

MAINS-ADVANCED

TOPIC

ATOMIC
STRUCTURE

SOLUTIONS

ATOMIC STRUCTURE

Exercise-01

3. $\frac{r_A}{r_N} = 10^5$
- $$\frac{V_A}{V_N} = \left(\frac{r_A}{r_N}\right)^3 = (10^5)^3 = 10^{15} \quad \frac{V_A}{V_N} = 10^{-15}$$
4. $R = R_0 A^{1/3} = 1.33 \times 10^{-13} \times (64)^{1/3} \text{ cm}$
 $= 5.32 \times 10^{-13} \times (64)^{1/3} \text{ cm}$
 $\therefore 1 \text{ fm} = 10^{-15} \text{ m} \approx 5 \text{ fm}$
10. $\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{400 \times 10^6} = 0.75 \text{ m}$
14. $d = 20 \text{ nm}$
- $$r = \frac{20}{2} = 10 \text{ nm} = 100 \text{ \AA}$$
- $$\therefore r = 0.529 \times \frac{n^2}{Z} \text{ \AA} \quad \text{For H atom } Z = 1$$
- $$100 = 0.529 \times n^2 \quad n = 14$$
15. $E_n = -13.6 \times \frac{Z^2}{n^2}$
- $$E_1(\text{H}) = -13.6 \times \frac{1}{1} = -13.6 \text{ eV}$$
- $$E_2(\text{He}^+) = -13.6 \times \frac{4}{4} = -13.6 \text{ eV}$$
- $$E_3(\text{Li}^{2+}) = -13.6 \times \frac{3^2}{3^2} = -13.6 \text{ eV}$$
- $$E_4(\text{Be}^{3+}) = -13.6 \times \frac{4^2}{4^2} = -13.6 \text{ eV}$$
- \therefore Ans B
16. $E = -78.4 \text{ kcal/mol}$
- $$E_n = -313.6 \times \frac{Z^2}{n^2} \text{ kcal/mol}$$
- for H atom $Z = 1$ $-78.4 = 313.6 \times \frac{1}{n^2}$
- $$n^2 = \frac{313.6}{78.4} \quad n = 2$$
17. $V_n = 2.188 \times 10^6 \times \frac{Z}{n} \text{ m/sec.}$
- $$\frac{V_3(\text{Li}^{2+})}{V_1(\text{H})} = \frac{Z_3/n_3}{Z_1/n_1} = \frac{3/3}{1/1} \quad V(\text{Li}^{2+}) = V$$

18. Let state (ekuk volFkk) (1) = n_1
state (volFkk) (2) = n_2
 $r_1 - r_2 = 624 r_0$
- $$0.529 \times \frac{n_1^2}{Z} - \frac{0.529 n_2^2}{Z} = 624 \times \frac{0.529 \times 1}{Z}$$
- $$n_1^2 - n_2^2 = 624$$
- $$n_1 = 25$$
- $$n_2 = 1$$
- $$25 \rightarrow 1$$
19. (A) Energy of ground state (ewy volFkk dh \AA tk)
 $\text{He}^+ = -13.6 \times 4 \text{ eV} = -54.4 \times 4 \text{ eV}$
(B) P.E. of 1st orbit of H-atom (gkbMktu ijek.kqdsi Fke d{k dh P.E.) = $2T.E. = -2 \times 13.6 \text{ eV} = -27.2 \text{ eV}$
(C) Energy of II excited state (II m\AA kstr volFkk dh \AA tk)
 $= -13.6 \times \frac{Z^2}{n^2} = -13.6 \times \frac{(2)^2}{(3)^2}$
 $= -13.6 \times \frac{4}{9} = -6.04 \text{ eV}$
(D) I.E. = $-E_1 = 21.8 \times 10^{-19} \times 4J = 8.7 \times 10^{-18} J$
20. $E_5 = -13.6 \times \frac{1}{(5)^2} = -0.54 \text{ eV}$
22. Li^{2+} & He^+ both have same no. of electron so spectrum pattern will be similar. Li^{2+} o He^+ nkska l eku byDVVkh j [krs g\AA bl fy, Li DVVe l eku gk\AA kA
23. $\lambda = \frac{h}{\sqrt{2mqV}} \quad \lambda \propto \frac{1}{\sqrt{V}}$
- $$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} = \sqrt{\frac{200}{50}} = \frac{2}{1}$$
24. $\Delta x \cdot \Delta p = \frac{\lambda}{4\pi}$
put value $\Delta p = 1.0 \times 10^{-5} \text{ kg ms}^{-1}$
26. Orbital angular momentum (d{k{k; d{k{k.k; l o\AA x)
 $= \sqrt{\ell(\ell+1)} \cdot \frac{h}{2\pi} \quad \text{for } \ell = 0$

28. ${}_{25}\text{Mn} = 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^2$
 $\text{Mn}^{+4} = 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^3, 4s^0$
29. ${}_{30}\text{Zn}^{2+} = 1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}$
 (unpaired (v; fer) $de^- = 0$)
 ${}_{26}\text{Fe}^{2+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$ (unpaired $de^- = 4$)
 ${}_{28}\text{Ni}^{3+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$ (unpaired $de^- = 3$)
 ${}_{29}\text{Cu}^+ = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$ (unpaired $de^- = 1$)
30. $d^7 = \boxed{\uparrow\downarrow \uparrow\downarrow \uparrow \uparrow \uparrow}$
 Total spin (dy pØ.k) = $+\frac{1}{2} + \frac{1}{2} + \frac{1}{2} = \frac{3}{2}$
31. $K = 2e^- = 1s^2$
 $L = 8e^- = 2s^2 2p^4$
 $M = 11e^- = 3s^2 3p^6 3d^3$
 $N = 2e^- = 4s^2$
 for $d e^- = 3, l = 2$
33. $\text{Cl}^- = 1s^2 2s^2 2p^6 3s^2 3p^6$
 For last $e^- n = 3, l = 1, m = \pm 1$

35. (A) $v = 2.18 \times 10^6 \times \frac{Z}{n} \Rightarrow v \propto \frac{Z}{n}$ or $v \propto \frac{1}{n}$
 (B) $f = \frac{v}{2\pi r}$ or $f = \frac{v}{r} \propto \frac{Z/n}{n^2/Z}$ $f \propto \frac{Z^2}{n^3}$
 (C) $r \propto n^2 / Z$ $[T \propto \frac{n^3}{Z^2}]$ $F = \frac{mV^2}{r}$
 $F \propto \frac{v^2}{r} \propto \frac{(Z^2/n^2)}{n^2/Z}$ $F \propto \frac{Z^3}{n^4}$

So ans (A,B,D)

37. Change in angular momentum = $(n_2 - n_1) h$
 (dskh; l ox ea iforU)
 $(n_2 - n_1)$ is an integer value $((n_2 - n_1), d ikkid eku gS$
 so ans (B,C)

Exercise-02

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.
 (ukfhkd l snij tkus ij Åtklc<rh gsvr% ukfhkd l svulr njih ij Åtkl vfkdre gkshA)
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.
 tc byDVtu mPp Lrj l sfuEu Lrj dh vlg vkrk gS rks QkVku eDr gkrsgsrfkk tc fuEu Lrj l smPp Lrj dh vlg tkrk gS rks QkVku vo'kk'kr gkrsgsvr%'1s' døy QkVku vo'kk'kr djrk gSD; kkd ; g fuEu ÅtkLrj gA
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.
 $5 \rightarrow 2$
 (ckej Jskh ea byDVtu mPp ÅtkLrj l s2nd ÅtkLrj ea vkrk gsvr% rrrh; d jfk ikir gkrh gStc byDVtu ikpos ÅtkLrj l sf)rh; d ÅtkLrj ea vkrk gA $5 \rightarrow 2$)
4. ${}_{37}\text{Rb} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$

n	l	m	s
5	0	0	+1/2

5. Aufbau's principle : electron fills in orbital increasing order of energy level.
 vkkckÅ fl kkr %d{kid ea byDVtu kdk ÅtkLrj ds c<rs Øe ea Hkjk tkrk gS
6. ${}_{30}\text{Zn}^{2+} = n = A - Z = 70 - 30 = 40$
7. $n > l, m = -l$ to $+l$

n	l	s
3	2	½

 The value of cm is wrong
 $l = 2, m = -2, -1, 0, +1, +2$
8. Hund's rule
9. $\text{Cr} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$; $\text{Mn}^+ = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
 i.e. it represent both ground state and cationic form.
10. $\text{Fe}^{3+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

↑	↑	↑	↑	↑
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11. Schrodinger equation gives only n, l and m quantum number, spin quantum number is not related to schrodinger equation.
 JkMxj l ehdj.k l sdøy n, l o m Dok. Ve l Å; k i klr gkrh gS pØ.k Dok. Ve l Å; k JkMxj l ehdj.k l s l Ecfu/kr ugha gkrh gA
12. $h\nu = h\nu_0 + \frac{1}{2} m v^2$
 $\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{1}{2} m v^2$

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

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

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

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

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

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

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

$$\Rightarrow (8 + 8) = 16 m_p$$

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

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

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

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

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

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

$$\frac{1}{\lambda} = R_H z^2 \left[\frac{1}{9} - \frac{1}{16} \right] \quad \frac{1}{\lambda} = R_H x^2 \left[\frac{7}{9 \times 16} \right]$$

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

16. $(IE)_{Li^{2+}} = (IE)_H \times z^2$
 $= 21.8 \times 10^{-19} \times 9 \text{ J/atom}$

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

$$\lambda = \frac{6.62 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 2.18 \times 10^{-9} \times 9}}$$

$$\lambda = 1.17 \text{ \AA}$$

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



unpaired electron (n) = 4

Magnetic moment (pfcch; vk?kwkz)

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

orbital angular momentum (d{kh; dks kh; l os) =

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

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

$$\lambda_e \propto \frac{1}{\sqrt{M_e \times 16 E}} \quad ; \quad \lambda_{p^+} = \frac{1}{\sqrt{M_p \times 4 E}}$$

$$\lambda_{\infty} \propto \frac{1}{\sqrt{4M_p \times 4 E}} \quad ; \quad \text{hence } \lambda_e > \lambda_{p^+} = \lambda_{\infty}$$

19. $Cu^+ = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
 all the electron are paired ; hence it is paramagnetic

(I kh byDVW ; fer gsvr% ; g ifrpjcdh ; gskkA)

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

$Li^+(g) \rightarrow Li^{2+} + e^- \quad ; \quad \Delta n = a \text{ KJ/mol.}$

$Li^{2+}(g) \rightarrow Li^{2+} + e^- \quad ; \quad \Delta n = b \text{ KJ/mol.}$

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

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

$$520 + a + 11817 = 19800$$

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

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

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

1st line of lyman series $n_2 = 2, n_1 = 1$

2nd line of lyman series $n_2 = 3, n_1 = 1$

3rd line of lyman series $n_2 = 4, n_1 = 1$

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

, ukM fdj.ka ; k dsuky fdj.ka byDVW ds inkfz ij fuhkj ugha djrh gs

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.

(Åtk dk Øe (n + l) fu ; e }kj k Kkr fd ; k tkrk gs

; (n + l) dk eku de gks ij Åtk U ; ure gkrh gs

; ; fn (n + l) dk eku l eku gks rks 'n' dk U ; ure eku

gh Åtk dk U ; ure eku gskk) $e_3 > e_2 > e_4 > e_1$

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

$$r_3 = r/4 \times 9 \qquad r_3 = 2.25 R$$

25. $\lambda = \frac{h}{mv} = \frac{6.62 \times 10^{-34} \times 3600}{0.2 \times 5}$

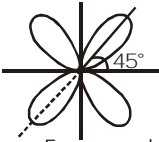
$$\lambda = 2.38 \times 10^{-30} \text{ metre}$$

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


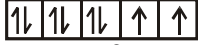
(i khyh fu ; e dsvuñ kj d{kd eavf/kdre nksbyDVW

gskl drsgsvr% i khyh viotz fu ; e dk ikyu ugha

gskk gA)

27. For d_{yz} , xy and xz are nodal plane
 node = $(n - \ell - 1) = 6 - 2 - 1 \Rightarrow 3$
29. $x \longrightarrow y + {}^4_2\text{H}_2$
 $y \longrightarrow {}^8_8\text{O}^{18} + {}^1_1\text{H}^1$
 $y = {}^9_9\text{Y}^{19}$
 $x = {}^{11}_{11}\text{X}^{23}$
 Hence $x = \text{Na}$
 Na present in 3rd period
 No of neutron = $23 - 11 \Rightarrow 12$
 mole of Na = $\frac{4.6}{23} \Rightarrow 0.2$
 Mole of neutron $\Rightarrow 0.2 \times 12 \Rightarrow 2.4$
30. $E = \frac{hc}{\lambda} \Rightarrow \frac{1240}{\lambda_{nm}} \text{ eV}$ $E = \frac{1240}{31} \Rightarrow 40 \text{ eV}$
 $40 = 12.8 + \text{K.E.}$
 $\text{K.E.} = 10 - 12.8 = 27.2 \text{ eV}$
 $\text{K.E.} = 27.2 \times 1.6 \times 10^{-19}$
 $27.2 \times 1.6 \times 10^{-19} = \frac{1}{2} \times 9.1 \times 10^{-31} \times v^2$
 $v = 2.18 \times \sqrt{2} \times 10^6 \text{ m/s}$
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 ($f=T; h; ukM$) = $(n - \ell - 1)$
 Angular node ($dksh; ukM$) = ℓ
 $4s, 5p_x, 6d_{xy}$ having 3 radial node.
 angular node in all 's' orbital in zero.
 (I Hkh 's' d{kdkla ea dkskh; ukM 'kh; gkrs gA)
33. s-orbital is spherical hence it is non-directional.
 (s-d{kdk xksh; gkrs gsvr%; g vfn'kkRed gkrs gA)
34. B.E. = I.E.
 $(\text{I.E.})_{\text{any atom}} = (\text{I.E.})_{\text{H}} \times z^2$
 $\frac{122.4}{13.6} = z^2$
 $z^2 = 9$ $z = 3$
 $E_2 - E_1 = 122.4 - 30.6 = 91.8 \text{ eV}$
35. $\Delta x = 2\Delta p$ $\Delta x \cdot 2\Delta p = \frac{h}{4\pi}$
 $2(\Delta p)^2 = \frac{h}{4\pi}$ $(\Delta v)^2 = \frac{h}{8\pi m^2}$
 $\Delta v = \frac{1}{2m} \sqrt{\frac{h}{2\pi}}$ $\Delta v = \frac{1}{2m} \sqrt{h}$
36. 
37. $n = 5$ $\ell = 0, 1, 2, 3, 4$ 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. $\lambda = v$ $\lambda = \frac{h}{mv}$
 $\lambda^2 = \frac{h}{m} \Rightarrow \lambda = \sqrt{\frac{h}{m}}$
41. Acc to schrodinger model e^- behave as wave only.
 (JkMxj ekMy dsvuq kj e^- rjx dh rjg 0; ogkj djrs gA)
42. The maximum porbability of finding an electron is describe the orbital, which is denote by Ψ^2 .
 (byDVW ds ik; s tkus dh vf/kdre ikf; drk dh d{kdk ds : i ea 0; k[; k dh tkrh gA ftl s Ψ^2 s inE'kr fd; k tkrk gA)
43. $\lambda_m = \lambda_e$ $\lambda = \frac{h}{mv}$
 $\frac{h}{m_c v_c} = \frac{h}{m_n v_n}$ $\frac{v_e}{v_n} = \frac{m_n}{m_c}$
45. (Ψ) it is a solution of schrodinger wave equation.
46. $2\pi r = n\lambda$ [acc to de-broglie theory]
47. $m_y = 0.25 m_x, v_y = 0.75 v_x$
 $\lambda = \frac{h}{mv}$ $\lambda_x = \frac{h}{m_x v_x}, \lambda_y = \frac{h}{m_y v_y}$
 $\lambda_y = \frac{h}{0.25m_x \times 0.75v_x}$ $\lambda_y = 5.33 \lambda_x$
48. Orbital angular momentum ($d\{kh; dkskh; l dx$) =
 $\sqrt{\ell(\ell+1)} \hbar$

	s	p	d	f
$\ell =$	0	1	2	3
48. $m = (2\ell + 1) \Rightarrow \ell = \frac{m-1}{2}$
50. $\text{Mn}^{4+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$

51. Acc to $(n + \ell)$ rule, after np , $(n + \ell)$ s always filled.
52. $\text{Ni}^{2+} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$

 $n = 2$
 magnatic moment ($p\{cdh; vk?kwkz = \sqrt{n(n+2)} \Rightarrow \sqrt{2(4)} = 5.8 = 2.83$
53. $T \propto \frac{n^3}{z^2}$ $\frac{T_1}{T_2} = \frac{n_1^3}{n_2^3} = 1/8$
54. $E_\infty - E_1 = hv_1, \Rightarrow E_1 \Rightarrow hv_1$
 $E_2 - E_1 = hv_2$

$$E_{\infty} - E_2 = hv_3, \quad \Rightarrow E_2 \Rightarrow hv_3$$

$$-hv_3 + hv_1 = hv_2$$

$$\boxed{v_2 = v_1 - v_3}$$

$$\boxed{v_3 = v_1 - v_2}$$

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

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

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

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. $\Delta E = \frac{hc}{\lambda}$

$$\Delta E = \frac{hc}{\lambda_1} \quad (\text{for H atom})$$

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

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

57. First Excitation potential (iFke mRstu folko)

$$= E_2 - E_1 \Rightarrow -4 + 16 \Rightarrow 12 \text{ eV}$$

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. $n_2 = 5, n_1 = 1$
 total number of spectrum line are
 $\Sigma(5 - 1) \Rightarrow \Sigma^4$
 $\Sigma^4 \Rightarrow 4 + 3 + 2 + 1$
 lymer Balmer Pascher brackett
 3 line in visible reigon.

Exercise-03

Comprehension # 1

1. Cr = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
 Mn⁺ = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
 Fe²⁺ = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$
 Co³⁺ = $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

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. Fe³⁺ = [Ar] 3d⁵
 Ti³⁺ = [Ar] 3d¹
 Co³⁺ = [Ar] 3d⁶

all are having unpaired electron hence paramagnetic & coloured.

4. Fe = [Ar] 3d⁶ 4s²



Hund's and Pauli's principle is violated. (gqM rFk i khyh fu; e dh i kyuk ugha gsrh gS)

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

$$(p\emptyset.k \text{ Dok.Ve } I \text{ ; } k \text{ vFkr} \sim (m_s) = -\frac{1}{2}, 0, +\frac{1}{2}, d$$

d{kid ea vf/kdre $3e^-$ gsrh gS

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

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

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

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

6. for g - sub-shell

$$n = 5$$

$$l = 0, 1, 2, 3, 4$$

$$l = 4 \text{ \{g - subshell\}}$$

number of electron = $2(2l + 1)$

$$= 2 \times 9 \Rightarrow 18$$

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

any orbital can have more two electron

Exercise-4(A)

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

$$\text{Velocity} = \frac{\text{Distance}}{\text{Time}} = \frac{8 \times 10^{10} \text{ m}}{3 \times 10^8 \text{ sec}} = 3 \times 10^8 \text{ m/sec}$$

$$\therefore \text{Time} = \frac{\text{Distance}}{\text{Velocity}} = \frac{8 \times 10^{10} \text{ m}}{3 \times 10^8 \text{ m/sec}} = 2.66 \times 10^2 \text{ sec.}$$

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

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

$$\Delta E = [0 - (-5.3)] = 5.3 \text{ I.v.}$$

$$\Delta E = \frac{1240}{\lambda(\text{nm})} \quad \lambda = \frac{1240}{5.3} = 233.9 \text{ nm}$$

- (c) $|\Delta E_{3 \rightarrow 1}| = |-3.08 - (-15.6)| = 15.6 - 3.08 = 12.52 \text{ I.v.}$

$$= \frac{1240}{\lambda} = \frac{12.52}{1240} = \frac{1}{\lambda} (\text{I.v.})$$

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

- (d) (i) $E = -15.6 - (-6) = -15.6 + 6 = -9.6$
(ii) $E = -15.6 - (-11) = -15.6 + 11 = -4.6$

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

$$10^{-17} = \frac{10^{-17}}{1.6 \times 10^{-19}} \text{ eV} = 0.625 \times 10^2$$

$$E = \frac{nhc}{\lambda} \quad 0.625 \times 10^2 = n \frac{1240}{550}$$

$$2.77 \times 10 = n$$

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

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

$$\frac{330}{6.62 \times 10^{-34} \times 5 \times 10^{13}} = n \quad 10^{22} = n$$

5. $E = \frac{hL}{\lambda} \quad n = \frac{3.15 \times 10^{-14} \times 850 \times 10^{-9}}{6.62 \times 10^{-34} \times 3 \times 10^8}$

$$n = 134.8 \times 10^3 \quad n = 1.35 \times 10^5$$

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

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

$$\frac{10^9}{1093.6 \times 10^7 \times 1.09} = \frac{1}{9} - \frac{1}{n_2^2}$$

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

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

7. $n_2 = 3 \quad n_1 = 2$ [first line]
 $n_2 = 4 \quad n_1 = 2$ [second line]

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

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

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

$$\frac{\lambda}{6565} = \frac{\frac{5}{36}}{\frac{3}{16}} = \frac{5 \times 16}{36 \times 3} \quad \lambda = 4863 \text{ \AA}$$

8. $3 \rightarrow 2$

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

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

$$(\lambda_1 - \lambda_2) = 133.7 \text{ nm} \quad \dots (iii)$$

we will solve the three equation and we will get
 $R = 1.096 \times 10^7 \text{ m}^{-1}$

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

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

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

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

$$= \frac{1240}{85.4} \times 96.368 \text{ kJ/mole} \approx 1399.25 \text{ kJ/mol}$$

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

$$16 \times 0.0529 = 0.0529 \times \frac{n^2}{Z}$$

$$16 = \frac{n^2}{1} \quad \boxed{n = 4}$$

$$\text{T.E.} = -13.6 \times \frac{n^2}{Z^2} \text{ I.v.} = 0.85 \text{ I.v.} = -1.36 \times 10^{-19} \text{ J}$$

12. $E_n = \frac{-21.7 \times 10^{-12}}{n^2} \text{ 1 erg} = 10^{-7} \text{ Joule}$

$$E_n = \frac{-21.7 \times 10^{-12}}{4}$$

$$\text{J.E.} = 0 - \left[\frac{-21.7 \times 10^{-12}}{4} \right] = \frac{21.7 \times 10^{-12}}{4}$$

$$= 5.425 \times 10^{-12} \text{ ergs}$$

- (b) $5.425 \times 10^{-12} = \frac{6.624 \times 10^{-34} \times 10^8}{\lambda}$

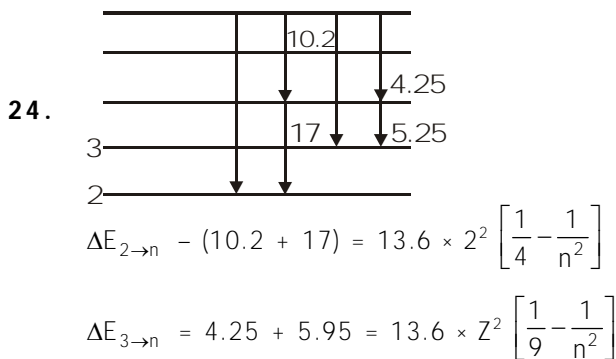
$$\lambda = \frac{6.624 \times 3 \times 10^8 \times 10^{12}}{5.425 \times 10^{34}} = 3.7 \times 10^{-14} \text{ (nm)}$$

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

13. $\Delta E_{2 \rightarrow 1} = I.E. \left[\frac{1}{4} - \frac{1}{1} \right]$
 $2.17 \times 10^{-11} \text{ erg/atom} \left[\frac{1}{4} - \frac{1}{1} \right] = \frac{hc}{\lambda(m)}$
 $2.17 \times 10^{-11} \times 10^{-7} \text{ J} \left[\frac{1}{4} - \frac{1}{1} \right] = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{\lambda}$
 $\lambda = \frac{6.626 \times 10^{-34} \times 3 \times 10^8 \times 4}{2.17 \times 10^{-18} \times 3} = \frac{6.626 \times 4 \times 10^8}{2.17}$
 $= 12.20 \times 10^{-8} \text{ m}$
 $1 \text{ m} \rightarrow 10^{10} \text{ \AA}$
 $6.10 \times 10^{-8} \text{ m} \rightarrow \frac{12.2 \times 10^{10}}{10^8} = 1220 \text{ \AA}$
14. $V_n = 2.18 \times 10^6 \times \frac{Z}{n} = \frac{2.18 \times 10^6}{n}$
 $\frac{2.18 \times 10^6}{n} = \frac{1}{275}$
 $\frac{2.18 \times 10^6}{n} = \frac{1}{3 \times 10^8} = \frac{1}{275}$
 $\frac{2.18}{n(300)} = \frac{1}{275} \quad \frac{1}{n} = \frac{300}{599.5}$
 $n = \frac{599.5}{300} = \frac{1}{275} \quad \frac{1}{n} = \frac{300}{599.5}$
 $n = 1.99 \approx 2$
15. $Z = 3, n_1 = 1, n_2 = 3$
 $E_n = 13.6 \times (Z^2) \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = 13.6 \times 9 \left[\frac{1}{1} - \frac{1}{9} \right]$
 $= 13.6 \times 9 \times \frac{8}{9} = 108.8 \text{ eV}$
- 16.(i) $E_{n_2 \rightarrow n_1} = 13.6 \times Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = 13.6 [1]^2 \left[\frac{1}{1} - \frac{1}{4} \right]$
 $= 13.1 \times 1 \times \frac{3}{4} = 10.22 \text{ eV}$
- (ii) $\frac{1}{\lambda} = R_H Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$
 $\frac{1}{3 \times 10^{-8}} = 1.09 \times 10^7 \times Z^2 \left[\frac{1}{4} - \frac{1}{1} \right]$
 $\frac{10^8}{3 \times 10^7 \times 1.09} = Z^2 \times \frac{x-3}{4}$
 $\frac{10 \times 4}{3 \times 1.09 \times x - 3} = Z^2 \quad Z^2 = -4 \quad Z = 2$
17. 1.8 mole = (1.8 Na) atoms
 27% = IIIrd energy level = $1.8 \times \text{Na} \times 0.27$
 15% = IIInd energy level = $1.8 \times \text{Na} \times 0.15$
 $\Delta E = \Delta E_{3 \rightarrow 1} + \Delta E_{2 \rightarrow 1} = 1.8 \times N_A \times 0.27 \times I.E. \left[\frac{1}{9} - \frac{1}{1} \right] + 1.8$

- $\times N_A \times 0.15 \times I.E. \left[\frac{1}{4} - \frac{1}{1} \right] = 292.68 \times 10^{21} \text{ atom}$
18. Number of atom in 3rd orbit = $0.5 N_A$
 Number of atom in 2nd 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 = $n \left(\frac{h}{2\pi} \right)$
 $\left(\frac{hc}{\lambda} \right) = -3.4 \text{ eV} \quad -3.4 = -13.6 \times \frac{(1)^2}{n^2}$
 $\frac{-3.4}{-13.6} = \frac{1}{n^2} \quad n^2 = \frac{3.4}{3.4}$
 $n^2 = 4 \Rightarrow n = 2$
 $= 2 \left(\frac{6.626 \times 10^{-34} \times 7}{2 \times 22} \right) = \frac{h}{\pi} \text{ or } \frac{6.62 \times 10^{-39} \times 7}{2}$
20. $4.5 \text{ eV} = \frac{1240}{\lambda(\text{nm})} \quad \frac{1}{\lambda} = \frac{4.5}{1240}$
 $\frac{1}{\lambda} = 0.0036 \text{ nm}^{-1} \quad 1 \text{ nm} \rightarrow 10^{-9} \text{ m}^{-1}$
 $0.0036 \text{ nm}^{-1} \rightarrow 3.6 \times 10^6 \text{ m}^{-1}$
21. $\frac{n(n-1)}{2} = 15 \quad n^2 - n = 30$
 $n^2 - n - 30 = 0 \quad n = 6$
 $\frac{1}{\lambda \text{ \AA}} = R_H \left[\frac{1}{1} - \frac{1}{36} \right]$
 $\frac{1}{x} = \frac{1}{912} \times \frac{35}{36} = \frac{35 \times 2496}{32832}$
 $\boxed{\lambda = 932 \text{ \AA}}$
22. $V_2 = V_0 \times \frac{1}{2} = \frac{V_0}{2}$
 $x = v \times t$
 $x = \frac{V_0}{2} \times 10^{-8} \text{ sec} = \left(\frac{V_0 \times 10^{-8}}{2} \right) \text{ m}$
 $2\pi r \rightarrow 1 \text{ round}$
 $\frac{V_0 \times 10^{-8}}{2} = \frac{V_0 \times 10^{-8}}{2} \times \frac{1}{2\pi r}$
 $r_2 = r_0 \times n^2 = 4r_0$
 so, no. of revolutions (pDdjka dh dgy l d ; k)
 $= \frac{V_0 / 2 \times 10^{-8}}{2\pi \times 4r_0} = \frac{V_0 \times 10^{-8} \times 1}{2 \times 2\pi \times 4r_0}$
 $= \frac{2.18 \times 10^6 \times 10^{-18}}{2 \times 2 \times 3.14 \times 4 \times 0.529}$
 $= \frac{2.18 \times 10^{-12}}{2.6 \times 10^{-21}} = 0.838 \times 10^9 = \boxed{8 \times 10^6}$

23. $V = \frac{v}{\lambda}$
 E of 1st Bohr orbit = -13.6
 $-13.6 = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{\lambda}$
 or $-13.6 = \frac{1240}{\lambda(\text{in nm})}$
 $\lambda = \frac{1240}{136} \times 10$ | $V = \frac{3 \times 10^8}{912 \times 10^{10}}$
 $\lambda = 91.17 \text{ (nm)}$ | $= \frac{3}{912} \times 10^{+R}$
 $= 912 \text{ \AA}$ | $= 6530 \times 10^{12} \text{ Hz}$



25. $E = -2.18 \times 10^{-18} \frac{Z}{n^2} \text{ g/atom}$
 $\Delta E = (E_2 - E_1) = \frac{1}{2} mv^2$
 $v = 1.89 \times 10^6 \text{ m/sec}$
 $v = 1.89 \times 10^8 \text{ cm/sec}$

26. $V_2 = V_0 \times \frac{1}{2} = \frac{V_0}{2}$ | $r = r_0 \times 4$
 $N = \frac{(V_0/2) \times 10^{-8}}{2\pi \times 4r_0}$ | $\lambda_p = \frac{0.286}{\sqrt{V}} \text{ \AA}$
 $\lambda_\infty = \frac{101}{\sqrt{V}} \text{ \AA}$

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

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

$IE = 2.7 \times \frac{16}{3} \text{ eV}$

(c) $\Delta E_{4 \rightarrow 1}^{\text{max}} = IE \left[\frac{1}{k} - \frac{1}{1} \right]$

$\Delta E_{4 \rightarrow 3} = IE \left[\frac{1}{16} - \frac{1}{9} \right]$

29. B.E. = 180.69 kJ/mole $\Rightarrow w = hv_0$
 $\frac{180.69}{96.368} \text{ eV/atom} = hv_0$

$\frac{180.69}{96.368} \times 1.6 \times 10^{-19} = 6.6 \times 10^{-34} \times v_0$
 $v_0 = 6.626 \times 10^{-34}$

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

$E = 497.9 \text{ kJ/mol}$

31. $hv_1 = hv_0 + 2E_1$ | $hv_2 = hv_0 + E_1$
 $hv_1 - w_0 + 2E_1$ | $hv_2 - w_0 + E_1$
 $2 = \frac{hv_1 - w_0}{hv_2 - w_0}$ | $2hv_2 - 2w_0 = hv_1 - w_0$

$h[2v_2 - v_1] = w_0$
 $w_0 = 6.62 \times 10^{-34} (2 \times 10^{15} - 3.2 \times 10^{15})$

$w_0 = 6.62 \times 10^{-34} \times 0.8 \times 10^{15}$
 $w_0 = 5.29 \times 10^{-19}$ | $w_0 = 318.9 \text{ kJ/mol}$

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

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

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

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

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

$\lambda = \frac{1240}{20000} = 62 \times 10^{-3} \text{ nm} = 0.62 \text{ \AA}$

34. (KE) max = stopping potential (fojke folko)
 \therefore stopping potential = 3.06 V

35. $U_{\text{avg.}} = \sqrt{\frac{8 \text{ kJ}}{\pi m}}$
 $U_{\text{avg.}} = \sqrt{\frac{8 \times 1.38 \times 10^{-23} \times 298}{3.14 \times 4 \times 1.67 \times 10^{-27}}}$

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

$\lambda = \frac{h}{mV} \Rightarrow \frac{6.62 \times 10^{-34}}{4 \times 1.67 \times 10^{-27} \times 1.25 \times 10^3}$
 $\lambda = 0.79 \text{ \AA}$

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

$\therefore \frac{150}{250000} = V$ | $\therefore V = 6 \times 10^{-4} \text{ volt}$

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

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

$$\Delta x \times 1.672 \times 10^{-27} \text{ kg} \times 3 \times 10^7 = \frac{6.626 \times 10^{-34}}{4 \times 3.14} \Rightarrow \Delta x$$

$$= \frac{6.626 \times 10^{-34} \times 100}{1.672 \times 10^{-27} \times 3 \times 10^7 \times 4 \times 3.14}$$

$$\boxed{\Delta x = 1.05 \times 10^{-13} \text{ m}}$$

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

$$= \sqrt{2 \times 1.67 \times 10^{-27} \times 1.6 \times 10^{-19} \times V}$$

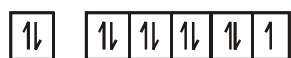
$$\therefore 1 = 6.6 \times 10^{-24} = \sqrt{5.344 \times 10^{-8}} \text{ eV}$$

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

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

39. Cu = [Ar]. 4s, 3d⁹

or



$$\text{no. of ex change pair} = \frac{n(n+1)}{2} = \frac{5 \times 4}{2} = 10$$

$$\frac{4 \times 3}{2} = 6$$

$$\text{Total exchanges} = 10 + 6 = 16$$

41. E of light absorbed in one photon ($E = \frac{hc}{\lambda_{\text{absorbed}}}$)

$$\text{Let } n_1 \text{ photons are absorbed, therefore, Total energy absorbed} = \frac{n_1 hc}{\lambda_{\text{absorbed}}}$$

Now, E of light re-emitted out in one photon = $\frac{hc}{\lambda_{\text{emitted}}}$

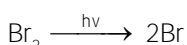
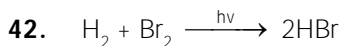
$$\text{Let } n_2 \text{ photons are re-emitted then, Total energy re-emitted out} = n_2 \times \frac{hc}{\lambda_{\text{emitted}}}$$

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

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

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

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



$$\text{BE} = 192 \text{ kJ / mole}$$

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

$$\lambda = 6235 \text{ \AA}$$

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

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

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

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

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

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

45. Energy required to break H-H bond = $\frac{430.53 \times 10^3}{6.023 \times 10^{23}} \text{ J/molecule} = 7.15 \times 10^{-19} \text{ J}$

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

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

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

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

$$\therefore \% \text{ of energy used in kinetic energy} =$$

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

46. Energy given to I₂ molecule

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

Also energy used for breaking up of I₂ molecule

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

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

$$= [4.417 - 3.984] \times 10^{-19} \text{ J}$$

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

$$= 0.216 \times 10^{-19} \text{ J}$$

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

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

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

$$50. \quad \Delta V = 30 \times 10^2 \text{ cm/sec}$$

$$\lambda = 5000 \text{ \AA} \quad m = 200 \text{ g}$$

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

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

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

$$51. \quad v = 40 \text{ m/sec} \quad \Delta v = 0.01$$

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

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

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

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

Exercise-4(B)

$$1. \quad \text{Given that } \lambda_1 = 486.1 \times 10^{-9} \text{ m}$$

$$= 486.1 \times 10^{-7} \text{ cm}$$

$$\lambda_2 = 410.2 \times 10^{-9} \text{ m} = 410.2 \times 10^{-7} \text{ cm}$$

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

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

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

For line I of Balmer series

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

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

$$\therefore n_1 = 4$$

For line II of Balmer series ;

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

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

$$\therefore n_2 = 6$$

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

(vr%fn; k x; k by DVNud I De.k 6th I s4th dsk esgskA)

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

$$\therefore \lambda = 2.63 \times 10^{-4} \text{ cm}$$

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

$$116.71 \text{ kJ/mol H}$$

$$\text{D.E.} = 116.71 \times 2.67 = 311.62 \text{ kJ/mol H}_2$$

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

$$\Rightarrow \text{T.E.} = 0.04 \times 311.62 + 0.08 \times 116.71 = 21.8 \text{ kJ}$$

$$3. \quad E(\text{eV}) = \frac{1240}{\lambda(\text{nm})}$$

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

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

$$E_n = 52.217 - 54.4 = -2.182 \text{ eV} \quad (E_1 = -54.4 \text{ eV})$$

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

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 :

(D; kld 6 mRI tU jfk, ai klr gsrh gsvfkr-by DVNud
4th d(k I svrk gA mRI Etr Atk 2.7 eV dscjkj)
I s de rFk I svf/kd gsrh gA)

$$E_4 - E_2 = 2.7 \text{ eV},$$

$$E_4 - E_3 < 2.7 \text{ eV},$$

$$E_4 - E_1 > 2.7 \text{ eV}$$

$$(a) \quad n = 2,$$

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

$$2.7 = 2.55 \times Z^2 = 1.029$$

(b) $IP = 13.6 Z^2 = 13.6 \times (1.029)^2 = 14.4 \text{ eV}$

(c) Maximum energy emitted = $E_4 - E_1 = (E_4 - E_1)^H \times Z^2$
 $= 12.75 \times (1.029)^2$
 $= 13.5 \text{ eV}$

Minimum energy emitted = $E_4 - E_3 = (E_4 - E_3)^H \times Z^2$
 $= .66 \times (1.029)^2 = 0.7 \text{ eV}$

5. $n \rightarrow 2\Delta E = 27.2 \text{ eV}(17 + 10.2)$
 $n \rightarrow 3\Delta E = 10.2 \text{ eV}(4.25 + 5.95.2)$ } $E_3 - E_2 = 17 \text{ eV}$

$17 \text{ eV} = 1.89 \times Z^2 \Rightarrow Z = 3$

$E_2 = -3.4 \times 9 = -30.6 \text{ eV}$

$E_n - E_2 = 27.2 \text{ eV}$

$E_n = 27.2 + E_2 = -3.4 \text{ eV}$

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

6. $\lambda = 975 \text{ \AA}$

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

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

minimum energy emitted = $E_4 - E_3 = 0.66 \text{ eV}$

(vr%byDVWU 4th \AA tkLrj rd mRrftr gskk rFkk tc okil vkrk gSmRI tzu folko dh l [; k 6 gkschA)

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

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

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

$PE = \frac{kq_1q_2}{d} = \frac{9 \times 10^9 \times 2 \times 1.6 \times 10^{-19} \times 47 \times 1.6 \times 10^{-19}}{5 \times 10^{-14}}$

$PE = 4.33 \times 10^{-13} \text{ J}$

By energy conservation :

$6.4 \times 10^{-13} = x + 4.33 \times 10^{-13}$

$x = 2.06 \times 10^{-13} \text{ J}, \quad kE = PE$

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

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

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 $\frac{ke^2}{r^4} = \frac{mv^2}{r} \dots(1)$

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

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

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

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

putting this in equation (2)

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

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

putting this in equation (3)

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

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

9. (a) $(E_3 - E_2) = 68 \text{ eV} = (E_3 - E_2)^H \times Z^2$

$68 = 1.89 \times Z^2$

$Z = 6$

(b) $(kE)_1 = -E_1 = 13.6 \times 36 = 489.6 \text{ eV}$

(c) Energy required = $-E_1 = 489.6 \text{ eV}$

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

10. $E_1 = IP$

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

$= -8.72 \times 10^{-18} \text{ J}$

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

$\Delta E = E_2 - E_1 = 6.54 \times 10^{-18} \text{ J} = \frac{hc}{\lambda}$

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

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

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

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

$W_0 = 25 \text{ eV}$

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

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

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

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

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

12. Since electron is in some excited state of He^+ so its energy $\leq 13.6 \text{ eV}$ so energy need to excitation is also $< 13.6 \text{ eV}$ & only for hydrogen $E_3 - E_1 < 13.6 \text{ eV}$. 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.

pid by DVN He+ dh dN mRrfr volFkk egs vr%bl dh Atk $\leq 13.6 \text{ eV}$ gskh bl idkj mRrstu dsfy, vko'; d Atk $< 13.6 \text{ eV}$ gskh vj dny gkbMst u dsfy, $E_3 - E_1 < 13.6 \text{ eV}$ gskh vr% Z = 1 gskh vc He^+ dsfy, ; g Atk 2nd o 6th d{kk ds Atk vlrjky dscjkj gskh vr%i kj fHkd volFkk 2 o vflre volFkk 6 gS

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

$$n = 3$$

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