PHYSICAL CHEMISTRY

DPP No. 11 & 22

Total Marks : 52

Max. Time : 62 min.

Topic : Mole Concept

Hints & Solutions

DPP No. # 11

1. Mass of a neutron = 1.675×10^{-24} g mass of a proton = 1.672×10^{-24}

2. Carbon is $_6C^{12}$ and silicon is $_{14}Si^{28}$.

3. No change by doubling mass of electrons, however by reducing mass of neutron to half total atomic mass becomes 6 + 3 instead of 6 + 6. Thus reduced by 25%.

4. $_ZX^A$, A = N + P

6. NO_3^- = 7 + 8 × 3 + 1 = 32

7. $$\text{fraction} = \frac{\text{vol. of nucleus}}{\text{vol. of atom}} = \frac{\frac{4}{3}\pi(10^{-13})^3}{\frac{4}{3}\pi(10^{-8})^3} = 10^{-15}.$$

8._ 2 (p + n) + 3p = 140 ∴ 7x = 140 ∴ x = 20
∴ p = e = n = 20 ∴ Total number of nucleons = n + p = 40
∴ Element = Calcium

DPP No. # 12

1. $PE = -\frac{KZe^2}{r}$.

2.* Isotopes have same atomic number but different mass number.

3. Isobars have same mass number.

4.* Isotones have same number of neutrons.

5. Each has 10 electrons.

In CH_3^+ = 6 + 3 – 1 = 8 e

In H_3O^+ = 3 + 8 – 1 = 10 e

6.* Isoelectronic specis have same number of electrons.

7. $$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$$

$\Rightarrow \quad \frac{1}{2} = \left(\frac{A_1}{A_2}\right)^{1/3}$

$\Rightarrow \quad \frac{A_1}{A_2} = \frac{1}{8}$

ratio of atomic mass number.

8. $r_0 = \frac{4KZe^2}{M_0 v_0^2}$

$\Rightarrow \quad 2r_0 = \frac{4KZe^2}{M_0 v'^2}$

$\Rightarrow \quad r_0 {v_0}^2 = 2\, r_0\, v'^2$

$\Rightarrow \quad v' = \frac{v_0}{\sqrt{2}}$

9. Given $R = \frac{4KZe^2}{M_0 v_0^2}$

$\therefore \quad R' = \frac{4KZe^2}{M_0\left(\frac{v_0}{2}\right)^2} = 4R$

$\therefore \quad \%\text{ error} = \frac{4R - R}{R} \times 100 = 300\ \%.$

10. Use $\quad R = \frac{4Kze^2}{m_\alpha {v_\alpha}^2}$.

11. Definition

12. In one second, wave can travel distance = $\nu \times \lambda = 10 \times 2.5$ m = 25 m
In 40 seconds, it will travel = 25 × 40 m = **1000 m**.

DPP No. # 13

1. Maximum wave length will correspond to minimum frequency as $\lambda \propto \frac{1}{\nu}$, and that is given for red light in the spectrum.

$$\lambda_{max.} = \frac{C}{\nu_{min.}} = \frac{3 \times 10^8\, m/s}{4 \times 10^{14}\, m} = 750 \times 10^{-9}\ m.$$

$\Rightarrow \quad 7500$ Å.

2. $\lambda = \frac{C}{\nu} = \frac{3 \times 10^8\ m/s}{1200 \times 10^3\ s^{-1}} = 250$ m = 0.25 km.

$\bar{\nu}$ = Wave no. = $\frac{1}{\lambda} = \frac{1\,km}{0.25\ km}$ = 4 wave per km.

3. **(a)** $R = R_0 A^{1/3} \quad \therefore \quad \frac{4}{3}\pi R^3 = \frac{4}{3}\pi {R_0}^3 A$

$\therefore \quad V \propto A \quad \therefore \quad n = 1$

(b) $\bar{\nu} = \frac{\nu}{c} = \frac{7.5 \times 10^{14}}{3 \times 10^8} = 2.5 \times 10^6\ m^{-1}$

4. $\frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} = \frac{6000}{3000} = 2.$

5. Use $E = \frac{nhc}{\lambda}$, Here n is number of protons.

6. Photon absorb = $\frac{hc}{300 \times 10^{-9}} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{300 \times 10^{-9}} = 6.6 \times 10^{-19}$ Joule

One re-emitted photon energy = $\frac{hc}{500 \times 10^{-9}} = 3.96 \times 10^{-19}$ Joule

other photon have energy = $6.6 \times 10^{-19} - 3.93 \times 10^{-19} = 2.65 \times 10^{-19}$ Joule.

7. Use $E = \frac{nhc}{\lambda}$

$$60 \times 60 = \frac{n \times 6.64 \times 10^{-34} \times 3 \times 10^{8}}{620 \times 10^{-9}}$$

$n = 1.125 \times 10^{22}$

8. Energy of one photon = $\frac{12400}{6200}$ = 2 eV = 2 × 96 = 192 KJ mol^{-1}

$\therefore$ % of energy of photon converted to K.E. of A atoms = $\frac{192 - 144}{192} \times 100 = \frac{48}{192} \times 100$ = 25%

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

No. of emitted photons × Energy of emitted photon = $\frac{50}{100}$ × No. of absorbed photon × Energy of absorbed photon.

$\therefore$ $5x \times \frac{12400}{5000} = \frac{50}{100} \times 8x \times \frac{12400}{\lambda(Å)}$.

$\lambda(Å) = 4000$ Å

DPP No. # 14

1. For I experiment, $h\nu_1 = W + KE_{max1}$ .... (1)

For II experiment, $h\nu_2 = W + KE_{max2}$ .... (2)

here, $\nu_2 = 2\nu_1$ and $KE_{max2} = 3\,KE_{max1}$

$\therefore$ $2h\nu_1 = W + 3\,KE_{max1}$ .... (3)

From (1) and (3) : $h\nu_1 = 2KE_{max1}$ or $h\left(\frac{\nu_2}{2}\right) = 2\left(\frac{KE_{max\,2}}{3}\right)$

$\therefore$ % of incident energy converted into max KE in II experiment

$$= \frac{KE_{max\,2}}{h\nu_2} \times 100 = \frac{3}{4} \times 100 = 75\%.$$

2. The maximum KE of potoelectron is corresponding to maximum stopping = 18.6 eV

$\therefore$ $E_{incident} = W + KE_{max}$

$\frac{12400}{400}$ eV = W + 18.6 eV

W = 12.4 eV

$\therefore \quad \lambda_0 = \frac{12400}{12.4}$ Å = 1000 Å

3. Only for Single electron species.

4. $\frac{1}{\lambda_1} = RZ^2\left[\frac{1}{n_C} - \frac{1}{n_A}\right]$ .... (1)

$\frac{1}{\lambda_1} = RZ^2\left[\frac{1}{n_C} - \frac{1}{n_B}\right]$ .... (ii)

$\frac{1}{\lambda_3} = RZ^2\left[\frac{1}{n_B} - \frac{1}{n_A}\right]$

$\frac{1}{\lambda_3} = \frac{1}{\lambda_1} - \frac{1}{\lambda_2} = \frac{\lambda_2 - \lambda_1}{\lambda_1\lambda_2} = \frac{1}{3000}$

λ_3 = 3000 Å.

5. For $r = 0.52$ Å $\times \frac{12}{1}$

For L^{2+} $r_1 = 0.529 \times \frac{12}{3}$

$\frac{r}{r_1} = 3 \quad \Rightarrow \quad r_1 = \frac{r}{3}$

6. $r_4 - r_3 = 7 \times r_1$

7. Use $V_n = 2.185 \times 10^8 \left(\frac{z}{n}\right)$ cm/sec.

8. $PE = -\frac{KZe^2}{r}$.

9. $\frac{nh}{2\pi} = \frac{2h}{\pi} \quad \Rightarrow n = 4,$

P.E. = 2(T.E.) = $2\left(-13.6 \times \frac{2^2}{4^2}\right) = -6.8$ eV.

10. (A) $E_n^{-y} \propto r_n / Z$

$\left(\frac{Z^2}{n^2} \times 13.6 \text{ eV}\right)^{-y} \propto \frac{1}{z}\left(\frac{n^2}{Z} \times 0.529 \text{ Å}\right)$

y = 1

(B) $\ell_n \propto n^x \Rightarrow \frac{nh}{2\pi} \propto n^x \Rightarrow \quad x = 1$

(C) Potential energy = 2 (total energy)

(D) $T_n \propto \frac{n^3}{z^2} \quad \Rightarrow \quad t = -2 \quad \Rightarrow \quad m = -3.$

DPP No. # 15

1. $E_{\text{I Photon}} + E_{\text{II Photon}} = E_{\text{single Photon}}$

$hc\,\overline{v}_1 + hc\,\overline{v}_2 = \frac{hc}{\lambda}$

$\therefore\ \lambda = \dfrac{1}{\bar{\nu}_1 + \bar{\nu}_2} = \dfrac{1}{5.25 \times 10^8 + 7.25 \times 10^8} = \dfrac{1}{12.5 \times 10^8}$ = 8 x 10^{-10} m = 8 Å

2. Use : $E_1 - E_2\ /\ E_2 - E_3$

3. $\dfrac{r_1}{r_2} = \dfrac{1}{4} \Rightarrow \dfrac{r_3}{r_4} = \dfrac{9}{16} \Rightarrow \dfrac{r_2}{r_4} = \dfrac{1}{4}$

So corresponding energy of ratio $\dfrac{1}{4}$ is $E_2 - E_1$ and $E_4 - E_2$.

4. $\dfrac{R_1}{R_2} = \dfrac{4}{9} = \dfrac{n_1^2}{n_2^2}$, hence $\dfrac{n_1}{n_2} = \dfrac{2}{3}$ .So, $\dfrac{f_1}{f_2} = \dfrac{n_2^3}{n_1^3} = \dfrac{27}{8}$.

5. Electrostatic force of attraction $F \propto \dfrac{Z^3}{n^4}$

$\therefore\ \dfrac{(F_{n=3})_{He^+}}{(F_{n=2})_{Li^{2+}}} = \dfrac{2^3/3^4}{3^3/2^4} = \left(\dfrac{2}{3}\right)^7 = \left(\dfrac{3}{2}\right)^{-7}$ $\therefore$ x = –7 $\qquad F = \dfrac{KZe^2}{R^2}$

6. Order of energy $\rightarrow$ Violet > Blue > yellow > red

Order of energy $\rightarrow E_{2\rightarrow 1} > E_{5\rightarrow 2} > E_{6\rightarrow 3} > E_{4\rightarrow 3}$

$\therefore$ Violet ($2\rightarrow 1$), Blue ($5\rightarrow 2$), yellow ($6\rightarrow 3$), Red ($4\rightarrow 3$)

7.* BE for (n = 3) = 1.51 Z^2 = 12 eV (given)

$\therefore\ Z^2 = 12/1.51$

I Excitation potential = 10.2 Z^2 = 10.2 × (12/1.51) = 81V

II Excitation potential = 12.09 Z^2 = 12.09 × (12/1.51) = 96eV

Ionisation potential = 13.6 Z^2 = 13.6 (12/1.51) = 108 V

BE of (n = 2) = 3.4 Z^2 = 3.4 x (12/1.51) = 27eV

8. Let the given transition for both the species is $n_1 \rightarrow n_2$

Then $\quad X_{cm}^{-1} = R \times 2^2 \left[\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right]$ For He^+ ..... (i)

and $\quad$ (wave no.) $Be^{3+} = R \times 4^2 \left[\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right]$ For Be^{3+} ..... (ii)

From eq. (i) and (ii) (wave no.) Be^{3+} = 4x cm^{-1}.

DPP No. # 16

1. $\lambda = \dfrac{h}{p} = \dfrac{h}{mv} = \dfrac{h}{v^2}$

but $v^2 = \dfrac{2KE}{m}$ therefore $\lambda = \dfrac{hm}{2KE}$

2. Use $\quad C = \upsilon\lambda \Rightarrow \bar{u} = \dfrac{1}{\lambda}$

3. $K.E._{proton}$ = 1 + (1) (3) = 4 eV $\therefore\ \lambda_p = \dfrac{h}{\sqrt{2m_p(KE)_p}}$ & $KE_{\alpha\text{-particle}}$ = 20 – (2) (2) = 16 eV $\therefore\ \lambda_\alpha = \dfrac{h}{\sqrt{2m_\alpha(KE)_\alpha}}$

$\therefore\ \dfrac{\lambda_p}{\lambda_\alpha} = \sqrt{\dfrac{m_\alpha(KE)_\alpha}{m_p(KE)_p}} = \sqrt{\dfrac{4 \times 16}{1 \times 4}} = \dfrac{4}{1}$

4.* $4.25 = (W_0)_A + (K.E.)_A$

$4.70 = (W_0)_B + (K.E.)_A - 1.5$

So $(W_0)_B - (W_0)_A = 0.45 + 1.5$

$= 1.95$

Now , $\lambda_B = 2\lambda_A$

$$\frac{h}{\sqrt{2m(K.E)_B}} = \frac{2h}{\sqrt{2m(K.E)_A}}$$

So $(K.E)_A = 4\ (K.E)_B$

$4.25 - (W_0)_A = 4\ [\ 4.7 - (W_0)_B]$

$4(W_0)_B - (W_0)_A = 14.55$

So $(W_0)_B = 4.2\text{eV}$

So $(W_0)_A = 2.25$ eV

$(K.E.)_A = 2\text{eV}$

$(K.E)_B = 0.5\text{eV}$

5. number of revolutions per second

$$= \frac{V}{2\pi r} = \frac{2.18\times10^{6}\left(\frac{Z}{n}\right)}{2\times3.14\times0.529\times\left(\frac{n^2}{Z}\right)\times10^{-10}} = \frac{2.18\times10^{6}\left(\frac{1}{2}\right)}{2\times3.14\times0.529\times\left(\frac{2^2}{1}\right)\times10^{-10}}$$

Number of revolution in 10^{-8} second = $\dfrac{2.18\times10^{6}\left(\frac{1}{2}\right)}{2\times3.14\times0.529\times\left(\frac{2^2}{1}\right)\times10^{-10}} \times 10^{-8} = 8.2 \times 10^{6}$.

6. The ionisation energy of He^+ is 19.6×10^{-18} J.

$\therefore$ Energy of the first orbit of He^+ (Z = 2) = 19.6×10^{-18} J.

$\therefore$ Energy of the first orbit of H^+ (Z = 1) = $\dfrac{19.6\times10^{-18}}{4}$ J

$\therefore$ Energy of the first orbit of Li^{2+} (Z = 3) = $\dfrac{19.6\times10^{-18}}{4}\times9 = 4.41 \times 10^{-17}$ J.

7. **(A)** Transition $n \rightarrow 6$ to $n \rightarrow \infty$ For Li^{2+} sample

(B) Transition $n \rightarrow 1$ to $n \rightarrow 2$ For H-atom sample

(C) Transition $n \rightarrow 1$ to $n \rightarrow 3$ For He^+ sample

(D) Transition $n \rightarrow 1$ to $n \rightarrow \infty$ For H-atom sample

8. $\Delta E = \dfrac{12400}{1026} = 12.09$ eV.

So, $\Delta E = E_3 - E_1$.

Hence, induced radiations will be correspond to following energy transition

$E_3 \rightarrow E_1$, $E_3 \rightarrow E_2$ and $E_2 \rightarrow E_1$.

9. $-13.6\ \dfrac{Z^2}{n^2} = 4R = 4 \times 2.2 \times 10^{-18}$ J.

$Z^2 = \dfrac{4\times2.2\times10^{-18}\ J}{13.6\times1.6\times10^{-19}} = 4$; Z = 2.

$r = 0.529\ \dfrac{n^2}{Z} \times 10^{-10}$ m. $r = 0.529 \times 10^{-10} \times \dfrac{1}{2} = 2.645 \times 10^{-11}$ m.

DPP No. # 17

1. Z = 2 $n_1 = 2$ $n_2 = \infty$

$$\bar{\nu} = R\,(2)^2 \left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = R$$

2. $h\nu_1 = 13.6$ eV

$h\nu_2 = 13.6 \times 2^2$ eV

$h\nu_3 = 13.6 \times 2^2 \times \frac{3}{4}$ eV

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

$\Rightarrow \nu_2 = \nu_1 + \nu_3$

3. (i) Series limit of Lyman series $\Rightarrow n = \infty$ to $n = 1$.

(ii) Series limit of Balmer series $\Rightarrow n = \infty$ to $n = 2$.

$E_{n = 2 \text{ to } n = 1} = E_{n = \infty \text{ to } n = 1} - E_{n = \infty \text{ to } n = 2}$

$$\frac{hC}{\lambda} = \frac{hC}{\lambda_1} - \frac{hC}{\lambda_2}$$

$$\frac{1}{\lambda} = \frac{1}{\lambda_1} - \frac{1}{\lambda_2} \qquad \Rightarrow \qquad \lambda = \frac{\lambda_1\lambda_2}{\lambda_2 - \lambda_1}$$

4. Both the photons will not be absorbed by the electron of H-atom as the energy levels are quantised.

Sum of energies of both photons = $\frac{12400}{1240} + \frac{12400}{2000} = 10 + 6.2 = 16.2 \text{ eV} > (IE)_H$

5. (A) Only first four spectral lines belonging to Balmer series in hydrogen spectrum lie in visible region.
(B) If a light of frequency ν falls on a metal surface having work functional $h\nu$, photoelectric effect will take place only if $\nu \geq \nu_0$, since ν_0 is the minimum frequency required for photoelectric effect.

6. $\frac{\Delta n(\Delta n + 1)}{2} = 15$

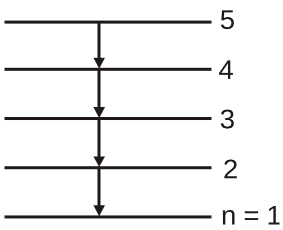
$\Rightarrow \Delta n = 5 \qquad \Rightarrow n - 2 = 5 \qquad \Rightarrow n = 7$

7. $\bar{\nu}_1 = R \times 3^2 \left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{4}$

$\bar{\nu}_2 = R \times \frac{3^2}{3^2} = R$

$\bar{\nu}_2 - \bar{\nu}_1 = \frac{5R}{4} - R = \frac{R}{4}$

8.



$$\frac{n_1}{n_3} = \frac{n_2}{n_4} = \frac{z_1}{z_2}$$

Clearly 2nd lowest energy is $4 \rightarrow 3$ transition
hence transition is Li^{2+} having same energy is $9 \rightarrow 12$

9. (A) $6 \rightarrow 3 \qquad \Delta n = 3$

$\therefore$ no. of lines = $\frac{3(3+1)}{2} = 6$. All lines are in infrared region

(B) $7 \rightarrow 3 \qquad \Delta n = 4$

$\therefore$ no. of lines = $\frac{4(4+1)}{2}$ = 10. All lines are in infrared region

(C) $5 \rightarrow 2$ $\Delta n = 3$

no. of lines = $\frac{3(3+1)}{2}$ = 6. All lines are in visible region

(D) $6 \rightarrow 2$ $\Delta n = 4$

no. of lines = $\frac{4(4+1)}{2}$ = 10. All lines are in visible region.

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

For 2 $\rightarrow$ 1 transition in H– atom sample, $\nu = Rc(1)^2 \left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \frac{3Rc}{4}$

$\therefore (H)_{2 \rightarrow 1} = (He^+)_{4 \rightarrow 2} = (Li^{2+})_{6 \rightarrow 3}$

Thus, given photon is not emitted from 8 $\rightarrow$ 3 transition in He^+ ion sample.

DPP No. # 18

1. Total spectral lines obtained from H-atom = 6

Total spectral lines obtained from He^+-ion = 6

One line is common between them so total number of lines are 11.

2. Balmer series lines lies in visible region.

3. $n_2 \rightarrow n_1$, max different spectral lines = 10

$\therefore \Delta n = n_2 - n_1 = 4$

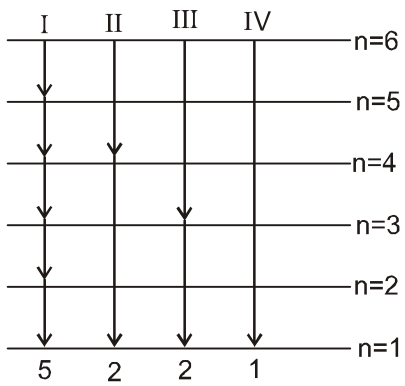
$\therefore$ change in angular momentum = $(\Delta n)\frac{h}{2\pi} = 4\left(\frac{h}{2\pi}\right) = 8\left(\frac{h}{4\pi}\right)$

$\therefore$ y = 8

4. $(Li^{2+})_{12 \rightarrow 3} = (H)_{4 \rightarrow 1}$

$\therefore$ No. of lines in infrared region = 1 ($4 \rightarrow 3$) paschen series

5.



$\therefore$ Minimum number of atoms required = 4

6. Let excited state be n.

Case - I : There is a transition to first exited state i.e. 2nd level from n^{th} level.

$$10.20 + 17.00 = 13.6\, Z^2 \left[\frac{1}{2^2} - \frac{1}{n^2}\right] \quad ..... (1)$$

Case - II : There is a transition to second excited state i.e. 3rd levle from n^{th} level.

$$4.25 + 5.95 = 13.6\, Z^2 \left[\frac{1}{3^2} - \frac{1}{n^2}\right] \qquad ..... (2)$$

on dividing (1) to (2), we have n^{th} level is **= 6.**
So, excited state is 5^{th}.
So, **n = 5.**

7. $n\lambda = 2\pi r \Rightarrow$ so $\lambda = \frac{2\pi r}{3} = \frac{2\pi}{3} \times (53 \text{ pm}) \times \frac{9}{2} \simeq 5\text{Å}$

8. Use formula $2\pi r_n = n\,\lambda$
We can't apply Bohr radius formula for Be^{2+}
$2\pi r_n = n\,\lambda$ l ¥kdk mi ; ksx djsa

9. $\frac{4}{n} = \frac{6}{3} \Rightarrow n = 2$ electron is present in 2^{nd} orbit of Be^{3+}. (Be^{3+} dsf}rh; d{kk esa mifLFkr bysDVªkWu½

$2\pi r = 2\,\lambda \Rightarrow \lambda = \pi r \Rightarrow r = 0.529 \times 10^{-10} \times \frac{2^2}{4} = 0.529 \times 10^{-10} = 0.529\text{Å}$.

DPP No. # 19

1. Only Spin quantum number (s) is not derived from Schrodinger wave equation.

5. number of electrons in subshells = 2 (2l + 1)

7. For n = 8 to n = 6, energy difference is minimum and $\lambda \propto \frac{1}{\text{Energy}}$

8. **S_1 :** Photoelectric effect can be explained on the basis of particle nature of electromagnetic radiations.
S_2 : n = 2, $\ell = 1$ ∴ 2p-orbital ∴ dumb-bell shaped.
S_3 : d_{xy} orbital has its lobes directed at an angle of 45º from X-axis and Y-axis. So, it has zero probability of finding electrons along X-axis and Y-axis.

9. **S_1 :** Angular momentum = mvr = $n\left(\frac{h}{2\pi}\right)$ ∴ Angular momentum ∝ n.
S_2 : An orbital can only accomodate 2 electrons with opposite spin.
S_3 : s-orbital is non-directional in nature, rest all orbitals are directional.

DPP No. # 20

1. n = 4, m = – 3 ∴ only possible value of ℓ is 3.

∴ Orbital angular momentum = $\sqrt{\ell(\ell+1)}\,\frac{h}{2\pi} = \frac{2\sqrt{3}\,h}{2\pi} = \frac{\sqrt{3}\,h}{\pi}$.

2. Z = 26 → $[Ar]4s^2 3d^6$
$\sqrt{n(n+2)} = \sqrt{24} \Rightarrow n = 4$
In d orbital number of unpaired electron = 4 , but element have charge so 4s electron have to be removed hence n+ = 2.

3. V (Z = 23), $[Ar]\ 4s^2 3d^3$ unpaired electron = 3 ;
Cr (Z = 24), $[Ar]\ 4s^1 3d^5$ unpaired electron = 6
Mn (Z = 25), $[Ar]\ 4s^2 3d^5$ unpaired electron = 5

4. For n = 4, $\ell \neq 4$, for $\ell = 3$, $m \neq 4$

5. Total spin = 3 $\Rightarrow \frac{n}{2} = 3$ $\Rightarrow$ n = 6

i.e. magnetic moment = $\sqrt{n(n+2)} = \sqrt{6(6+2)} = \sqrt{48}$ B.M.

6. 25^{Mn} – [Ar] $3d^5 4s^2$

Given $\sqrt{n(n+2)} = \sqrt{15} \Rightarrow n = 3$

Hence to have '3' unpaired electrons Mn must be in '+4' state.

7. Magnetic moment = $\sqrt{n(n+2)}$

8. Orbital angular momentum of electron

$= \sqrt{\ell(\ell+1)}\ \frac{h}{2\pi} \Rightarrow \sqrt{\ell(\ell+1)}\ \frac{h}{2\pi} = \sqrt{3}\frac{h}{\pi} \Rightarrow \ell = 3$

$\therefore$ number of orientations = $2\ell + 1 = 2 \times 3 + 1 = 7$

9. Configuration of the following elements

Cr^{3+} – [Ar] $3d^3$ clearly

Mn^{4+} – [Ar] $3d^3$ Fe^{3+} has 5 unpaired electrons and

Fe^{3+} – [Ar] $3d^5$ Cr^{3+}, Mn^{4+} has 3 unpaired electrons

10. Maximum possible number of electrons in an atom with $(n + \ell = 7)$ = 7s (2) + 6p (6) + 5d (10) + 4f (14) = 32

11. total spin = **± 1/2** × No. of Unpaired e^-

DPP No. # 21

1. Definition

2. $\lambda = \frac{12.3}{\sqrt{v}}$.

3. ${}_{16}S^{32}$ = $e^- = 16$

x^{+2} = $e^- = 16$

($\because$ A = Z+ N)

4. (B) has same number of electrons i.e., 18.

$[NH_3 \rightarrow BH_3]$ = 10 + 8 = 18.

5. E.C. $\rightarrow$ $1s^2,2s^2,2p^6,3s^2,3p^6,3d^1,4s^2$

6. (a) Co^{3+} : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$ $\therefore$ 4 unpaired electrons $\therefore \mu = \sqrt{4(4+2)}$ **=** $\sqrt{24}$ = 4.9 BM

(b) Number of radial nodes = $n - \ell - 1$

Number of radial nodes in 3p orbital = 3 – 1 – 1 = 1

(c) Number of electrons with (m = 0) in Mn^{2+} ($1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$) ion = 1s (2) + 2s (2) + 2p (2) + 3s (2) + 3p (2) + 3d (1) = 11

(d) Orbital angular momentum for the unpaired electron in V^{4+} lies in 3d orbital. $\therefore \ell = 2$

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

7. (a) $x + e^- \rightarrow x^-$

energy released = $E.A_1$ = 30.87 eV/atom

Let no. of moles of X be a

$\therefore$ $a \times N_A \times 30.87 = 4 \times N_A \times 4.526 + 4 \times N_A \times 13.6 + 4 \times N_A \times 12.75$ $\Rightarrow$ a = 4 moles.

8. Number of unpiared electron are given by

Magnetic moment = $\sqrt{[n(n+2)]}$ B.M.

where n is number of unpaired electrons

or $1.73 = \sqrt{[n(n+2)]}$ or $1.73 \times 1.73 = n^2 + 2n$ $\therefore$ n = 1

Now Vanadium atom must have one unpaired electron and thus its configuration is

$_{23}V^{4+}$: $1s^2$, $2s^2$ $2p^6$, $3s^2$ $3p^6$ $3d^1$

DPP No. # 22

8. A and D are isotpes. B, C and D are isobars.

9. **(i) p,s (ii) q,r (iii) p,s (iv) q,r**

10. Isotopic ($_{11}Na^{24}$) is less stable than $_{11}Na^{23}$ because it show radioactive decays. (Less stability of Na^{24} w.r.t. Na^{23} is also based upon $\frac{13}{11}\left(\frac{n}{p}\right)$. Higher value of $\frac{n}{p}$, higher will be unstability so it is disintegrated to attain the stability).

$_{11}Na^{24} \longrightarrow {}_{11}Na^{23} + {}_{0}n^{1}$

Less stable — stable — neutron

This neutron on decomposition to give proton and β^- particle ($_{-1}e^0$)

$_{0}n^{1} \longrightarrow {}_{1}H^{1}$ or $_{1}p^{1} + {}_{-1}e^{0}$

Proton — (β^- particle)

Hence, isotopic sodium is changed into sodium by means of emission of β^- emission.

11. (i) The atomic mass of an element reduces by 4 and atomic number by 2 on emission of an α-particle.

(ii) The atomic mass of an element remains unchanged and atomic number increses by 1 on emission of a β-particle.

Thus change in atomic mass on emission of 8α–particles will be $8 \times 4 = 32$

New atomic mass = old atomic mass – 32 = 238 – 32 = 206

Similarly change in atomic number on emission of 8α-particle will be : $8 \times 2 = 16$

i.e., New atomic number = old atomic number – 16 = 92 – 16 = 76

On emission of 6β-particles the atomic mass remains unchanged thus, atomic mass of the new element will be 206.

The atomic number increases by 6 unit thus new atomic nubmer will be 76 + 6 = 82

Thus, the equation looks like : $_{92}X^{238} \xrightarrow[-6\beta]{-8\alpha} {}_{82}Y^{206}$

12. (a) $^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{87}_{38}Sr + ^{147}_{54}Xe + 2\,^{1}_{0}n$

(b) $^{84}_{34}Se \longrightarrow ^{84}_{36}Kr + 2\,^{0}_{-1}e$

13. $^{23}_{11}Na \longrightarrow ^{23}_{10}Ne + ^{0}_{+1}e$; So ratio of atomic mass and atomic number $= \frac{23}{10}$.

14. $^{238}_{92}U \longrightarrow ^{214}_{82}Pb + 6(^{4}_{2}He) + 2(_{-1}e^{0})$

$\alpha = 6$, $\beta = 2$

Total = 8

15. $^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{142}_{54}Xe + ^{90}_{38}Sr + 4\,^{1}_{0}n$

(slow neutron)