times 10^{-14}}$

PE = 4.33 10^{-13} J

By energy conservation :

6.4 10^{-13} = x + 4.33 10^{-13}

x = 2.06 10^{-13} J, kE = PE

6.4 10^{-13} = $\frac{9 \times 10^9 \times 2 \times 47 \times (1.6 \times 10^{-19})^2}{d}$

$\Rightarrow$ d = 3.384 10^{-14} m

8. $pE = \frac{-ke^2}{3r^3}$, since $F = -\frac{du}{dr} = -\frac{ke^2}{r^4}$

For stable atom $F = \frac{mv^2}{r}$ so $\frac{ke^2}{r^4} = \frac{mv^2}{r}$ ...(1)

$mv^2 = \frac{ke^2}{r^3}$ ...(2)

$kE = \frac{1}{2}mv^2 = \frac{ke^2}{2r^3}$, $PE = \frac{-ke^2}{3r^3}$

$T.E = \frac{ke^2}{2r^3} - \frac{ke^2}{3r^3} = + \frac{ke^2}{6r^3}$ ...(3)

Form bohr's postulate $mvr = \frac{nh}{2\pi} \Rightarrow V = \frac{nh}{2\pi mr}$

putting this in equation (2)

$$m\left(\frac{nh}{2\pi mr}\right)^2 = \frac{ke^2}{r^3} \Rightarrow m\left\{\frac{n^2h^2}{4\pi^2 m^2r^2}\right\} = \frac{ke^2}{r^3}$$

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

putting this in equation (3)

$$T.E. = \frac{ke^2}{6\left\{\frac{4\pi^2 m^2ke^2}{n^2h^2}\right\}^3} = \frac{ke^2}{6\left\{\frac{64\pi^6 m^3k^3e^6}{n^6h^6}\right\}}$$

$$E = \frac{n^6h^6}{384\,m^3\pi^6k^2e^4}$$

9.(a) $(E_3 - E_2) = 68$ eV $= (E_3 - E_2)^H \quad Z^2$

$68 = 1.89 \quad Z^2$

$z = 6$

(b) $(kE)_1 = -E_1 = 13.6 \quad 36 = 489.6$ eV

(c) Energy required $= -E_1 = 489.6$ eV

$\lambda = \frac{1240}{489.6} = 2.53$ nm

10. $E_1 = IP$

$= -4\ R = -4 \quad 2.18 \quad 10^{-18}$ J

$= -8.72 \quad 10^{-18}$ J

$E_2 = \frac{E_1}{4} = -2.18 \quad 10^{-18}$ J

$\Delta E = E_2 - E_1 = 6.54 \quad 10^{-18}\ J = \frac{\lambda c}{\lambda}$

$\lambda = \frac{1.9878 \times 10^{-25}}{6.54 \times 10^{-18}} = 0.3039 \quad 10^{-7}$ m $= 303.9$ Å

$E_1 = -8.72 \quad 10^{-18} = -21.79 \quad 10^{-19} \quad Z^2 \Rightarrow Z = 2$

(ii) $r_1 = \frac{0.529 \times 1}{2}$ A $= 0.2645$A $= 2.645 \quad 10^{-11}$m

11.(a) $\lambda = 12.4$ nm, E (ev) $= \frac{1240}{12.4} = 100$ eV

$W_0 = 25$ eV

$kE = E - W_0 = 75$ eV $\Rightarrow V = 75$ volt

(b) $\lambda = \sqrt{\frac{150}{V}}$ A $= \sqrt{2}$ A $= 1.414$ A

(c) since $p = \frac{h}{\lambda} \Rightarrow dp = \frac{h}{\lambda^2}d\lambda$

$$d\lambda = \frac{\lambda^2 dp}{h} = \frac{(1.414 \times 10^{-10})^2 \times 6.62 \times 10^{-28}}{6.626 \times 10^{-34}}$$

$d\lambda = 2 \quad 10^{-14}$ m

12. Since electron is in some exited state of He^+ so it's energy ≤ 13.6 eV so energy need to exitation is also $<$ 13.6 eV & only for hydrogen $E_3 - E_1 < 13.6$ eV. So Z =1. Now for He^+ this energy is equal to the energy gap of 2nd and 6th orbit so initial state is 2 and final state is 6.

(चुंकि इलेक्ट्रॉन He^+ की कुछ उत्तेजित अवस्था में है अत: इसकी ऊर्जा ≤ 13.6 eV होगी। इस प्रकार उत्तेजन के लिए आवश्यक ऊर्जा भी < 13.6 eV होगी और केवल हाइड्रोजन के लिए $E_3 - E_1 < 13.6$ eV होगी। अत: Z =1 होगा। अब He^+ के लिए यह ऊर्जा 2nd व 6th कक्षा के ऊर्जा अन्तराल के बराबर होगी अत: प्रारम्भिक अवस्था 2 व अन्तिम अवस्था 6 है)

13. $mvr = \frac{nh}{2\pi} \Rightarrow 3.1652 \quad 10^{-34} = n \left\{\frac{6.626 \times 10^{-34}}{2 \times 3.14}\right\}$

$n = 3$

$$\bar{v} = R\left[\frac{1}{1} - \frac{1}{3^2}\right] = \left(\frac{8R}{9}\right)$$