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

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

$\because 1$ fm $= 10^{-15}$ m ≈ 5 fm

10. $\lambda = \frac{C}{\nu} = \frac{3\times10^8}{400\times10^6} = 0.75$ m

14. d = 20 nm

$r = \frac{20}{2} = 10$ nm $= 100$ A°

$\because r = 0.529 \times \frac{n^2}{Z}$ A° $\quad$ For H atom Z = 1

$100 = 0.529 \times n^2$ $\quad$ n = 14

15. $E_n = -13.6 \times \frac{Z^2}{n^2}$

$E_1(H) = -13.6 \times \frac{1}{1} = -13.6$ eV

$E_2(He^+) = -13.6 \times \frac{4}{4} = -13.6$ eV

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

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

$\therefore$ Ans B

16. E = –78.4 kcal/mol

$E_n = -313.6 \times \frac{Z^2}{n^2}$ kcal/mol

for H atom Z = 1 $\quad -78.4 = 313.6 \times \frac{1}{n^2}$

$n^2 = \frac{313.6}{78.4}$ $\quad$ n = 2

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

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

18. Let state (ekuk voLFkk) (1) = n_1

state (voLFkk) (2) = n_2

$r_1 - r_2 = 624\ r_0$

$0.529 \times \frac{n_1^2}{Z} - \frac{0.529 n_2^2}{Z} = 624 \times \frac{0.529\times1}{Z}$

$n_1^2 - n_2^2 = 624$

$n_1 = 25$

$n_2 = 1$

$25 \to 1$

19. (A) Energy of ground state (ey voLFkk dh Åtk)

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

(B) P.E. of Ist orbit of H-atom (gkbMkstu ijek.kq d iFke d{k dh P.E.)=2T.E.= -2×13.6eV = –27.2eV

(C) Energy of II excited state(II mÙksftr voLFkk dh Åtk)

$= -13.6 \times \frac{Z^2}{n^2} = -13.6 \times \frac{(2)^2}{(3)^2}$

$= -13.6 \times \frac{4}{9} = -6.04$ eV

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

20. $E_5 = -13.6 \times \frac{1}{(5)^2} = -0.54$ eV

22. Li^{+2} & He^+ both have same no. of electron so spectrum pattern will be similar. Li^{+2} o He^+ nkuk leku byDVku j[kr g blfy, LiDVe leku gkxkA

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

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

26. Orbital angular momentum (d{kh; dks.k; laox)

$= \sqrt{\ell(\ell+1)}.\frac{h}{2\pi}$ $\quad$ 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 (v;fXer) $de^- = 0$)
$_{26}Fe^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$(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 = | ⇅ | ⇅ | ↿ | ↿ | ↿ |

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

33. $Cl^- = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
For last e^- n = 3, l = 1, m = ±1

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

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

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

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

So ans (A,B,D)

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

(dk.kh; laox e ifjoru)

$(n_2 - n_1)$ is an integer value ($(n_2 - n_1)$,d i.kkd eku g)

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 ls nj tku ij Åtk c<rh g vr% ukfHkd ls vuUr njh ij Åtk vf/kdre gksxhA)

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 byDVku mPp Lrj ls fuEu Lrj dh vkj vkrk g] rk QkVku eDr gkrk g rFkk tc fuEu Lrj ls mPp Lrj dh vkj tkrk g rk QkVku vo'kf"kr gkrk g vr% '1s' doy QkVku vo'kf"kr djrk g D;kfd ;g fuEu Åtk Lrj 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. $5 \to 2$
(ckej J.kh e, byDVku mPp Åtk Lrj ls 2nd Åtk Lrj e vkrk g vr% rrh;d j[kk iklr gkrh g tc byDVku ikpo Åtk Lrj ls f}rh;d Åtk Lrj e vkrk gA $5 \to 2$)

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.
vkQckÅ fl)kr % d{kd e byDVkuk dk Åtk Lrj d c<r Øe e Hkjk tkrk g

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

7. n > ℓ, m = $-\ell$ 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. $Cr = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$; $Mn^+ = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$
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.
JkfMxj lehdj.k ls doy n, l o m Dok.Ve la[;k iklr gkrh g] pØ.k Dok.Ve la[;k JkfMxj lehdj.k ls lEcfU/kr ugh gkrh gA

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

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

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

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

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

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

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

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

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

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

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 $n_2 = \infty$, $n_1 = 2$

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

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

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

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

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

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

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

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

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 (pEcdh; vk?k.k)

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

orbital angular momentum (d{kh; dk.kh; lox) =

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

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

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

$\lambda_\propto\propto\frac{1}{\sqrt{4M_p\times 4E}}$; $\qquad$ 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

(lHkh byDVªku ;fXer g vr% ;g ifrpEcdh; gksxkA)

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.

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

$b = (IE_2)_{Li^+} = 11817$ 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.

,ukM fdj.k ;k duky fdj.k byDVksM d inkFk ij fuHkj ugh djrh g

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 }kjk Kkr fd;k tkrk g ; (n + ℓ) dk eku de gku ij Åtk U;ure gkrh g ; ;fn (n + ℓ) dk eku leku gk rk, 'n' dk U;ure eku gh Åtk dk U;ure eku gkxk) e3 > e2 > e4 > e1

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

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

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

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

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

(ikmyh fu;e d vuqlkj d{kd e vf/kdre nk byDVªku gk ldr g vr% ikmyh viotu fu;e dk ikyu ugh gkrk gA)

27. For d_{yz}, xy and xz are nodal palne
node = $(n - \ell - 1) = 6-2-1 \Rightarrow 3$

29. $x \longrightarrow y + {}^{4}_{2}H_2$
$y \longrightarrow {}_8O^{18} + {}_1H^1$
$y = {}_9y^{19}$
$x = {}_{11}x^{23}$
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 x 12 ⇒ 2.4

30. $E = \frac{hc}{\lambda} \Rightarrow \frac{1240}{\lambda_{nm}} ev$ $E = \frac{1240}{31} \Rightarrow 40$ eV
40 = 12.8 + K.E.
K.E. = 10 –12.8 = 27.2 eV
K.E. = $27.2 \times 1.6 \times 10^{-19}$
$27.2 \times 1.6 \times 10^{-19} = \frac{1}{2} \times 9.1 \times 10^{-31} \times v^2$
$v = 2.18 \times \sqrt{2} \times 10^6$ m/s

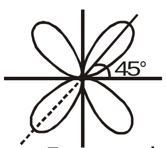
31. Frequency = $\frac{1}{T} \propto \frac{v}{r} \propto \frac{z/n}{n^2/z}$
Frequency $= \frac{1}{T} \propto \frac{z^2}{n^3}$ $T \propto \frac{n^3}{z^2} = \frac{1/4}{8/1} \Rightarrow \frac{1}{32}$

32. Radial node (f=T;h; ukM) = $(n - \ell - 1)$
Angular node (dk.kh; ukM) = ℓ
4s, $5p_x$, 6_{dxy} having 3 radial node.
angular node in all 's' orbital in zero.
(lHkh 's' d{kdk e dk.kh; ukM 'kU; gkr gA)

33. s-orbital is spherical hence it is non-directional.
(s-d{kd xkykh; gkr g vr% ;g vfn'kkRed gkr gA)

34. B.E. = I.E.
$(I.E.)_{any\ atom} = (I.E.)_H \times z^2$
$\frac{122.4}{13.6} = z^2$
$z^2 = 9$ $z = 3$
$E_2 - E_1 = 122.4 - 30.6 = 91.8$ eV

35. $\Delta x = 2\Delta p$ $\Delta x . 2\Delta p = \frac{h}{4\pi}$
$2(\Delta p)^2 = \frac{h}{4\pi}$ $(\Delta v)^2 = \frac{h}{8\pi m^2}$
$\Delta v = \frac{1}{2m}\sqrt{\frac{h}{2\pi}}$ $\Delta v = \frac{1}{2m}\sqrt{\hbar}$

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 ℓ = 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. $\lambda = v$ $\lambda = \frac{h}{mv}$
$\lambda^2 = \frac{h}{m} \Rightarrow \boxed{\lambda = \sqrt{\frac{h}{m}}}$

41. Acc to schrodinger model e^- behave as wave only.
(JkfMxj ekMy d vuqlkj e^- rjx dh rjg 0;ogkj djr gA)

42. The maximum porbability of finding an electron is decribe the orbital, which is denote by Ψ^2.
(byDVkWu d ik; tku dh vf/kdre ikf;drk dh d{kd d :i e 0;k[;k dh tkrh gA ftl Ψ^2 l in£'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. $m_y = 0.25\ m_x$, $v_y = 0.75\ v_x$
$\lambda = \frac{h}{mv}$ $\lambda_x = \frac{h}{m_x v_x}$, $\lambda_y = \frac{h}{m_y v_y}$
$\lambda_y = \frac{h}{0.25M_x \times 0.75v_x}$ $\lambda_y = 5.33$ A

48. Orbital angular momentum (d{kh; dk.kh; lox) = $\sqrt{\ell(\ell+1)}\,\hbar$

	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 (pEcdh; vk?k.k) = $\sqrt{n(n+2)} \Rightarrow$
$\sqrt{2(4)}$ = 58 = 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. $E_\infty - E_1 = hv_1$, $\Rightarrow E_1 \Rightarrow hv_1$
$E_2 - E_1 = hv_2$

$E_\infty - E_2 = hv_3$, $\Rightarrow E_2 \Rightarrow hv_3$

$-hv_3 + hv_1 = hv_2$

$\boxed{v_2 = v_1 - v_3}$

$\boxed{v_3 = v_1 - v_2}$

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

$E_B - E_A = \dfrac{hc}{\lambda_2}$ ...(ii)

$E_C - E_A = \dfrac{hc}{\lambda_3}$ ...(iii)

add equation (1) and (2)

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

put in equation (3)

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

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

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

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

$\Delta E \times z^2 = \dfrac{hc}{\lambda_2}$ (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 (iFke mRrstu foHko)

$= E_2 - E_1 \Rightarrow -4 + 16 \Rightarrow 12$ 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. $n_2 = 5$, $n_1 = 1$

total number of stectrum 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 $= 1s^2\, 2s^2\, 2p^6\, 3s^2\, 3p^6\, 3d^5\, 4s^1$

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

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

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

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. (g.M rFkk ikmyh fu;e dh ikyuk ugh gkrh g)

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

(pØ.k Dok.Ve l[;k vFkkr $(m_s) = -\frac{1}{2}, 0, +\frac{1}{2}$,d d{kd e vf/kdre $3e^-$ gkr g)

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 $\Rightarrow 3 \times 4 \Rightarrow 12$

6. for g - sub-shell

$n = 5$

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

$\ell = 4$ {g - subshell}

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

$= 2 \times 9 \Rightarrow 18$

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

any orbital can have more two electron

Exercise-4(A)

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

(exy l iFoh rd r; dh x;h njh) $= 8 \times 10^{10}$m

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

$\therefore$ Time = D/V $= \frac{8\times10^{10}}{3\times10^8} = 2.66 \times 10^2$ sec.

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

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

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

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

(c) $|\Delta E_{3\to1}| = |-3.08 - (-15.6)|$ =15.6–3.08=12.52l.v.

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

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

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

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

3. 1.6×10^{-19} J = 1 eV

$10^{-17} = \frac{10^{-17}}{1.6\times10^{-19}}$eV $= 0.655 \times 10^2$

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

$2.77 \times 10 = n$

4. 330 J = n(hν)

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

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

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

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

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

$= 1093.6 \times 10^{-9}$ 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. $n_2 = 3 \quad n_1 = 2$ [first line]

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

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

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

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

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

8. $3 \to 2$

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

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

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

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

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

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

$= 1.827 \times 10^5$ J/mole

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

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

11. Radius = 16(RH) = 16 × 0.0529

$16 \times 0529 = 0.0529 \times \frac{n^2}{Z}$

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

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

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

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

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

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

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

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

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

13. $\underset{2\to1}{\Delta E} = I.E.\left[\frac{1}{4}-\frac{1}{1}\right]$

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

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

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

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

1 m $\to 10^{10}$ Å

$6.10 \times 10^{-8}m \to \frac{12.2\times10^{10}}{10^{8}} = 1220$ Å

14. $V_n = 2.18 \times 10^6 \times \frac{Z}{n} = \frac{2.18\times10^6}{n}$

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

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

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

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

$n = 1.99 \simeq 2$

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

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

$= 13.6 \times 9 \times \frac{8}{9} = 108.8$ eV

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

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

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

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

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

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

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

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

$\times N_A \times 0.15 \times IE\left[\frac{1}{4}-\frac{1}{1}\right] = 292.68 \times 10^{21}$ 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 $N_A(E_3-E_1)+0.25N_A(E_2 - E_1)$

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

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

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

$n^2 = 4 \Rightarrow n = 2$

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

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

$\frac{1}{\lambda} = 0.0036\ nm^{-1}$ $\qquad 1\ nm \to 10^{-9}\ m^{-1}$

$0.0036\ nm^{-1} \to 3.6 \times 10^6\ m^{-1}$

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

$n^2 - n - 30 = 0$ $\qquad n = 6$

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

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

$\boxed{\lambda = 932\,Å}$

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

$x = v \times t$

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

$2\pi r \to 1$ round

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

$r_2 = r_0 \times n^2 = 4r_0$

so, no. of revolutions (pDdjk dh dy l[;k)

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

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

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

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

E of Ist Bohr orbit = –13.6

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

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

$\lambda = \frac{1240}{136}\times10$

λ = 91.17 (nm)

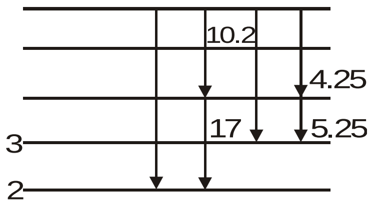
= 912 Å

$V = \frac{3\times10^{8}}{912\times10^{10}}$

$= \frac{3}{912}\times10^{+R}$

= 6530 $\times$ 10^{12} Hz

24.



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

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

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

$\Delta E = (E_2 - E_1) = \frac{1}{2}m\nu^2$

ν = 1.89 $\times$ 10^6 m/sec

ν = 1.89 $\times$ 10^8 cm/sec

26. $V_2 = V_0\times\frac{1}{2} = \frac{V_0}{2}$ $\qquad$ $r = r_0\times4$

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

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

27. **(a)** $\frac{1}{\lambda} = \left(\frac{1}{\lambda_1}+\frac{1}{\lambda_2}\right)$ = r $\times$ 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 $\times$ $\frac{16}{3}$eV

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

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

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

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

$\frac{180.69}{96.368}$ $\times$ 1.6 $\times$ 10^{-19} = 6.6 $\times$ 10^{-34} $\times$ ν_0

ν_0 = 6.626 $\times$ 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 $\times$ 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} $\qquad$ 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 = $\frac{hc}{\lambda} = \frac{1240}{\lambda(\text{nm})}$

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

34. (KE) max = stopping potential (fojke foHko)

$\therefore$ stopping potential = 3.06 V

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

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

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

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

λ = 0.79 Å

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

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

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

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

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

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

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

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

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

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

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

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

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

or

[⇅] [⇅ | ⇅ | ⇅ | ⇅ | ↑]

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

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

Total exchanges = 10 + 6 = 16

41. E of light absorbed in one photon (,d QksVku e vo'kksf"kr izdk'k dh E) $= \dfrac{hc}{\lambda_{absorbed}}$

Let n_1 photons are absorbed, therefore, (ekuk n_1 QksVku vo'kksf"kr gksrs g)

Total energy absorbed(vo'kksf"kr dy ÅtkZ)$= \dfrac{n_1hc}{\lambda_{absorbed}}$

Now, E of light re-emitted out in one photon =

$\dfrac{hc}{\lambda_{emitted}}$ (vc] ,d QksVku e iqu% mRlftZr izdk'k dh E)

Let n_2 photons are re-emitted then, (ekuk n_2 QksVku iqu% mRlftZr gksrs g)

Total energy re-emitted out $= n_2 \times \dfrac{hc}{\lambda_{emitted}}$

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

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

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

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

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

$Br_2 \xrightarrow{hv} 2Br$

BE = 192 kJ / mole

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

λ = 6235 Å

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

$\dfrac{0.2\times n}{10\times127} = \dfrac{1}{100}$ $\qquad 2 \times n = \dfrac{127}{10}$

$n = \dfrac{127}{10\times2} = \dfrac{12.7}{2} = 6$

No. of protons $= \dfrac{6\times10^{22}}{2} = 3\times10^{22}$

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

$\lambda = \dfrac{1240\times96.368}{243} = 491.75\times10^{-9}\,m \approx 4.9\times10^{-7}m$

45. Energy required to break H–H bond $= \dfrac{430.53\times10^{3}}{6.023\times10^{23}}$ J/molecule $= 7.15 \times 10^{-19}$ J

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

$= \dfrac{6.625\times10^{-34}\times3.0\times10^{8}}{253.7\times10^{-9}} = 7.83\times10^{-19}$ J

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

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

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

$\dfrac{0.68\times10^{-19}}{7.83\times10^{-19}}\times100 = 8.68\%$

46. Energy given to I_2 molecule

$= \dfrac{hc}{\lambda} = \dfrac{6.626\times10^{-34}\times3\times10^{8}}{4500\times10^{-10}} = 4.417\times10^{-19}$ J

Also energy used for breaking up of I_2 molecule

$= \dfrac{240\times10^{3}}{6.023\times10^{23}} = 3.984\times10^{-19}$ J

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

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

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

= 0.216 x 10^{-19} J

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

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

$= \dfrac{1 \times 1}{3} \times 10^{-65}$ = 3.68 x 10^{-65} m

50. ΔV = 30 x 10^2 cm/sec

λ = 5000 Å m = 200 g

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

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

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

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

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

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

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

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

Exercise-4(B)

1. Given that λ_1 = 486.1 x 10^{-9} m
= 486.1 x 10^{-7} cm
λ_2 = 410.2 x 10^{-9} m = 410.2 x 10^{-7} cm

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

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

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

For line I of Balmer series

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

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

$\therefore n_1 = 4$

For line II of Balmer series ;

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

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

$\therefore n_2 = 6$

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

(vr% fn;k x;k byDVkfud lØe.k 6^{th} l 4^{th} dk'k e gkxkA)

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

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

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

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

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

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

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

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

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

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

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

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;kfd 6 mRltuj[kk, iklr gkrh g vFkkr byDVku 4th d{kk l vkrk gA mRl£tr Åtk 2.7 eV d cjkcj] l de rFkk l vf/kd gkrh gA)

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

(a) n = 2,
$(E_4 - E_2)^{atom} = (E_4 - E_2)^H \times Z^2$
2.7 = 2.55 x Z^2 = 1.029

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

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

= 12.75 x $(1.029)^2$

= 13.5eV

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

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

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

17 eV = 1.89 x Z^2 ⇒ Z = 3

E_2 = –3.4 x 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

$E=\frac{\lambda c}{\lambda}=\frac{6.626\times 10^{-34}\times 3\times 10^8}{975\times 10^{10}}$ =2.03x10^{-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

(vr% byDVªku 4th Åtk Lrj rd mRrftr gksxk rFkk tc okil vkrk g mRlTtu foHkko dh l[;k 6 gksxhA)

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

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

(b) At distance d = 5 x 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 x 10^{-13} J

By energy conservation :

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

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

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

⇒ d = 3.384 x 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)

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

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

putting this in equation (3)

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

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

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

68 = 1.89 x Z^2

z = 6

(b) $(kE)_1$ = – E_1 =13.6 x 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 x 2.18 x 10^{-18} J

= –8.72 x 10^{-18} J

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

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

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

E_1=–8.72 x 10^{-18}=–21.79 x 10^{-19} x Z^2 ⇒ Z = 2

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

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

W_0 = 25 eV

kE = E – W_0 = 75 eV ⇒ V = 75 volt

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

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

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

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

12. Since electron is in some exited state of He^+ so it's energy $\leq$ 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.

pfd byDVku He^+ dh dN mRrftr voLFkk e g vr% bldh Åtk $\leq$ 13.6 eV gkxhA bl idkj mRrtu d fy, vko';d Åtk Hkh < 13.6 eV gkxh vkj doy gkbMkt u d fy, $E_3 - E_1 < 13.6$ eV gkxhA vr% Z =1 gkxkA vc He^+ d fy, ;g Åtk 2nd o 6th d{kk d Åtk vUrjky d cjkcj gkxh vr% ikjfEHkd voLFkk 2 o vfUre voLFkk 6 g

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

n = 3

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