Atomic Structure

EXERCISE-I

ELEMENTARY

Q.1 (1)

(1) It consists of proton and neutron and these are also known as nucleones.

Q.2 (3)

(3) Radius of nucleus $\simeq 10^{-15}$m.

Q.3 (2)

The β-ray particle constitute electrons.

Q.4 (3)

This is because chargeless particles do not undergo any deflection in electric or magnetic field.

Q.5 (2)

Mass of neutron is greater than that of proton, meson and electron.

Mass of neutron = mass of proton + mass of electron

Q.6 (3)

Proton is the nucleus of $H-$ atom ($H-$ atom devoid of its electron).

Q.7 (2)

According to quantum theory of radiation, a hot body emits radiant energy not continuously but discontinuously in the form of small packets of energy called quanta or photons.

Q.8 (2)

According to the Bohr model atoms or ions contain one electron.

Q.9 (1)

Q.10 (1)

Q.11 (1)

Q.12 (1)

According to Hydrogen spectrum series.

Q.13 (3)

Q.14 (4)

According to de-Broglie $\left(\lambda = \frac{h}{mv}\right)$.

Q.15 (3)

Q.16 (3)

Hund's rule states that pairing of electrons in the orbitals of a subshell (orbitals of equal energy) starts when each of them is singly filled.

Q.17 (1)

Principal quantum no. tells about the size of the orbital.

Q.18 (4)

If $n = 3$ then $l = 0, 1, 2$ but not 3.

Q.19 (2)

Hund's rule states that pairing of electrons in the orbitals of a subshell (orbitals of equal energy) starts when each of them is singly filled.

Q.20 (2)

Q.21 (4)

When $n = 3$ shell, the orbitals are $n^2 = 3^2 = 9$.

No. of electrons $= 2n^2$

Hence no. of orbital $= \frac{2n^2}{2} = n^2$.

Q.22 (4)

Orbitals are $4s, 3s, 3p$ and $3d$. Out of these 3*d* has highest energy.

Q.23 (2)

$N_7^{14} = 1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$.

Q.24 (3)

Q.25 (1)

JEE-MAIN
OBJECTIVE QUESTIONS

Q.1 (1)

Hydrogen atom contains 1 proton, 1 electron and no neutrons.

Q.2 (4)

$$\frac{(e/m)_e}{(e/m)_\alpha} = \frac{e/m_e}{2e/4\times1836\,m_e} = \frac{3672}{1}$$

Q.3 (1)

Volume fraction = $\frac{\text{Volume of nucleus}}{\text{Total vol. of atom}}$

$$= \frac{(4/3)\pi\,(10^{-13})^3}{(4/3)\pi\,(10^{-8})^3} = 10^{-15}$$

Q.4 (1)

Ne contains 10 electrons

O^{2-} contain 10 electrons

Q.5 (C)

$R = R_0 A^{1/3} = 1.3 \times 64^{1/3} = 5.2$ fm

Q.6 (1)

$r \alpha \left(\frac{n^2}{Z}\right)$ As Z increases, radius of I orbit decreases.

Q.7 (B)

$x \rightarrow y + {}_2He^4$

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

——————————————————————

Adding both eq.

$x \rightarrow {}_2He^4 + {}_8O^{18} + {}_1H^1$

By conservation of mass

X = 4 + 18 + 1 gm

= 23

23 gm → (2 + 10) moles neutrons.

$1 \text{ gm} \rightarrow \frac{12}{23}$ neutrone

$4.6 \text{ gm} \rightarrow \frac{12}{23} \times \frac{46}{10} = 2.4$ neutrans

Q.8 (2)

Given :

P = 1 kW

$P = 1 \times 10^3$ watt

$E = 10^3$ J/S in one sec

$v = 880$ Hz

$\therefore E = nhv$

$\Rightarrow 10^3 \; x \times 6.626 \times 10^{-34} \times 880$

$\Rightarrow x = 1.71 \times 10^{33}$ in one sec

Q.9 (3)

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

$$= \frac{1240}{31} = 40$$

K.E. max = 40 – 12.8

= 27.2 eV

$$\frac{1}{2} mv^2 = 27.2 \times 1.6 \times 10^{-19}$$

$$V^2 = \frac{54.4 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}$$

$V^2 = 9.56 \times 10^{12}$

$V = 3.09 \times 10^6$ m/sec.

Q.10 (1)

Photons or quanta

Q.11 (4)

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

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

$$\frac{E_1}{E_2} = \frac{4000}{2000} \Rightarrow \text{i.e. } \frac{\lambda_2}{\lambda_1} = 2$$

Q.12 (2)

$$\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{8 \times 10^{15}} = 3.75 \times 10^{-8} \text{ m}$$

Q.13 (1)

$$\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{400 \times 10^6} = 0.75 \text{ m}$$

Q.14 (3)

Violet colour has minimum wavelength so maximum energy.

Q.15 (1)

I.E. of one sodium atom $= \frac{hC}{\lambda}$

& I.E. of one mole Na atom $= \frac{hC}{\lambda} N_A$

$$= \frac{6.62 \times 10^{34} \times 3 \times 10^8 \times 6.02 \times 10^{23}}{242 \times 10^{-9}} = 494.65 \text{ kJ.mol.}$$

Q.16 (3)

For photoelectric effect to take place, $E_{light} \geq W$

$$\therefore \frac{hc}{\lambda} \geq \frac{hc}{\lambda_0} \text{ or } \lambda \leq \lambda_0 .$$

Q.17 (4)

Photoelectric effect is a random phenomena. So, electron It may come out with a kinetic energy less than (hν – w) as some energy is lost while escaping out.

Q.18 (D)

$$\text{Power} = \frac{nhC}{\lambda \times t} \Rightarrow 40 \times \frac{80}{100}$$

$$= \frac{n \times 6.62 \times 10^{-34} \times 3 \times 10^8}{620 \times 10^{-9} \times 20} \Rightarrow n = 2 \times 10^{21}$$

Q.19 (2)

We know that, for wave no.

$$\bar{\nu}_3 = \bar{\nu}_1 + \bar{\nu}_2$$

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

Q.20 (2)

$$r = 0.529 \times \frac{n^2}{Z} \text{ Å}$$

$$= 0.529 \times \frac{1^2}{1} \text{ Å}$$

$= 0.529 \times 10^{-10}$ m

$= 0.529 \times 10^{-8}$ cm

Q.21 (4)

$$\frac{r_3 = 0.529 \times 3^2/Z}{r_1 = 0.529 \times 1^2/Z}$$

$\therefore\ r_3 = 9r_1$

Q.22 (A)

$$\text{K.E. max} = \frac{hc}{\lambda} - \phi = 8 - 5 = 3\text{eV}$$

$\therefore\ V_0 = 3$ eV

Q.23 (1)

Refrence level is I^{st} orbit

itself T. E. = 0

Ratio becomes zero

Q.24 (4)

$r = \infty$

Q.25 (2)

$$\text{Radius} = 0.529\ \frac{n^2}{Z}\ \text{Å} = 10 \times 10^{-9}\ \text{m}$$

So, $n^2 = 189$ or, $n \approx 14$ **Ans.**

Q.26 (2)

$$E_1\ (H) = -\ 13.6 \times \frac{1^2}{1^2} = -13.6\ \text{eV}\ ;\ E_2\ (He^+)$$

$$= -\ 13.6 \times \frac{2^2}{2^2} = -13.6\ \text{eV}$$

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

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

$\therefore\ E_1(H) = E_2(He^+) = E_3\ (Li^{2+}) = E_4(Be^{3+})$

Q.27 (C)

$E_n = -78.4$ kcal/mole $= -78.4 \times 4.2 = -329.28$ kJ/mole

$$= -\frac{329.28}{96.5}\ \text{eV} = -3.4\ \text{eV}.$$ (energy of II orbit of H atom).

Q.28 (1)

$$V = 2.188 \times 10^6\ \frac{Z}{n}\ \text{m/s}$$

Now, $V \propto \frac{Z}{n}$ so, $\frac{V_{Li^{2+}}}{V_H} = -\frac{Z_1/n_1}{Z_2/n_2} = \frac{3/3}{1/1} = 1$ or,

$V_{Li^{2+}} = V_H$

Q.29 (A)

$IE_1 + IE_2 + IE_3 = 19800$

$IE_2 + IE_3 = 19800 - 520$

$IE_2 + IE_3 = 19280$

Q.30 (1)

$r_1 - r_2 = 24 \times (r_1)_H$

$$\frac{0.529 \times n_1^2}{1} - \frac{0.529 \times n_2^2}{1} = 24 \times 0.529$$

$$\therefore\ \left(n_1^2 - n_2^2\right) = 24$$

So, $n_1 = 5$ and $n_2 = 1$

Q.31 (C)

$$\text{I.P.} = 340\ \text{V so, I.E.} = 340\ \text{eV} = 13.6\ \frac{Z^2}{(1)^2}$$

so, $Z^2 = 25$ so, $Z = 5$ Therefore, (B) is correct option.

Q.32 (3)

(a) Energy of ground state of He^+ $= -13.6 \times 2^2$

$= -54.4$ eV (iv)

(b) Potential energy of I orbit of H-atom

$= -27.2 \times 1^2 = -27.2$ eV (ii)

(c) Kinetic energy of II excited state of

$$He^+ = 13.6 \times \frac{2^2}{3^2} = 6.04\ \text{eV}\ \ (i)$$

(d) Ionisation potential of He^+ $= 13.6 \times 2^2 = 54.4$ V (iii)

Q.33 (3)

S_1 : Be^{2+} ion has 2 electron so Bohr model is not applicable.

S_2, S_3 and S_4 are correct statement.

Q.34 (2)

S_1 : Potential energy of the two opposite charge system decreases with decrease in distance,

S_4 : The energy of Ist excited state of He$^+$ ion

$= -3.4\ Z^2 = -3.4 \times 2^2$

-13.6 eV.

S_2 and S_3 are correct statement.

Q.35 (4)

$$\frac{R}{R'} = \frac{0.529 \times 4}{0.529 \times 9}$$

$$R' = \frac{9R}{4}$$

= 2.25 R

Q.36 (1)

$$E_n = E_1 \frac{Z^2}{n^2}\ E_5 = -13.6 \times \frac{(1)^2}{(5)^2} = -0.54 \text{ eV}$$

Q.37 (4)

$$\lambda = \frac{hc}{\Delta E} \therefore \lambda \alpha \frac{1}{\Delta E}$$

Q.38 (2)

Bohr

Q.39 (2)

$r_1 = 0.529$ Å

$r_3 = 0.529 \times (3)^2$ Å $= 9x$

so, $\lambda = \frac{2\pi r}{n} = \frac{2\pi(9x)}{3} = 6\ \pi x$.

Q.40 (2)

$$T\ \alpha\ \frac{n^3}{Z^2}$$

$$\frac{T_1}{T_2} = \frac{1^3/1^2}{2^3/1^2} = \frac{1}{8}$$

Q.41 (B)

(i) $$\frac{U_{1,2}}{K_{1,Z}} = \frac{+2T.E._{1,2}}{-T.E._{1,Z}} = \frac{13.6 \times 2^2/1^2 \times 2}{+13.6 \times Z^2/1^2}$$

$$\Rightarrow \frac{8}{1} = \frac{2^2}{Z^2} \times 2$$

$Z = 1$

(ii) $$\frac{r_{1,Z}}{r_{2,1}} = \frac{0.529 \times \frac{1^2}{Z}}{0.529 \times \frac{2^2}{1}} = \frac{1}{8}$$

$$\frac{1}{4Z} = \frac{1}{8}$$

$Z = 2$

(iii)

$$\frac{V_{1,Z}}{V_{3,1}} = \frac{2.18 \times 10^6 \times Z/1}{2.18 \times 10^6 \times 1/3} = \frac{9}{1}$$

$\Rightarrow Z \times 3 = 9$

$\Rightarrow Z = 3$

(iv) $$\frac{T_{1,2}}{T_{2,Z}} = \frac{n^3/Z^2}{n^3/Z^2} = \frac{1^3/2^2}{2^3/Z^2} = \frac{9}{32}$$

$$\frac{Z^2}{2^3} = \frac{9}{32}$$

$Z = 3$

Q.42 (D)

Is → As it is the ground state

Q.43 (2)

Balmer means transition

to n = 2

1. line → 3 to 2
2. line → 4 to 2
3. line → 5 to 2

Q.44 (2)

$$\frac{1}{x} = R_H.4 \left\{\frac{1}{4} - 0\right\}$$

$$R_H = \frac{1}{x}$$

$$\frac{1}{\lambda} = R_H \times 9 \left\{\frac{1}{9} - \frac{1}{16}\right\}$$

$$\frac{1}{\lambda} = \frac{1}{x} \times 9 \left\{\frac{16-9}{144}\right\}$$

$$\frac{1}{\lambda} = \frac{1}{x} \times 9 \left\{\frac{7}{144}\right\}$$

$$\frac{1}{\lambda} = \frac{7}{16x}$$

$$\lambda = \frac{16x}{7}$$

Q.45 (2)

$$\frac{1}{\lambda} = 109677 \times 9$$

$$\lambda = 1.01 \times 10^{-6} \text{ cm}$$

$$E = \frac{6.62\times10^{-34}\times3\times10^{8}}{1.01\times10^{-8}}$$

$$= 19.66 \times 10^{-18} \text{ J}$$

$$\Rightarrow \frac{1}{2}mv^2 = 19.66 \times 10^{-18}$$

$$V^2 = \frac{39.32\times10^{-18}}{9.1\times10^{-31}}$$

$$V^2 = 4.32 \times 10^{13}$$

$$V^2 = 43.2 \times 10^{12}$$

$$V = 6.57 \times 10^{6}$$

$$\lambda_{\text{debroglie}} = \frac{6.62\times10^{-34}}{9.1\times10^{-31}\times6.57\times10^{6}}$$

$$= 1.17 \times 10^{-10} \text{ m}$$

$$= 1.17 \text{ Å}$$

Q.46 (2)

$$\frac{1}{\lambda_1} = R_H\left(1-\frac{1}{4}\right)$$

$$\frac{1}{\lambda_1} = R_H \times \frac{3}{4}$$

$$\lambda_1 = \frac{4}{3\,R_H}$$

$$\lambda_2 = \frac{9}{8\,R_H}$$

$$\lambda_1 - \lambda_2 = \frac{1}{R_H}\left\{\frac{9}{8}-\frac{16}{15}\right\}$$

$$= \frac{1}{R_H}\left\{\frac{32-27}{24}\right\} = \frac{1}{R_H}\left\{\frac{5}{24}\right\}$$

$$\lambda_2 = \frac{9/8}{R_H}$$

$$\lambda_3 = \frac{16}{15R_H}$$

$$\lambda_2 - \lambda_3 = \frac{1}{R_H}\left\{\frac{4}{3}-\frac{9}{8}\right\}$$

$$= \frac{1}{R_H}\left\{\frac{135-128}{120}\right\} = \frac{1}{R_H} \times \frac{7}{120}$$

$$\text{ratio} = \frac{5/24}{7/120} = 3.5$$

Q.47 (1)

$$\frac{1}{\lambda_{\text{Lymen}}} = R_H\left\{1-\frac{1}{4}\right\}$$

$$\lambda_{\text{Lymen}} = \frac{4}{3R_H}$$

$$\frac{1}{\lambda_{\text{Balmer}}} = R_H \times 4\left\{\frac{1}{4}-\frac{1}{16}\right\}$$

$$\lambda_{\text{Balmer}} = \frac{16}{8\times3R_H}$$

$$\frac{\lambda_{\text{Lymen}}}{\lambda_{\text{Balmer}}} = \frac{4/3R_H}{4/3R_H} = \frac{1}{1} \qquad 1:1$$

Q.48 (3)

$$(n_2^2 - n_1^2) = 8$$

$$(n_2 - n_1)(n_2 + n_1) = 8$$

$$\therefore (n_2 - n_1) = 8/4$$

$$n_2 - n_1 = 2$$

$$n_2 + n_1 = 4$$

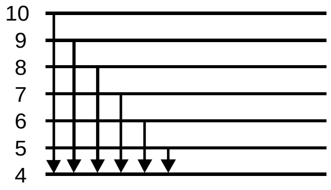
$$\therefore n_2 = 3$$

$$n_1 = 1$$

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

$$\lambda = \frac{9}{32\,R_H}$$

Q.49 (2)



First Excited level = 2

∴ ninth level = 10

Total line = 6

Q.50 (2)

When electron falls from n to 1, total possible number of lines = n – 1.

Q.51 (1)

Li^{2+} and He^{+} are single electron species.

Q.52 (3)

Visible lines ⇒ Balmer series

(5 → 2, 4 → 2, 3 → 2). So, 3 lines.

Q.53 (4)

$$\frac{1}{\lambda} = R_H \times 4 \left\{\frac{1}{9} - \frac{1}{16}\right\}$$

$$\frac{1}{m} = R_H \times \frac{7}{36}$$

$$\frac{1}{\lambda_{required}} = \frac{36}{7m} \times 16 \left\{\frac{1}{9}\right\}$$

$$\frac{1}{\lambda_{required}} = \frac{36}{7m} \times 16 \left\{\frac{1}{9}\right\}$$

$$\lambda_{req.} = \frac{7m}{64}$$

Q.54 (3)

infrared lines = total lines – visible lines – UV lines

$= \frac{6(6-1)}{2} - 4 - 5 = 15 - 9 = 6.$

(visible lines = 4   6→2, 5→2, 4→2, 3→2)

(UV lines = 5   6→1, 5→1, 4→1, 3→1, 2→1)

Q.55 (4)

According to energy, $E_{4\to1} > E_{3\to1} > E_{2\to1} > E_{3\to2}$.

According to energy, Violet > Blue > Green > Red.

∴ Red line ⇒ → 2 transition.

Q.56 (4)

For 1st line of Balmer series

$$\bar{v}_1 = R_H (3)^2 \left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] = 9R\left(\frac{5}{36}\right) = \frac{5}{4}R$$

For last line of Pachen series

$$\bar{v}_2 = R_H (3)^2 \left[\frac{1}{(3)^2} - \frac{1}{(\infty)^2}\right] = R \text{ so, } \bar{v}_1 - \bar{v}_2 =$$

$$\frac{5}{4}R - R = \frac{R}{4}.$$

Q.57 (3)

For an α particle, $\lambda = \frac{0.101}{\sqrt{V}}$ Å.

Q.58 (2)

$$\lambda \propto \frac{n}{Z} \quad \therefore \frac{n_1}{Z_1} = \frac{n_2}{Z_2}$$

or $\frac{2}{3} = \frac{4}{6}$ (n = 4 of C^{5+} ion).

Q.59 (1)

For a charged particle $\lambda = \frac{h}{\sqrt{2mqV}}$, ∴ $\lambda \propto \frac{1}{\sqrt{V}}$.

Q.60 (C)

$$\frac{1}{2} mV^2 = 6 \times 1.6 \times 10^{-19}$$

$$V^2 = \frac{12 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}$$

$V^2 = 2.10 \times 10^{12}$

$V = 1.44 \times 10^{6}$ m/sec

$$\lambda = \frac{6.62 \times 10^{-34}}{1.44 \times 10^{6} \times 9.1 \times 10^{-31}}$$

$= 0.5 \times 10^{-9}$

$$\Delta x . \frac{\Delta\lambda}{0.25 \times 10^{-18}} = \frac{1}{\lambda}$$

$$\frac{7}{22} \times 10^{-9} \times \frac{\Delta\lambda}{0.25 \times 10^{-18}} = \frac{1}{4\pi}$$

$$\Delta\lambda = \frac{0.25 \times 10^{-9}}{4}$$

$= 0.0625 \times 10^{-9}$

= 0.625 Å

Q.61 (4)

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

Q.62 (1)

Mass of α particle = 4 (mass of proton)

Mass of proton = 1840 (mass of e^-)

Let

Mass of e^- = m

∴ Mass of p^+ = 1840 m

and mass of α particle = 7360 m

$$\frac{1}{2} meV^2 = 16 E$$

$$V_e^2 = \frac{32E}{m}$$

$$V_p^2 = \frac{8E}{1840m}$$

$$V_\alpha^2 = \frac{E}{7360m}$$

Q.63 (2)

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

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

$$\frac{dp}{d\lambda} = \frac{d}{d\lambda}\left(\frac{L}{A}\right)$$

$$\left|\frac{dp}{d\lambda}\right| = \left|\frac{-h}{\lambda^2}\right|$$

$$dp = \frac{h}{\lambda^2}.\Delta\lambda$$

$$\therefore\ \Delta x\ .\ \frac{h}{\lambda^2}\ \Delta\lambda \geq \frac{h}{4\pi}$$

$$\Delta x\ .\ \frac{\Delta\lambda}{\lambda^2} = \frac{1}{4\pi}$$

$$\Delta x = \frac{\lambda}{\Delta\lambda} \times \frac{1}{4\pi}$$

$$= \frac{(5 \times 10^{-7})^2}{10^{-12} \times 4\pi}$$

Ans. 0.0199 m

Q.64 (3)

$\Delta p\ .\ \Delta x = \dfrac{h}{4\pi} \Rightarrow \Delta x = \dfrac{6.62 \times 10^{-34}}{4 \times 3.14 \times 1 \times 10^{-5}} = 5.27 \times 10^{-30}$ m.

Q.65 (3)

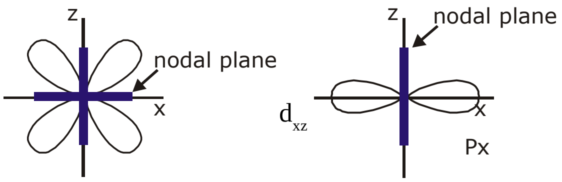
$\lambda = \dfrac{h}{mv} = \dfrac{6.626 \times 10^{-34}}{3.1 \times 10^{-31} \times 3 \times 10^{8} \times 10/100} = 2.4 \times 10^{-9}$ cm

Q.66 (1)

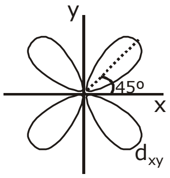
5-fold degenerate

All d-orbitals are of same energy.

Q.67 **(3)**



Q.68 (3)



Q.69 (A)

As graph is not starting from origin.

$\therefore$ For s-subshell with 1 radial no.

i.e., $n - \ell - 1 = 1$

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

$\therefore$ 2s

Q.70 (A)

Graph must be in increasing order

Q.71 (B)

$\Psi = 0$ at only one point.

Q.72 (4)

Q.73 (2)

Na^+, Co^{+2}, Cr^{2+}, Fe^{+3}

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

we get Na^+, Co^{+2}, Cr^{2+}, Fe^{+3}

Q.74 (2)

O.A.M. $= \dfrac{h}{2\pi}\sqrt{\ell(\ell+1)}$

here $l = 0$

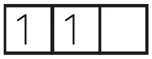
OAM = zero

Q.75 (4)

Spin

Q.76 (1)

$_6C \rightarrow 1s^2\ 2s^2\ 2p^2$



Q.77 (3)

5p, as using (n + l) rule energy of 5p > 4d

Q.78 (1)

Orbital angular momentum $= \sqrt{\ell(\ell+1)}\ \dfrac{h}{2\pi} = 0.$

$\therefore\ \ell = 0$ (s orbital).

Q.79 (4)

Cu : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$.

$\therefore$ Cu^{2+} : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$ or $[Ar]3d^9$.

Q.80 (1)

Magnetic moment = $\sqrt{n(n+2)}$ = $\sqrt{24}$ B.M.

$\therefore$ No. of unpaired electron = 4.

X_{26} : $1s^2\ 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$.

To get 4 unpaired electrons, outermost configuration will be $3d^6$.

$\therefore$ No. of electrons lost = 2 (from $4s^2$).

$\therefore$ n = 2.

Q.81 (4)

10 electrons → Neon

Q.82 (4)

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

$Fe^{2+} \rightarrow 4s^0\ 3d^6$

$$\underbrace{\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}}_{6\ e^-}$$

$_{17}Cl^- \rightarrow \underbrace{3s^2\ 3p^6}_{6\ e^-}$

Q.83 (2)

$\sqrt{n(n+2)}$ = $\sqrt{35}$

$\therefore$ n = 5

$x^{3+} \rightarrow 4s^o\ 3d^5$

$x \rightarrow 4s^2\ 3d^6$

i.e., $_{26}Fe$

Q.84 (2)

Zn^{2+} : [Ar] $3d^{10}$ (0 unpaired electrons).

Fe^{2+} : [Ar] $3d^6$ (4 unpaired electrons) maximum.

Ni^{3+} : [Ar] $3d^7$ (3 unpaired electrons).

Cu^+ : [Ar] $3d^{10}$ (0 unpaired electrons).

Q.85 (4)

d^7 : 3 unpaired electrons.

$\therefore$ Total spin = $\pm\ \frac{n}{2}$ = $\pm\ \frac{3}{2}$.

Q.86 (1)

X_{23} : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2$.

No. of electron with ℓ = 2 are 3 ($3d^3$).

Q.87 (B)

Cr (Zn = 24)

electronic configuration is : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

so, no of electron in ℓ = 1 i.e. p subshell is 12 and no of electron in ℓ = 2 i.e. d subshell is 5.

Q.88 **(1)**

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

$1s \rightarrow 0$

$3s \rightarrow 0$ } ($\because$ ℓ = 0 for s)

For 3d = $\frac{h}{2\pi}\sqrt{2(2+1)}$ (ℓ = 2 for d)

= $\hbar\sqrt{6}$

Q.89 (4)

Cl_{17}^- : [Ne] $3s^2\ 3p^6$.

Last electron enters 3p orbital.

$\therefore$ ℓ = 1 and m = 1, 0, –1.

Q.90 (3)

Number of radial nodes = n – ℓ – 1 = 1, n = 3.

$\therefore$ ℓ = 1.

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

Q.91 (3)

Cl_{17} : [Ne] $3s^2\ 3p^5$.

Unpaired electron is in 3p orbital.

$\therefore$ n = 3, ℓ = 1, m = 1, 0, – 1.

Q.92 (1)

$\mu = \sqrt{n(n+2)}$

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

$\therefore$ no of unpaired e^- = 1

$\mu = \sqrt{1(1+2)}$ = $\sqrt{3}$ = 1.732

Q.93 (3)

nℓ no. of e^-

3s $\ell = 0 \rightarrow s$

Q.94 (1)

$_{30}Zn^{2+} \rightarrow 3d^{10}\ 4s^0$

no. of unpaired e^- = 0

JEE-ADVANCED
OBJECTIVE QUESTIONS

Q.1 (A)

$$E = \frac{hc}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^{8}}{854\times10^{-10}}$$

For 1 mole

$$E_{mole} = \frac{6.626\times10^{-34}\times10^{18}\times3\times6.022\times10^{23}}{854}$$

$$= \frac{6.626\times10^{7}\times3\times6.022}{854}$$

$= 0.140 \times 10^{7}$ J/mole

$= 1.4 \times 10^{3}$ KJ/mole **Ans.**

Q.2 (A)

Energy = Charge × volts

$= 1.6 \times 10^{-19} \times 4.5$ J

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

$$\bar{\nu} = \frac{1.6\times10^{-19}\times4.5}{6.62\times10^{-34}\times3\times10^{8}}$$

$= 3.63 \times 10^{6}$ m^{-1} **Ans.**

Q.3 (D)

$$V = \frac{\lambda}{T}$$

$V = \lambda.\ \nu$

$3 \times 10^{8} = \lambda \times 5 \times 10^{13}$

$$\lambda = \frac{3}{5} \times 10^{-5}$$

$= 0.6 \times 10^{-5}$ m

$$E = \frac{6.6\times10^{-34}\times3\times10^{8}}{0.6\times10^{-5}} \Rightarrow 33 \times 10^{-21}$$

$$\text{No. of photons} = \frac{330}{33\times10^{-21}}$$

$= 10^{22}$ photons **Ans.**

Q.4 (C)

$$E_{photon} = \frac{hc}{\lambda}$$

$$= \frac{1240}{550} = 2.25 \text{ eV}$$

$$\text{no. of photons} = \frac{10^{-17}}{2.25\times1.6\times10^{-19}}$$

$= 0.277 \times 10^{2}$

$= 27.7$ photons = 28 photons **Ans.**

Q.5 (C)

ol. $\lambda = 58.44$ nm

$$\bar{\nu} = \frac{1}{\lambda} = \frac{10^{7}}{58.44} \text{ cm}^{-1} = 17115.67 \text{ cm}^{-1}$$

$\bar{\nu}_{req.} = 17115.67 - 485.7$

$= 166258.67$ cm^{-1}

$$\therefore\ E = \frac{hc}{\lambda} = hc\,\bar{\nu}$$

$= 6.62 \times 10^{-34} \times 3 \times 10^{8} \times 16625867$

$= 3.3 \times 10^{8} \times 10^{8} \times 10^{-34}$

$= 3.3 \times 10^{-18}$ J **Ans.**

Q.6 (A)

Let absored e^{-} be n_1

and emitted e^{-} be n_2

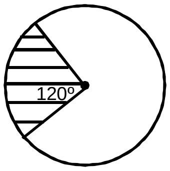
$$\frac{\frac{n_2hc}{\lambda_2}}{\frac{n_1hc}{\lambda_1}} = \frac{E\times\frac{47}{100}}{E}$$

$$\frac{n_2\lambda_1}{n_1\lambda_2} = \frac{47}{100}$$

$$\frac{n_2}{n_1} = \frac{47\times5080}{100\times4530}$$

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

Q.7 B)



The photons will strike the metal like only on shaded part and rest photons will escape out.

$\therefore$ Part Qd circular disc where

$$\text{photons will strike} = \frac{120}{360} = \frac{1}{3}$$

$\therefore$ $\frac{1}{3}$ rd part the disc.

Total energy = 90 J per sec.

$$E_{phaton} = \frac{1240}{400} = 3.1 \text{ eV}$$

No. of photons = $\dfrac{90}{3.1\times10^{-19}\times1.6}$

No. of photo e$^-$ ejected = $\dfrac{90}{3.1\times1.6\times10^{-19}}\times\dfrac{1}{3}$

$\therefore$ Magnitude of Photocurrent

$\equiv \dfrac{90}{3.1\times1.6\times10^{-19}}\times\dfrac{1}{3}\times1.6\times10^{-19}$

$= \dfrac{90}{3.1\times3}$ = 9.78 amp = 10 amp **Ans.**

Q.8 (D)
Stopping potential depends on metal surface or emitter's properties.

Q.9 (B)
$r_{H(1s\ orbit)} = 0.529 \times 10^{-10}$m
r_e = 16 × 0.529 × 10^{-10} m
= 16 × 0.529 Å

T. E. = $-\dfrac{1}{2}\ \dfrac{KZe^2}{r}$

$= -\dfrac{1}{2}\times\dfrac{9\times10^9\times1\times1.6\times.1.6\times10^{-19}\times10^{-19}}{16\times0.529}$

$\Rightarrow -13.6 \times 10^{-20}$ J $\Rightarrow$ -1.36×10^{-19} J **Ans.**

Q.10 (B)
r = 0.85 nm
= 8.5 Å

8.5 = 0.529 $\dfrac{n^2}{Z}$

$n^2 = \dfrac{8.5}{0.529}$

$n^2 = 16 \Rightarrow n = 4$

V = 2.18 × 10^6 × $\dfrac{z}{n}$ m/s

= 2.18 × 10^6 × $\dfrac{1}{4}$

= 5.45 × 10^5 m/sec **Ans.**

Q.11 (B)

$-3.4 = -13.6 \times \dfrac{z^2}{n^2}$

$n^2 = 4$

n = 2 (Angular momentum = $\dfrac{nh}{2\pi} = \dfrac{2h}{2\pi} = \dfrac{h}{\pi}$)

$\dfrac{h}{\pi}$ **Ans.**

Q.12 (D)

$\dfrac{T_1}{T_2} = \dfrac{n_1^3}{n_2^3} = \dfrac{1^3}{2^3} = \dfrac{1}{8}$.

$\because \left(T = \dfrac{2\pi r}{V}\right)$ so, $T \propto \dfrac{n^3}{Z^2}$

Q.13 (C)

$\dfrac{r_1}{r_2} = \dfrac{n_1^2}{n_2^2} = \dfrac{R}{4R} \Rightarrow \dfrac{n_1}{n_2} = \dfrac{1}{2}\ \therefore\ \dfrac{T_1}{T_2} = \dfrac{n_1^3}{n_2^3} = \dfrac{1}{8}$.

Q.14 (A)

Vel. of e$^-$ in n = 2 = 2.18 × 10^6 × $\dfrac{z}{n}$

= 1.09 × 10^6 m/s
Dist^n travelled in 10^{-8} sec = 1.09 × 10^6 ×10^{-8}
= 1.09 ×10^{-2} m
Circum ference = 2πr
= 2 × π × 0.529 × 4 × 10^{-10}
= 4.23 π × 10^{-10} m

$\therefore$ revolutions = $\dfrac{1.09\times10^{-2}}{4.23\pi\times10^{-10}}$

= 0.08 × 10^8 rev
= 8 × 10^6 rev **Ans.**

Q.15 (A)

$f_{rev} = \dfrac{V}{2\pi r}$

$= \dfrac{2.18\times10^6\times7}{2\times22\times0.529\times10^{-10}}$

= 0.6556 × 10^{16} Hz
= 6556 × 10^{12} Hz **Ans.**

Q.16 (B)
IP = 13.6Z^2 = 16 (given).

1st excitation potential = 13.6 × $\dfrac{3}{4}$ × Z^2

= 16 × $\dfrac{3}{4}$ = 12 V.

IP = 13.6Z^2 = 16 (given).

Q.17 (A)
Angular momentum J = mvr

$J^2 = m^2v^2r^2$

or $\frac{J^2}{2} = \left(\frac{1}{2}mv^2\right)mr^2$ or K.E. = $\frac{J^2}{2mr^2}$

Q.18 (D)

$$I_n = \frac{eV_n}{2\pi r_n} = \frac{e\times\left(\frac{2\pi Ke^2}{nh}\right)}{2\pi\times\left(\frac{n^2h^2}{4\pi^2me^2K}\right)} = \frac{4\pi^2mk^2e^5}{n^3h^3}.$$

Q.19 (D)

Energy required per atom = $\frac{192000}{6.022\times10^{23}}$

$= 31883.09 \times 10^{-23}$ J

$= \frac{31.88\times10^{-20}}{1.6\times10^{-19}}$

$= 19.92 \times 10^1$

= 1.992 eV

= 2 eV

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

$= \frac{1240}{1992} = 623.11$ nm

⇒ 6231.1 Å **Ans.**

Q.20 (B)

no. of photons = $\frac{0.01\times6\times10^{23}}{0.2}$

$= 3 \times 10^{22}$ **Ans.**

Quantum yield = $\frac{\text{Molecules reacting}}{\text{quanta absorbed}}$

Q.21 (B)

Energy per molecule = $\frac{243000}{6.022\times10^{23}}$

$= 40.35 \times 10^{-20}$

$40.35 \times 10^{-20} = \frac{6.62\times10^{-34}\times3\times10^8}{\lambda}$

$\lambda = 4.9 \times 10^{-7}$ m **Ans.**

Q.22 (C)

Energy required per molecule = 450530 J

$= \frac{6.62\times10^{-34}\times3\times10^8}{253.7\times10^{-9}}$

$= 0.078 \times 10^{-17}$ J

$= 0.078 \times 10^{-17} \times 10^{23} \times 6.02$ J/mol

$= 0.47 \times 10^6$ J/mol

K. E. = 470 – 430.53

= 39.47 KJ

% $= \frac{39.47}{470}\times100$

= 8.38% **Ans.**

Q.23 (A)

$\sqrt{\nu} = a(z-b) = \sqrt{\frac{c}{\lambda}} = a\,(29-b)$

or $\sqrt{\frac{3\times10^8}{15.42\times10^{-9}}} = a\,(29-b)$

or $13.94 \times 10^7 = 1\,(29-b)$

.............(1)

also,

$\sqrt{\frac{3\times10^8}{7.12\times10^{-9}}} = a\,(29-b)$

$\Rightarrow 20.52 \times 10^7 = a(29-b)$

..............(2)

Dividing eq. (1) and (2)

$\frac{13.94}{20.52} = \frac{29-b}{42-b}$

Solving we get

$b = \frac{60}{47} = 1.27$

$\therefore\ a = \frac{20.52\times10^7}{(42-1.27)} = 0.5 \times 10^7$

$\Rightarrow \sqrt{\frac{3\times10^8}{22.85\times10^{-9}}} = 0.5 \times 10^7\,(z-1.27)$

$11.45 \times 10^7 = 0.5 \times 10^7\,(z-1.27)$

$z = 22.9 + 1.27 \approx 24$ **Ans.**

Q.24 (A)

$\lambda = \sqrt{\frac{150}{\text{volt}}}$ Å

$= \sqrt{\frac{150}{100\times10^3}}$

$= \sqrt{15\times10^{-4}}$

= 0.0387 Å

= 3.88 pm **Ans.**

Q.25 (B)

Total energy = $\frac{13.6\,Z^2}{n^2} = \frac{13.6(Z)^2}{(4)^2}$ = 3.4 eV

Now K.E. = 3.4 – 1.4 = 2 eV

Now, Total energy = 2 + 4 = 6 eV i.e. potential = 6 V

For electron $\lambda = \sqrt{\frac{150}{V}}$ so λ = 5 Å.

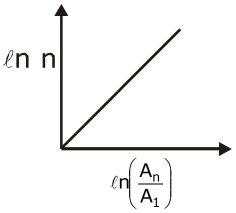
Q.26 (A)

Number of lines in Balmer series = 2.

$\therefore$ n = 4 (lines will be 4 → 2, 3 → 2).

KE of ejected photoelectrons = $E_{photon} - BE_n$ = 13 – $\frac{13.6}{4^2}$ = 13 – 0.85 = 12.15 eV.

Q.27 (B)



$$\ell n\left(\frac{A_n}{A_1}\right) = \ell n\left(\frac{4\pi r_n^2}{4\pi r_1^2}\right) = \ell n\left(\frac{r_n}{r_1}\right)^2$$

$$= \ell n\left(\frac{0.529\times n^2/1}{0.529\times 1^2/1}\right) = \ell n\left(n^4\right)$$

= 4 ℓn(n)

Using the straight line eq. with zero intercept

y = mx

comparing the eq. we get slope = 4 & line passing through origin.

Q.28 (C)

(C)

For Lymen series

$$\frac{1}{\lambda} = R_H Z^2\left(1-\frac{1}{n_2^2}\right) = 109700\left(1-\frac{1}{16}\right)$$

$$\frac{1}{\lambda} = 109700 \times \frac{15}{16}$$

$$\frac{1}{\lambda} = 102843.75$$

$\lambda = 9.72 \times 10^{-6}$ cm

$\lambda = 9.72 \times 10^{-8}$ m **Ans.**

Q.30 (C)

λ = 1093.6 nm

= 1093.6×10^{-9} m

$$\frac{1}{1093.6\times10^{-9}} = R_H Z^2\left(\frac{1}{3^2} - \frac{1}{n^2\ \text{wight}}\right)$$

$$\frac{9.14\times10^5}{10973000} = \left(\frac{1}{9} - \frac{1}{n^2}\right)$$

$$0.083 = \frac{1}{9} - \frac{1}{n^2}$$

$$\frac{1}{n^2} = \frac{1}{9} - 0.083$$

$$\frac{1}{n^2} = 0.11 - 0.083$$

n^2 = 35.93

n = 6 **Ans.**

Q.31 (A)

$$\frac{1}{\lambda} = 109700\left(\frac{1}{4} - \frac{1}{16}\right)\times 1^2$$

$$\frac{1}{\lambda} = 109700 \times \frac{3}{16}$$

$$\frac{1}{\lambda} = 20568.75$$

$\lambda = 4.861 \times 10^{-5}$ cm

= 4863 Å **Ans.**

Q.32 (B)

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

$$\lambda_1 - \lambda_2 = \frac{1}{R_H Z^2\left(\frac{1}{4}-\frac{1}{9}\right)} - \frac{1}{R_H Z^2\left(\frac{1}{1}-\frac{1}{4}\right)}$$

$$10^{-9} \times 133.7 = \frac{1}{R_H}\times\frac{1}{4}\left[\frac{36}{5} - \frac{4}{3}\right]$$

$$10^{-9} \times 133.7 = \frac{1}{R_H}\left[\frac{9}{5} - \frac{1}{3}\right]$$

$10^{-9} \times 133.7 = \frac{1}{R_H}\left[\frac{22}{15}\right]$

$\frac{1}{R_H} = \frac{133.7 \times 15 \times 10^{-9}}{22}$

$\Rightarrow R_H = 0.01096 \times 10^{+9}$
$= 1.096 \times 10^{7}\ \text{m}^{-1}$

Q.33 (D)

$\frac{1}{\lambda} = 109700 \times 4 \left[\frac{1}{4} - \frac{1}{16}\right]$

$\frac{1}{\lambda} = 109700 \times \left[\frac{1}{1} - \frac{1}{4}\right]$

$\frac{1}{\lambda} = 109700 \times \frac{3}{4}$

$\lambda = 1.21 \times 10^{-5}$
For Hydrogen

$109700 \times \frac{3}{4} = 109700 \times 1 \left[1 - \frac{1}{n^2}\right]$

$\frac{1}{n^2} = 1 - \frac{3}{4}$

n = 2
i.e., transition from n = 2 to n = 1 **Ans.**

Q.34 (A)
For visible region i.e. balmer series $n_1 = 2$ and for min energy transfer = $n_2 = 3$

$\frac{1}{\lambda} = R_H\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = 1.1 \times \frac{5}{30} \times 10^{7}\ \text{m}^{-1}$

$\lambda = 6.55 \times 10^{-7}$ m

$E = \frac{hc}{\lambda} = \frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{6.55 \times 10^{-7}}$

$= 3.032 \times 10^{-19}$ J
For 1 gm atom
Total energy = $E \times N_A$
$= 3.032 \times 10^{-19} \times 6.022 \times 10^{23}$
$= 18.25 \times 10^{4}$ J
$= 182.5 \times 1$ KJ
$= 1.825 \times 10^{5}$ J/mol **Ans.**

Q.35 (B)

$\frac{1}{\lambda} = 109700 \times 9 \left(\frac{1}{1} - \frac{1}{9}\right)$

$\lambda = \frac{1}{109700 \times 8}$

$= 1.139 \times 10^{-6}\ \text{cm}^{-1}$
$= 1.139 \times 10^{-8}\ \text{m}^{-1}$
113.9 Å **Ans.**

Q.36 (D)

$\frac{1}{\lambda} = 109677 \times 4 \left(\frac{1}{1} - \frac{1}{4}\right)$

$\lambda = \frac{1}{109677 \times 3}$

$= 3.03 \times 10^{-6}$ cm
= 30.3 nm

$E = \frac{1240}{30.3} = 40.92$ eV
∴ K. E. = 40.92 eV
$= 40.92 \times 1.6 \times 10^{-19}$ J

K. E. = $\frac{1}{2}mv^2$

$v^2 = \frac{2 \times 40.92 \times 1.6 \times 10^{-19} \times 10^{31}}{9.1}$

$v^2 = 14.38 \times 10^{+12}$

$v = \sqrt{14.38 \times 10^{12}}$

$= 3.79 \times 10^{6}$ m/s
$= 3.8 \times 10^{6}$ m/s
$= 3.8 \times 10^{8}$ cm/sec **Ans.**

Q.37 (A)

$\nu = RC\,Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right).$

$\nu_1 = RC\ Z^2 \left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) = RC\ Z^2,\ \nu_2 = RC\ Z^2 \left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3}{4} RC\,Z^2.$

$\nu_3 = RC\,Z^2 \left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = \frac{1}{4} RC\,Z^2.\ \therefore\ \upsilon_1 - \upsilon_2 = \upsilon_3.$

Q.38 (B)
Shortest wave length of Lyman series of H-atom

$\frac{1}{\lambda} = \frac{1}{x} = R\left[\frac{1}{(1)^2} - \frac{1}{(\infty)^2}\right]$

so, $x = \frac{1}{R}$

For Balmes series

$$\frac{1}{\lambda} = R\,(1)^2 \left\{\frac{1}{(2)^2} - \frac{1}{(3)^2}\right\}$$

$$\frac{1}{\lambda} = \frac{1}{x} \times \frac{5}{36}$$

so, $\lambda = \frac{36x}{5}$.

Q.39 (C)

Change is angular momentum = $\frac{\Delta nh}{2\pi}$

$= (5 - 2)\ \frac{h}{2\pi} = \frac{3h}{2\pi}$.

Q.40 (C)

Let quantum no. be ‘n’

2.7451×10^4

$$= R_H \times 4\left[\frac{1}{n^2} - \frac{1}{\infty}\right] - R_H \times 4\left[\frac{1}{n^2} - \frac{1}{(n+1)^2}\right]$$

$$= 27451 = 4R_H\left[\frac{1}{n^2} - 0 - \frac{1}{n^2} + \frac{1}{(n+1)^2}\right]$$

$$\frac{1}{(n+1)^2} = \frac{27451}{4\times 109677}$$

$(n+1)^2 = 15.98 = 16$

$\therefore\ n = 3$

$$\frac{1}{\lambda} = R_H(z)^2\left\{\frac{1}{3^2} - \frac{1}{4^2}\right\}$$

$$\frac{1}{\lambda} = 109677 \times 4 \times \frac{7}{36\times 4}$$

$\lambda = 4.689 \times 10^{-5}$ cm^{-1}

$= 4689$ Å **Ans.**

Q.41 (C)

$\Delta x = 2\Delta p$

$$\Delta x\,.\,\Delta p = \frac{\hbar}{2} = \frac{h}{4\pi} \Rightarrow 2\,\Delta p\,.\,\Delta p = \frac{\hbar}{2}$$

$$\Rightarrow 2(m\Delta V)^2 = \frac{\hbar}{2}\,;\ (\Delta V)^2 = \frac{\hbar}{4m^2} \Rightarrow \Delta V = \frac{\sqrt{\hbar}}{2m}.$$

Q.42 (D)

$\lambda = v$

then $\lambda = \frac{h}{mV}$ or $\lambda^2 = \frac{h}{m}$ So, $\lambda = \sqrt{\frac{h}{m}}$.

Q.43 (D)

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

Q.44 (B)

$$\frac{\lambda_y}{\lambda_x} = \frac{m_x v_x}{m_y v_y}\ .\Rightarrow \frac{\lambda_y}{1} = \frac{m_x v_x}{(0.25m_x)(0.75\,v_x)} = \frac{16}{3}.$$

$\therefore\ \lambda_y = 5.33$Å.

Q.45 (B)

For an electron accelerated with potential difference

V volt, $\lambda = \frac{h}{\sqrt{2mqV}} = \frac{12\,.\,3}{\sqrt{V}}$ Å .

Q.46 (B)

$$\lambda_{\text{debrogli}} = \frac{6.64\times 10^{-34}}{mv}$$

$$V = \frac{6.64\times 10^{-34}}{500\times 10^{-10}\times 9.1\times 10^{-31}} = 1.45 \times 10^4 \text{ m/sec}$$

$1/2\ mv^2 = eV_0$

$$\frac{\frac{1}{2}\times 9.1\times 10^{-31}\times 1.45\times 10^{8}\times 1.45}{1.6\times 10^{-19}} = V_0$$

$V_0 = 5.97 \times 10^{-4}$ Volts **Ans.**

Q.47 (D)

Velocity of proton $= \frac{1}{10} \times 3 \times 10^8$

$= 3 \times 10^7$ m/sec

$\Delta V = 3 \times 10^5$ m/sec

$$\Delta V.\ \Delta x = \frac{h}{4\pi m}$$

$$\Delta x = \frac{6.62\times 10^{-34}}{4\times 3.14\times 9.1\times 10^{-31}\times 3\times 10^{5}\times 1840} =$$

$$\frac{6.62\times 10^{-8}}{4\times 3.14\times 9.1\times 1840}$$

$\Rightarrow 1.05 \times 10^{-13}$ m **Ans.**

Q.48 (C)

$$10^{-10} = \frac{6.62\times 10^{-34}}{m}$$

$$V = \frac{6.62\times 10^{-34}}{1840\times 9.1\times 10^{-31}\times 10^{-10}} = 3.95 \times 10^3 \text{ m/sec}$$

$\frac{1}{2}\ mv^2 = eV_0$

$$\frac{\frac{1}{2}\times 1840\times 9.1\times 10^{-31}\times 3.95\times 3.95\times 10^{6}}{1.6\times 10^{-19}} = V_0$$

$V_0 = 81640.08 \times 10^{-6}$ V

= 0.0816 Volts **Ans.**

Q.49 (D)

$$\frac{hc}{\lambda} = E_1 - E_2 = KE_2 - KE_1$$

$$\therefore\ \lambda = \frac{h}{mV}\ (mV)^2 = \left(\frac{h}{\lambda}\right)^2\ ;\ \frac{1}{2}mV^2 = \frac{1}{2m}\frac{h^2}{\lambda^2}$$

$$\therefore\ \frac{hc}{\lambda} = \frac{h^2}{2m\lambda_2^2} - \frac{h^2}{2m\lambda_1^2}\ .\ \therefore\ \lambda = \frac{2mc}{h}$$

$$\left\{\frac{\lambda_1^2\lambda_2^2}{\lambda_1^2-\lambda_2^2}\right\}.$$

Q.50 (A)

$$\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha KE_\alpha}{m_p KE_p}} = \sqrt{\frac{4m_p\times 325}{m_p\times 50}} = \sqrt{26} \approx 5.$$

Q.51 (A)

$$\lambda_{\text{debroglie}} = \frac{hc}{mv}$$

$$= \frac{6.62\times 10^{-34}}{6\times 10^{24}\times 3\times 10^{6}} = 0.368\times 10^{-64}\text{ m} = 3.68\times^{-65}\text{ m}$$

Ans.

Q.52 (D)

ΔV = (100 – 99.99%) of 40

$$= \frac{0.01}{100}\times 40$$

$$\Delta x.\ \Delta V = \frac{h}{4\pi m}$$

$$\Delta x = \frac{6.62\times 10^{-34}}{4\times 3.14\times 4\times 10^{-3}\times 9.1\times 10^{-31}}$$

$$= \frac{0.132\times 10^{-31}}{9.1\times 10^{-31}}\text{ m}$$

= 0.0145 m **Ans.**

Q.53 (B)

KE = – TE

⇒ KE = – (–3.4)

⇒ KE = +3.4 eV

& for e^-

$$\lambda_{Å} = \sqrt{\frac{150}{KE}},\ \lambda_{Å} = \sqrt{\frac{150}{3.4}}$$

$\lambda_{Å}$ = 6.6 Å

$\lambda = 6.6 \times 10^{-10}$ m

Q.54 (A)

orbital is spherical so non-directional.

Q.55 (C)

The lobes of d_{xy} orbital are at an angle of 45° with X and Y axis. So along the lobes, angular probability distribution is maximum.

Q.56 (A)

I : For n = 5, l_{min} = 0. ∴ Orbital angular momentum = $\sqrt{\ell(\ell+1)}\,\hbar$ = 0.(False)

II : Outermost electronic configuration = $3s^1$ or $3s^2$.

∴ possible atomic number = 11or 12 (False).

III : Mn_{25} = [Ar] $3d^5\ 4s^2$. ∴ 5 unpaired electrons.

∴ Total spin = $\pm\ \frac{5}{2}$ (False).

IV : Inert gases have no unpaired electrons.

∴ spin magnetic moment = 0 (True).

Q.57 (C)

The lobes of $d_{x^2-y^2}$ orbital are alligned along X and Y axis. Therefore the probability of finding the electron is maximum along x and y-axis.

Q.58 (C)

$\Psi_{(x)} = K_1.\ e^{-r/K_2}\ (r^2 - 5K_3r + 6K_3^2)$

∴ is quadratic in ‘r’ and is a f(σ)

∴ it certainly represents

3 → sheell

s → subshell

A → n = 3

B → ang. nodes = 0

C → l = 0

D → (n + 5)s → 8S → 8

(n + 5)p → 8P → 9

i.e., 6f, 2d, 5g

E → 0 i.e., $\frac{h}{2\pi}\sqrt{\ell(\ell+1)}$

F → $\Psi_r = K_1\, e^{-r/K_2}(r^2 - 5r + 6)$

$$= \frac{1}{9\sqrt{3}.a_0^{3/2}}(6 - 5\sigma + \sigma^2).e^{-\sigma/2}$$

solving is quadratic

$\sigma^2 - 5\sigma + 6 = 0$

$\sigma^2 - 2\sigma - 3\sigma + 6 = 0$
$\sigma(\sigma - 2) - 3(\sigma - 2) = 0$
$\sigma = 3, 2$
code is = 300303 **Ans.**

Q.59 (D)
Total number of electrons in an orbital = $2(2\ell + 1)$.
The value of ℓ varies from 0 to n – 1.

$\therefore$ Total numbers of electrons in any orbit $= \sum_{\ell=0}^{\ell=n-1} 2(2\ell+1)$.

Q.60 (D)
Spin quantum number does not comes from Schrodinger equation.
$s = +\frac{1}{2}$ and $-\frac{1}{2}$ have been assigned arbitrarily.

Q.61 (A)
After np orbital, (n + 1) s orbital is filled.

Q.62 (B)
Magnetic moment = 2.83 so, no. of unpaired electrons = 2
so, Ni^{2+} is the answer.

Q.63 (A)
Cr : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$
$n + \ell = 3$
so the combinations are 2p, 3s. So 8 electrons.

JEE-ADVANCED
MCQ/COMPREHENSION/COLUMN MATCHING

Q.1 (B,D)
$\nu = \frac{c}{\lambda} = \frac{3\times10^8}{600\times10^{-9}} = 5 \times 10^{14}\ \text{sec}^{-1}$

$E = \frac{12400}{6000} = 2.07$ eV.

Q.2 (A,C)

Q.3 (A,C)
Ground state binding energy = $13.6\ Z^2 = 122.4$ eV.

$\therefore$ Z = 3.
1st excitation energy = $10.2\ Z^2 = 91.8$ eV.
$\therefore$ an 80 eV electron cannot excite it to a higher state.

Q.4 (A,C)

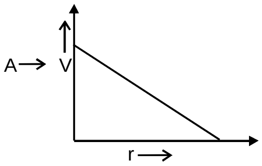
Q.5 (B,C,D)

$V \alpha \frac{z}{n}$ $\therefore V \alpha \frac{1}{n}$

$r \alpha \frac{n^2}{z}$ $\therefore r \alpha n^2$

P. E. $\alpha -\frac{1}{r}$

K.E. $\alpha \frac{1}{r}$

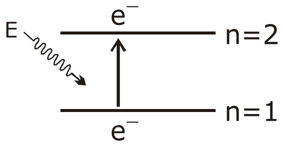


Q.6 (C,D)
$\nu \propto \frac{1}{\lambda}$

Q.7 (A,B,D)
Velocity $\propto \frac{Z}{n}$; Frequency $\propto \frac{Z^2}{n^3}$;

Radius $\propto \frac{n^2}{Z}$; Force $\propto \frac{Z^2}{n^4}$.

Q.8 (A,C,D)
Binding energy of ground state means energy required to more e⁻ from n = 1 to n = ∞ .
$\Delta E_{\text{binding energy}} = \Delta E_{n=1 \text{ to } n=\infty} \times \cancel{Z}^2$
$\Rightarrow 122.4 = 13.6 \times \cancel{Z}^2$
$\Rightarrow \cancel{Z}^2 = 9$
$\Rightarrow \cancel{Z} = 3$
(C) Minimum energy required to excite e⁻ from n = 1 to n = 2.



$E = 10.2 \times \cancel{Z}^2$
$E = 10.2 \times 3^2$
$E = 91.8$ eV

(D) $E_{\text{gained}} - \text{I.E.} = kEe^-$
$kEe^- = 2.6$ eV

Q.9 (A, D)
$\frac{T_1}{T_2} = \frac{n_1^3/\cancel{Z}^2}{n_2^3/\cancel{Z}_2^2}$, $\frac{T_1}{T_2} = \frac{n_1^3}{n_2^3}$

$\frac{8T_1}{T_2} = \frac{n_1^3}{n_2^3} \Rightarrow \frac{n_1}{n_2} = 2$

(A) $\frac{n_1}{n_2} = \frac{4}{2} = 2$

(B) $\frac{n_1}{n_2} = \frac{8}{2} = 4$

(C) $\frac{n_1}{n_2} = \frac{8}{1} = 8$

(D) $\frac{n_1}{n_2} = \frac{6}{3} = 2$

∴ (A) & (D) are correct

Q.10 (A,C)

Max. number of different photons emitted is 4 [(4 → 3 → 1 and 4 → 2 → 1) or (4 → 3 → 2 → 1 and 4 → 1)].

Minimum number of different photons emitted is 1(4 → 1 and 4 → 1).

Q.11 (A,B,C)

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mKE}} = \frac{h}{\sqrt{2mqV}} .$$

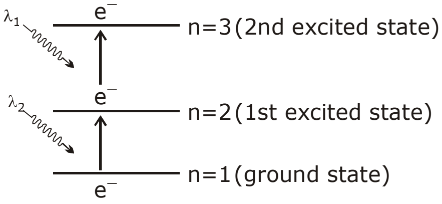
When v, KE and V are same, as m increasing, λ decreases. $\lambda_e > \lambda_p > \lambda_\alpha$ (if v, KE and V are same).

Q.12 (A,B,C)

Q.13 (B,C)

If intensity or no. of photons falling per unit area is increased then photocurrent will increase in surface area also causes increases in no. of photons.

Q.14 (C, D)



$$\frac{1/\lambda_1}{1/\lambda_2} = \frac{R_H \times 1^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right]}{R_H \times 1^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right]}$$

$$\frac{\lambda_2}{\lambda_1} = \frac{1}{x} = \frac{5}{27}$$

$$x = \frac{27}{5}$$

As , $\lambda = \frac{h}{me}$

for photons

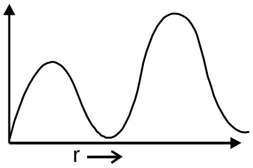
$$\therefore \frac{(mc)_1}{(mc)_2} = \frac{h/\lambda_1}{h/\lambda_2}$$

$$\frac{\lambda_2}{\lambda_1} = \frac{5}{27} = y$$

$$\frac{E_1}{E_2} = \frac{hc/\lambda_1}{hc/\lambda_2} = \frac{\lambda_2}{\lambda_1} = z = \frac{5}{27}$$

Q.15 (C, D)

Q.16 (B,C)



R. N. = 3 – 1 – 1 = 1

Peaks = 1 + 1 = 2

Q.17 (A,B,C)

n = 4, m = 2

Value of ℓ = 0 to (n – 1) but m = 2. ∴ ℓ = 2 or 3 only

Value of s may be +1/2 or – 1/2.

Q.18 (A,B,C)

(A) $_{24}Cr$: $[Ar]3d^5 4s^1$

(B) m = – ℓ to + ℓ through zero.

(C) $_{47}Ag$: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1 4d^{10}$.

Since only one unpaired electron is present.

∴ 23 electrons have spin of one type and 24 of the opposite type.

Comprehension # 01 (Q. No. 19 & 21)

Q.19 (B)

As the frequency of incident radiations increases, the kinetic energy of emitted photoelectrons increases.

Decreasing order of ν ⇒ Violet > Blue > Orange > Red

∴ Decreasing order of KE of photoelectrons ⇒ Violet > Blue > Orange > Red

Q.20 (C)

The interaction between photon and electron is always one to one for ejection of photoelectrons,

Frequency of incident radiations > threshold frequency

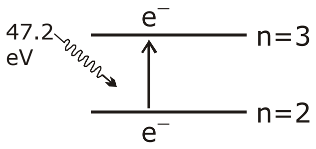
∴ $5.16 \times 10^{15} > 6.15 \times 10^{14}$

Q.21 (A)

The number of photoelectrons emitted depend on the intensity or brightness of incident radiation.

Comprehension # 02 (Q. No. 22 & 25)

Q.22 (D)



$\Delta E = 1.89 \times Z^2$

$\Rightarrow 47.2 = 1.89 \times Z^2$

$\Rightarrow Z^2 = 25$

$Z = 5$

Q.23 (C)

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

$$= 13.6 \times 5^2 \left[\frac{1}{3^2} - \frac{1}{4^2}\right] \text{eV}$$

$= 26.5 \times 10^{-12}$ erg

Q.24 (A)

$$\lambda = \frac{12400}{E} \text{Å}$$

$$= \frac{12400}{13.6 \times 5^2} \text{Å}$$

$= 36.5$ Å

Q.25 (C)

KE = –TE

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

$$= +\ 13.6 \times \frac{5^2}{1^2} \times 1.6 \times 10^{-19}\ \text{J}$$

$= 544 \times 10^{-19} \times 10^{7}$ erg

$= 5.5 \times 10^{-10}$ erg

Comprehension # 03 (Q. No. 26 & 28)

Q.26 (A)

Last line of Bracket series for H-atom

$$\frac{1}{\lambda_1} = R\left[\frac{1}{(4)^2} - \frac{1}{(\infty)^2}\right] \qquad \text{so, } \lambda_1 = \frac{16}{R}$$

2nd line of Lyman series

$$\frac{1}{\lambda_2} = R\left[\frac{1}{(1)^2} - \frac{1}{(3)^2}\right] \qquad \text{so, } \lambda_2 = \frac{9}{8R}$$

or, $\frac{128}{\lambda_1} = \frac{9}{\lambda_2}$

Q.27 (D)

1. Spectral lines of H atom only belonging to Balmer series are in visible range.

2. In the Balmer series of H-atom, first 4 lines are in visible region and rest all are in ultra violet region.

3. 2nd line of Lyman series of He^+ ion has energy = $(E_{3\to1}) \times 2^2 = 12.1 \times 4 = 48.4$ eV.

Q.28 (C)

$$\bar{v} = R\,(4)^2 \left[\frac{1}{(3)^2} - \frac{1}{(4)^2}\right] = \frac{7R}{9}.$$

Comprehension # 04 (Q. No. 29 & 32)

Q.29 (A)

$$\frac{1}{\lambda} = 109677 \times 1 \left\{1 - \frac{1}{9}\right\}$$

$$\frac{1}{\lambda} = 109677 \times \frac{8}{9}$$

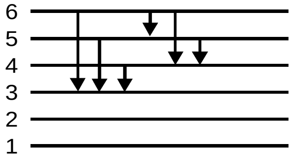
$\lambda = 1.025 \times 10^{-5}$ cm

$= 1.025 \times 10^{-7}$ m

$$E = \frac{6\times10^{-34}\times3\times10^{8}\times10^{7}}{1.025}$$

$= 1.76 \times 10^{-18}$ J

Q.30 (C)



Q.31 The difference in the wavelength of the 1st line of Lyman series and 2nd line of Balmer series in a hydrogen atom is :

(B)

$$\frac{1}{\lambda_1} = R_H \left\{1 - \frac{1}{4}\right\}$$

$$\lambda_1 = \frac{4}{3R_H}$$

$$\frac{1}{\lambda_2} = R_H \left\{\frac{1}{4} - \frac{1}{10}\right\}$$

$$\lambda_2 = \frac{16}{3R_H}$$

$$\lambda_2 - \lambda_1 = \frac{16}{3R_H} - \frac{4}{3R_H}$$

$= \frac{12}{3R_H} = \frac{4}{R_H}$

Q.32 (C)

$n_1 + n_2 = 4$

$n_1 - n_2 = 2$

____

$n_1 = 3$

$n_2 = 1$

$\bar{v} = R_H \times 9\left\{1-\frac{1}{9}\right\}$

$= 8\ R_H$

Comprehension # 05 (Q. No. 33 & 35)

Q.33 (D)

$\Delta x = \frac{h}{4\pi\ Me} \times \frac{1}{\Delta V}$ $\quad \Delta V = V\ ´\ \frac{0.001}{100} = 300 \times 10^{-5}$ m/s

$\Delta x = 5.8 \times 10^{-5} \times \frac{1}{300 \times 10^{-5}} = 1.92 \times 10^{-2}$ m

Q.34 (D)

The maximum KE of potoelectron is corresponding to maximum stopping = 22 eV

$\therefore\ E_{incident} = E_{thresold} + KE_{maxi} = 40\ eV + 22 eV = 62\ eV$

$\lambda_{incident} = \frac{12400\ Å}{62} = 200\ Å$

Q.35 (C)

Circumference = 2πr = nλ

de-broglie $-\lambda = \frac{2\pi r}{n} = \frac{3nm}{3} = 1\ nm = 10Å$

$\therefore\ \lambda = \frac{12.3}{\sqrt{V}}\ Å$

∴ KE of electron in third orbit = 1.51 eV ≡ binding energy of third orbit in this atom

λ = of photon required to ionise = $\frac{1240\ eV\ Å}{1.51\ eV} = 821$ nm

Comprehension # 06 (Q. No. 36 & 38)

Q.36 (A)

Mass$\uparrow$ $\lambda_{debrogli}\downarrow$

Q.37 (C)

$\lambda_{debrogli} = \frac{h}{mv} \rightarrow$ costant

$\lambda\ \alpha\ \frac{1}{v}$

and $v\ \alpha\ \frac{z}{n} \rightarrow$ costant

$\therefore\ v\ \alpha\ \frac{1}{n}$

i.e. transition from

n = 1 to n = 3, n = 2 to n = 6

n = 3 to n = 9

Q.38 (A)

$\Delta x, \Delta mv = \frac{h}{4\pi}$

$\Delta V, \Delta mv = \frac{h}{4\pi}$

multiplying by m $(\Delta mv)^2 = \frac{hm}{4\pi}$

Comprehension # 07 (Q. No. 39 & 41)

Q.39 (C)

Two unpaired electrons present in carbon atom are in different orbitals. So they have different magnetic quantum number.

Q.40 (B)

Electronic configuration of Zn^{2+} ion is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$ so no electron in 4s orbitals.

Q.41 (B)

$\sqrt{s(s+1)}\ \frac{h}{2\pi} = \sqrt{\frac{1}{2}\left(\frac{1}{2}+1\right)}\ \frac{h}{2\pi} = \frac{\sqrt{3}}{2}\ \frac{h}{2\pi} = 0.866\ \frac{h}{2\pi}$

Q.42 (A) – u ; (B) – s ; (C) – p ; (D) – t ; (E) – q ; (F) – r

It is factual.

Q.43 (A) – b , (B) – a, (C) – b, c , (D) – c, d.

$f_n = \frac{v_n}{2\pi r_n}$, $f_n \propto \frac{Z^2}{n^3}$, $\quad T_n = \frac{2\pi r_n}{v_n}$, $T_n \propto \frac{n^3}{Z^2}$.

$E_n = -13.6\ \frac{Z^2}{n^2}$, $E_n \propto \frac{Z^2}{n^2}$, $r_n \propto \frac{n^2}{Z}$.

Q.44 (A) s, (B) r, (C) q, (D) p

$A \rightarrow \lambda_{debroglie} = \sqrt{\frac{150}{13.6}}$ (S)

B → Vel. = $2.18 \times 10^6 \times \frac{z}{n}$ (R) = $\frac{2.18 \times 10^6}{3}$ m/s

C → Energy = $-13.6 \times \frac{z^2}{n^2} = -13.6 \times 9$

D → r = $-0.529 \times \frac{n^2}{z}$

P = 0.529 Å

Q.45 (A) – c, (B) – d, (C) – a, (D) – b.

i : For Lyman series, $\bar{\nu}$ for second line (3 → 1) = $R(1)^2\left[\frac{1}{1^2}-\frac{1}{3^2}\right] = \frac{8R}{9}$ (c).

ii : For Balmer series, $\bar{\nu}$ for second line (4 → 2) = $R(1)^2\left[\frac{1}{2^2}-\frac{1}{4^2}\right] = \frac{3R}{16}$ (d).

iii : In a sample of H-atom for 5 → 2 transition, maximum number of spectral lines observed = $\frac{(5-2)(5-2+1)}{2}$ = 6 (a).

iv : In a single isolated H-atom for 3 → 1 transition, maximum number of spectral lines observed = 2 (3 → 2, 2 → 1) (b).

Q.46 (A)-p, (B)-pqs, (C)-pr, (D)-qs

A → R.N. = 3	P
B → R.N. = 3	PQR
D → A.N. = l	QS

Q.47 (A) – s ; (B) – s ; (C) – u ; (S) – q ; (E) – p ; (F) – r

It is factual.

NUMERICAL VALUE BASED

Q.1 6

$$\frac{(n_2-n_1)(n_2-n_1+1)}{2} = \frac{(5-2)(5-2+1)}{2} = 6$$

Q.2 2

No. of nodal axis in a px orbital are 2.

Q.3 3

For hydrogen

$$\frac{1}{\lambda} = RZ^2\left[\frac{1}{1}-\frac{1}{3^2}\right]$$

$$\frac{1}{\lambda} = \frac{8R}{9}$$

for ionic species

$$\frac{1}{\lambda} = RZ^2\left[\frac{1}{3^2}-\frac{1}{9^2}\right]$$

$$\frac{1}{\lambda} = RZ^2 \times \frac{8}{81}$$

$$\frac{8R}{9} = RZ^2 \times \frac{8}{81}$$

$Z^2 = \frac{81}{9} = 9;$ Z = **3**

Q.4 6

No. of spherical lines produced = $\frac{(n_2-n_1)(n_2-n_1+1)}{2} = \frac{(5-2)(5-2+1)}{2} = 6$

Q.5 5

Q.6 3

No of waves = principal quantum no.

n = 3

Q.7 3

λ of e- in nth Bohr's orbit = $\frac{2\pi a_0 n}{z}$

n = Bohr's orbit, z = atomic number, a_0 = radius of 1st Bohr's orbit of H-atom.

Q.8 1

Number of radial node is equal to n – l – 1

For p-orbital l = 1.

Q.9 3

Maximum three quantum number can be same but fourth must be different.

Q.10 2

One orbital can accommodate only two electrons

KVPY
PREVIOUS YEAR'S

Q.1 (D)

n is always greater then ℓ

and m = – ℓ..........0........+ℓ

If n = 2, then ℓ = 0, 1

and m_ℓ = 0, {–1, 0, +1}

Q.2 (A)

$$\Delta E = 13.6\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right)\text{eV / atom};$$

$$\frac{\Delta E_{1\to3}}{\Delta E_{1\to2}} = \frac{\frac{1}{1^2}-\frac{1}{3^2}}{\frac{1}{1^2}-\frac{1}{2^2}} = \frac{.32}{27}$$

Q.3 (B)

$\xrightarrow{Rb,K,Na,Li}$ I.P.L $\downarrow$

Q.4 (C)

${}^{40}_{19}K^{+}$ Neutrons = 21, Electron = 18,

21 + 18 = 39

Q.5 (1)

Q.6 (3)

E = ϕ + K.E.

$$\because E = \frac{hC}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^{8}}{660\times10^{-9}}$$

3×10^{-19}

ϕ = lev = 1.6×10^{-19} J

K.E. $3 \times 10^{-19} - 1.6 \times 10^{-19} = 1.4 \times 10^{-19}$ J

for wave length of emitted electron

$$\lambda = \frac{h}{\sqrt{2mKE}} = \frac{6.6\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times1.4\times10^{-19}}}$$

$$= \frac{6.6\times10^{-34}}{5\times10^{-25}} = 1.32\times10^{-9}$$ meter $^{-}$

Q.7 (C)

$$r = 0.529\times\frac{n^2}{z}$$

$r\alpha\frac{1}{z}$ So correct order is $r_H + > r_{He^+} > r_{Li^{2+}}$

Q.8 (C)

Q.9 (B)

Q.10 (A)

All elements have isotopes. All isotopes of carbon can form chemical compounds with oxygen-16.

Q.11 (C)

$$r_{He^{\oplus}} = r_H \times \frac{n^2}{Z}$$

$r_{He^+} = 53\times\frac{1}{2} = 26.5$pm It is closest to 27 pm.

Q.12 (4)

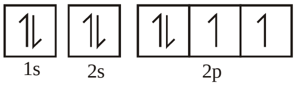
l = 4 →n ′g′ subshell

$\therefore$ no of e^- = 2 (2l + 1)

= 2(2 × 4 + 1) = 18e

Q.13 (A)

C $\Rightarrow$ $1s^2\ 2s^2\ 2p^2$



→ Energy increase

Q.14 (C)

On increasing intensity of radiation, value of photo electric current increase no. of photon incident increase

Q.15 (D)

4s, 4p, 4d & 4f contains total 32 electrons.

Q.16 [D]

no. of radial node = n – ℓ – 1 = 4 – 1 – 1 = 2

no. of angular node = ℓ = 1

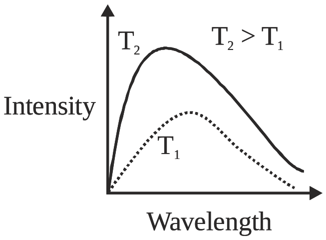
Q.17 (B)

The maximum number of electrons in the nth shell is $2n^2$.

Q.18 (A)

As the atomic number increases the energy of orbitals decreases.

Q.19 (A)



Q.20 **(A)**

(i) $E = -13.6\times\frac{z^2}{n^2}$ Application only for single electron species.

For 2S $\Rightarrow$ n = 2

Order of energy E_{2s}(H) > E_{2s}(Li) > E_{2s}(Na) > E_{2s}(K)

(ii) Maximum number of electron which can accommodate in a principal energy shell is equal to $2n^2$.

(iii) Extra stability of half -field subshell is due to to higher exchange energy.

(iv) Only two electron with opposite spin can exists in same orbital.

So correct statement –(i), (ii).

Q.21 **(B)**

In the absence of external electrical or magnetic field, cathode rays travel in straight lines.

Q.22 **(D)**

For multielectron species energy depends on (n + l) value.

$n = 5, l = 1, m = 0, s = +\frac{1}{2}$

(n + l) = 6 orbital is '5p'

Q.23 (B)

For single electron species $v_n \propto \frac{1}{n}$

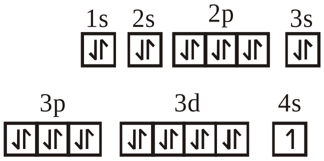
$$\frac{v_2}{v_1} = \frac{n_1}{n_2} = \frac{1}{2}$$

$$v_2 = \frac{1}{2}v_1 = \frac{1}{2}v = \frac{v}{2} = 0.5\,v$$

Q.24 (C)

Cu [Ar] $3d^{10}4s^1$

Cu(29)



The set of quantum numbers for the unpaired e^- of Cu atom is.

$n = 4, l = 0, m = 0, s = +\frac{1}{2}$

Q.25 (C)

Work function of metal (ϕ) = 2 eV

Energy of photon (λ = 400 nm) = $\frac{hc}{\lambda}$ = 3.105 eV

Energy of photon (λ = 800 nm) = $\frac{hc}{\lambda}$ = 1.5525 eV

Hence, photon with λ = 400 nm will emit photoelectrons while photon with λ = 800 nm will not emit photoelectrons.

JEE-MAINS

PREVIOUS YEAR'S

Q.1 (1)

Orbital	Angular Node	Radial Node
5d	2	2
4f	3	0
3p	1	1
2s	0	1

Q.2 181

$$E = \frac{hc}{\lambda} = \frac{(6.62 \times 10^{-34})(3 \times 10^{8})}{(663 \times 10^{-9})} \times \frac{6.62 \times 10^{24}}{1000}$$

$$= \frac{6.62 \times 3 \times 6.02}{66.3} \times 1000 \frac{\text{kJ}}{\text{mole}}$$

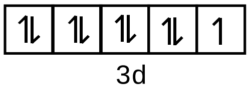
= 180.6 kJ/mole

Q.3 1.732

Z = 29 [Cu element]

Cu → $[Ar]4s^1\,3d^{10}$

$Cu^{+2} \rightarrow [Ar]3d^9$



No of unpaired electron = 1

Magnetic moment $\mu = \sqrt{n(n+2)}$ BM

$= \sqrt{1 \times 3}$ BM = 1.732 BM

Q.4 (2)

Q.5 2

$$\lambda_{DB}\ \alpha\ \frac{1}{\sqrt{m.K.E.}}$$

$$\frac{\lambda_{Li^{3+}}}{\lambda_P} = \sqrt{\frac{m_p \times e_p V}{8.33m_p \times 3e_p V}}$$

$$\sqrt{\frac{1}{25}} = \frac{1}{5} = 0.2 = 2 \times 10^{-1}$$

Q.6 (4)

$\lambda_p = \lambda_\alpha$

$$\frac{h}{m_p v_p} = \frac{h}{m_\alpha v_\alpha}$$

$$\frac{v_p}{v_\alpha} = \frac{m_\alpha}{m_p}$$

$$\frac{v_p}{v_\alpha} = \frac{4m_p}{m_p} = 4$$

Ans. 4

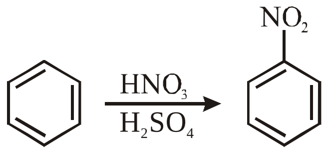
Q.7 (0)

n = 4 and $m_l = -3$

Hence, l value must be 3.

Now, number of radial nodes = n – l – 1

= 4 – 3 – 1 = 0



Q.8 **(3)**

For, n = 5

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

If $l = 0$, $m = 0$

$l = 1$, $m = \{-1, 0, +1\}$

$l = 2$, $m = \{-2, -1, 0, +1, \mathbf{+2}\}$

$l = 3$, $m = \{-3, -2, -1, 0, +1, \mathbf{+2}, +3\}$

$l = 4$, $m = \{-4, -3, -2, -1, 0, +1, \mathbf{+2}, +3, +4\}$

5d, 5f and 5g subshell contain one-one orbital having ml = +2

Q.9 (9)

$$\text{Energy incident} = \frac{hc}{\lambda}$$

$$= \frac{6.63\times10^{-34}\times3.0\times10^{8}}{248\times10^{-9}\times1.6\times10^{-19}}\text{ eV}$$

$$= \frac{6.63\times3\times100}{248\times1.6}$$

= 0.05 eV × 100 = 5 eV

Now using

$E = \phi + K.E.$

$5 = 3 + K.E.$

$K.E. = 2eV = 3.2\times10^{-19}J$

for debroglie wavelength $\lambda = \frac{h}{mv}$

$$K.E = \frac{1}{2}mv^2$$

$$\text{so} = \sqrt{\frac{2KE}{m}}$$

$$\text{hence } \lambda = \frac{h}{\sqrt{2KE\times m}}$$

$$= \frac{6.63\times10^{-34}}{\sqrt{2\times3.2\times10^{-19}\times9.1\times10^{-31}}}$$

$$= \frac{6.63}{7.6}\times\frac{10^{-34}}{10^{-25}} = \frac{66.3\times10^{-10}\text{m}}{7.6}$$

$= 8.72\times10^{-10}$ m

$\approx 9\times10^{-10}$ m

= 9Å

Q.10 **(2)**

Statement-I is false since Bohr's theory accounts for the stability and spectrum of single electronic species (eg : He^+, Li^{2+} etc)

Statement II is true.

Q.11 **(2)**

$l = 0 \Rightarrow$'s' orbital

ν □ $l - 1 = 2$

$n - 1 = 2$

$n = 3$

Q.12 (4)

Q.13 (4)

Q.14 (58)

Q.15 (2)

Q.16 (6)

Q.17 [5]

Q.18 (3)

Q.19 **(50)**

Q.20 [3155]

Q.21 (2)

JEE-ADVANCED PREVIOUS YEAR'S

Paragraph for Question Nos. 1 to 3

Q.1 **(B)**

For lower state (S_1)

No. of radial node = 1 = $n - \ell - 1$

Put n = 2 and $\ell = 0$ (as higher state S_2 has n = 3)

So, it would be 2s (for S_1 state)

Q.2 **(C)**

$$\text{Energy of state } S_1 = -13.6\left(\frac{3^2}{2^2}\right)\text{ eV/atom}$$

$$= \frac{9}{4}\text{(energy of H-atom in ground state)}$$

= 2.25 (energy of H-atom in ground state).

Q.3 **(B)**

For state S_2

No. of radial node = 1 = $n - \ell - 1$

.... (eq.-1)

Energy of S_2 state = energy of e^- in lowest state of H-atom

= – 13.6 eV/atom

$$= -13.6\left(\frac{3^2}{n^2}\right)\text{ eV/atom}$$

n = 3.

put in equation (1) $\ell = 1$

so, orbital ⇒ 3p (for S_2 state).

Q.4 4

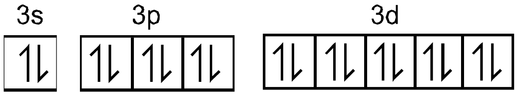
$$E_{photon} = \frac{12400}{3000} = 4.13\text{ ev}$$

Photoelectric effect can take place only if $E_{photon} \geq \phi$

Thus,

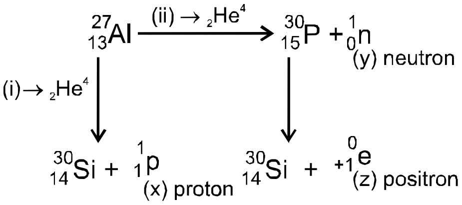
Li, Na, K, Mg can show photoectric effect.

Q.5 9



So, electrons with spin quantum number = $-\frac{1}{2}$ will be 1 + 3 + 5 = 9.

Q.6 **(A)**



Q.7 **(C)**

$$mv\,(4a_0) = \frac{h}{\pi}$$

$$\text{so,}\quad v = \frac{h}{4m\pi a_0}$$

$$\text{so}\quad KE = \frac{1}{2}mv^2 = \frac{1}{2}m.\frac{h^2}{16m^2\pi^2a_0^2} = \frac{h^2}{32m\pi^2a_0^2}$$

Q.8 8

$$^{63}_{29}Cu + ^1_1H \rightarrow 6^1_0n + ^4_2\alpha + 2^1_1H + X$$

64 = 6 + 4 + 2 + A ⇒ A = 52

29 + 1 = 30 = 0 + 2 + 2 + z ⇒ z = 26

Element X should be iron in group 8.

Q.9 **(A,B)**

$$_4Be^9 + X \longrightarrow {}_4Be^8 + Y$$

If X is $_0\gamma^0$ then Y is $_0n^1$

If X is $_1P^1$ then Y is $_1D^2$

Q.10 6

n = 4,

$m_\ell = 1, -1$

Hence ℓ can be

= 3,2,1

i.e. H_f ;

2 orbitals

H_d ;

2 orbitals

H_p ;

2 orbitals

Hence total of 6 orbitals, and we want $m_s = -\frac{1}{2}$, that is only one kind of spin. So, 6 electrons.

Q.11 3

Energy order of orbitals of H is decided by only principle quantum number (n)

while energy order of H^- is decided by (n + ℓ) rule :

Electronic configuration of 'H^-' is - $1s^2$ its Energy order is decided by n+ℓ rule.

$H^- = 1s^2 2s^0 2p^0$

Its 2nd excited state is 2p

and degenery 2p is '3'

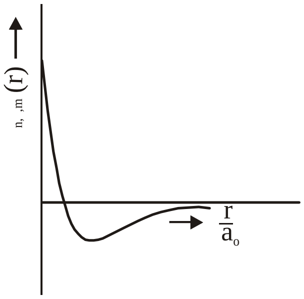
Q.12 **(D)**

Q.13 **(C)**

s-orbital is non directional so wave function will be independent of cos θ.

Q.14 **(A)**

For 2s orbital no. of radial nodes = n – ℓ – 1 = 1



Q.15 **(D)**

For 1s orbital Ψ should be independent of θ, also it does not contain any radial node.

Q.16 (1,3)

$-3.6 = \dfrac{-13.6\times 4}{n^2}$

n = 4

$\ell = 2$

m = 0

Angular nodes = ℓ = 2

Radial nodes = $(n - \ell - 1) = 1$

n ℓ = 4d state

Q.17 (C)

$r = 0.529 \times \dfrac{n^2}{z} \Rightarrow r \propto n^2$

$\Rightarrow$ (I) (T)

$mvr = \dfrac{nh}{2\pi} \qquad \Rightarrow (mrv) \propto n$

$\Rightarrow$ (II) (S)

$KE = +13.6 \times \dfrac{z^2}{n^2} \qquad \Rightarrow KE \propto n^{-2}$

$\Rightarrow$ (II) (S)

$PE = -2 \times 13.6 \times \dfrac{z^2}{n^2} \qquad \Rightarrow PE \propto n^{-2}$

$\Rightarrow$ (IV) (P)

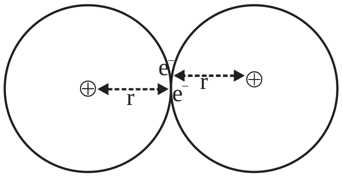
Q.18 (4)

Same as 1 (Section-3)

Q.19 (–5246.49)

At d = d_0, nucleus-nucleus & electron-electron repulsion is absent.

Hence potential energy will be calculated for 2 H atoms. (P.E. due to attraction of proton & electron)



$$P.E. = \frac{-Kq_1q_2}{\underset{(\text{Bohr radius})}{r}} = \frac{\left(9\times10^{9}\right)\left(1.6\times10^{-19}\right)^2}{0.529\times10^{-10}} = -4.355\times10^{-21}\,kJ$$

For 1 mol = $-4.355 \times 10^{-21} \times 6.023 \times 10^{23}$

= –2623.249 kJ/mol

For 2 H atoms = –5246.49 kJ/mol

Q.20 30

Mole Concept

EXERCISE-I

Elementary

Q.1 (3)

Q.2 (1)

(1) 6×10^{23} molecules has mass $=18\text{gm}$

1 molecules has mass $=\dfrac{18}{6\times10^{23}}=3\times10^{-23}\text{gm}$

$=3\times10^{-26}\text{kg}$.

Q.3 (1)

(1) 14 *gm* N^{3-} ions have $=8N_A$ valence electrons

4.2*gm* of N^{3-} ions have $=\dfrac{8N_A\times4.2}{14}=2.4N_A$

Q.4 (2)

(2) $\because$ 22400 *ml* at NTP has 6.023×10^{23} molecule

$\therefore$ 1 *ml* at NTP has $=\dfrac{6.023\times10^{23}}{22400}$

$=0.0002688\times10^{23}=2.69\times10^{19}$ ·

Q.5 (2)

(2) $\because$ 22400*cc* of gas at STP has 6×10^{23} molecules

$\therefore$ 1.12 $\times10^{-7}$ of gas at STP has $\dfrac{6\times10^{23}\times1.12\times10^{-7}}{22400}=.03\times10^{14}=3\times10^{12}$ ·

Q.6 (1)

(1) $\because$ 2.24*L* of gas has mass = 4.4*gm*

$\therefore$ 22.4*L* of gas has mass $=\dfrac{4.4}{2.24}\times22.4=44$

So given gas is CO_2 because CO_2 has molecular mass=44.

Q.7 (3)

(3) $\because$ 100*gm* $CaCO_3=6.023\times10^{23}$ molecules

$\therefore$ 10*gm* $CaCO_3=\dfrac{6.023\times10^{23}}{100}\times10$

$=6.023\times10^{22}$ molecule

1 molecule of $CaCO_3=$ 50 protons

6.023×10^{22} molecule of $CaCO_3=50\times6.023\times10^{22}$

$=3.0115\times10^{24}$

Q.8 (1)

(1) 100*gm* caffeine has 28.9*gm* nitrogen

194*gm* caffeine has $=\dfrac{28.9}{100}\times194=56.06\text{gm}$

$\therefore$ No. of atoms in caffeine $=\dfrac{56.06}{14}\approx4$.

Q.9 (4)

(4) $C=24\text{gm}$, $H=4\text{gm}$, $O=32\text{gm}$

So, Molecular formula $=C_2H_4O_2$

So, Empirical formula $=CH_2O$

(Simplest formula).

Q.10 (2)

Element	At.wt.	Mole	Ratio	Empiricalformula
C =86%	12	7.1	1	CH_2
H =14%	1	14	2	Beleongs to alkene

Q.11 (2)

(2)

Element	%(1)	At.wt.(2)	a/b	Ratio
X	50	10	5	2
Y	50	20	2.5	1

Simplest formula $=X_2Y$

Q.12 (3)

$$\begin{array}{lcccc} & 4NH_{3(g)}+ & 5O_{2(g)}\rightarrow & 4NO_{(g)}+ & 6H_2O_{(g)} \\ t=0 & 1 & 1 & 0 & 0 \\ t=t & 1-4x & 1-5x & 4x & 6x \end{array}$$

Oxygen is limiting reagent

So, $X=\dfrac{1}{5}=0.2$ all oxygen consumed

Left $NH_3=1-4\times0.2=0.2$.

Q.13 (3)

(3) $\because$ 100*gm Hb* contain = 0.33*gm Fe*

$\therefore$ 67200*gm Hb* -= $\dfrac{67200\times0.33}{100}$ gm Fe

gm atom of *Fe* $=\dfrac{672\times0.33}{56}=4$.

Q.14 (1)

(1) Isobutane and *n*-butane $[C_4H_{10}]$ have same molecular formula; $C_4H_{10}+\dfrac{13}{2}O_2\rightarrow4CO_2+5H_2O$

For 58*gm* of C_4H_{10} 208 *gm* O_2 is required then for 5 *kg* of C_4H_{10} $O_2=\dfrac{5\times208}{58}=17.9\,\text{kg}$

Q.15 (3)

(3) $\underset{100g}{CaCO_3} + \underset{2N}{2HCl} \rightarrow CaCl_2 + \underset{44\,g}{CO_2} + H_2O$

100 *g* $CaCO_3$ with 2 *N HCl* gives 44 *g* CO_2

100 *g* $CaCO_3$ with 1 *N HCl* gives 22 *g* CO_2

JEE-MAIN
OBJECTIVE QUESTIONS

Q.1 mole = $\frac{\text{mass}}{\text{at. wt.}} = \frac{46}{23}$ = 2 mole.

Q.2 **(3)**

In $Ca_3(PO_4)_2$

$$\frac{\text{mole of Ca atom}}{\text{mole of O atom}} = \frac{3}{8}$$

Mole of 'O' atom = $\frac{8}{3}$ (mole of Ca atom)

Mole of 'Ca' atom = 3

Q.3 (1) No. of atom of $(C_4H_{10}) = \frac{1}{58} \times 14\ N_a$;

(2) No. of atom of $(N_2) = \frac{1}{28} \times 2\ N_a$

(3) No. of atom of (Ag) = $\frac{1}{108} \times 2\ N_a$;

(4) No. of atom of water = $\frac{1}{18} \times 3\ N_a$

Hence greatest No. of atom = C_4H_{10}

Q.4 **(1)**

H_2SO_4 $\Downarrow$ 32

so total molecular mass = 98

$A\ell_2(SO_4)_3$ $\Downarrow$ 3×32 $\Downarrow$

$\frac{1}{3}\ (A\ell_2(SO_4)_3)$ $\Downarrow$

$\frac{1}{3} \times 342$ $\Downarrow$ 114

$\frac{98}{114} = 0.86$

Q.5 **(1)**

Let mole of B = x

V.D = 25 mole of A = 100 x

Mol. mass = 50

$\Rightarrow 250 = \frac{80x + 40(100 - x)}{100}$

$x = \frac{100}{4} = 25$

Q.6 N_2

: Ne : N_2O : SO_3

Ratio of total no. of moleculas = 1

: 1 : 1 : 1

So ratio of total no. of atoms = 2

: 1 : 3 : 4

Q.7 **(3)**

NaI mass = $\frac{3 \times 0.5}{100}$ = 0.015 gm

No. of moles of NaI = $\frac{0.015}{150} = 1 \times 10^{-4}$

No. of I^- ions = $10^{-4} \times 6.023 \times 10^{23} = 6.023 \times 10^{19}$

Q.8 **(1)**

$1.17 = \frac{M_{gas}}{M_{air}}$

$1.17 = \frac{M_{gas}}{29}$

M gas = 29 × 1.17 = 33.9

Q.9 mole of $SO_2Cl_2 = \frac{13.5}{135}$ = 0.1 mole.

Q.10 **(3)**

$P = \frac{M}{V_f - V_i} = 8.533$

Q.11 **(3)**

(1) $n = \frac{10 \times 1}{18} = 0.55$

(2) n = 0.1 × 5 = 0.5

(3) $n = \frac{12}{48} \times 3 = 0.75$

(4) $n = \frac{N}{NA} = 0.2 \times 2 = 0.4$

Q.12 $\frac{4.4}{x} = \frac{2.24}{22.4}$ (where x is mol. wt of gas)

$x = 4.4 \times 10$

$x = 44$ (N_2O and CO_2 both gases may be possible).

Q.13 **(1)**

No. of atoms = $\frac{10^{23}}{3.9854}$

$= 2.509 \times 10^{+22}$

Q.14 **(3)**

(1) $n = \frac{12}{12} = 1$ (2) $n = \frac{8}{16} = 05$

(3) $n = \frac{32}{32} = 1$ (4) $n = \frac{24}{24} = 1$

Q.15 mole = $\frac{5.6}{22.4}$

$\therefore$ no. of molecule = $\frac{5.6}{22.4} \times 2N_a = \frac{1}{2} \times 6.02 \times 10^{23} = 3.01 \times 10^{23}$ atoms

Q.16 **(2)**

$N = 6.023 \times 10^{23} \times \frac{2}{100} = 1.20 \times 10^{22}$

Q.17 Moles of $Mg_3(PO_4)_2 = \frac{1}{8} \times 0.25 = 3.125 \times 10^{-2}$

Q.18 mole = $\frac{1.12 \times 10^{-7}}{22400}$

No. of molecule = $\frac{1.12 \times 10^{-7}}{22400} \times 6.02 \times 10^{23} = 3.01 \times 10^{12}$

Q.19 No. of carbon atom in glucose = $\frac{1.71}{342} \times 12\ N_a$

$= 3.6 \times 10^{22}$

Q.20

	No.of atoms	mole	simplest ratio	ratio
Cr	4.8×10^{10}	$\frac{4.8 \times 10^{10}}{6 \times 10^{23}} = 8 \times 10^{-14}$	$\frac{8 \times 10^{-4}}{8 \times 10^{-4}} = 1$	1
O	9.6×10^{10}	$\frac{9.6 \times 10^{10}}{6 \times 10^{23}} = 16 \times 10^{-14}$	$\frac{16 \times 10^{-14}}{8 \times 10^{-14}}$	2

Hence E.F. is CrO_2

Q.21 **(1)**

	C	H	O
Mass	24	8	32
Moles	$\frac{24}{12}$	$\frac{8}{1}$	$\frac{32}{16}$
Ratio	2	8	2
Simple integer ratio			
	1	4	1

Hence empirical formula is CH_4O

Q.22 **(1)**

X	Y
$\frac{75.8}{75}$	$\frac{24.2}{16}$
1.01	1.5 × 2
2	3

Q.23 $n = \frac{M.F.M}{E.F.M} = \frac{120}{30} \Rightarrow n = 4$

$\Rightarrow$ M.F = $n \times CH_2O$

$= 4 \times CH_2O$

$= C_4H_8O_2$

Q.24

			Simplest ratio	Ratio
C	75	75/12 = 6.25	6.25/6.25=1	1
H	25	25/1=25	25/6.25=4	4

Hence E.F is CH_4 & M.F is = n × E.F (n =1, 2, 3.....) = $1 \times CH_4 = CH_4$.

Q.25

X	$\frac{a}{30}$	Simplest ratio $a/30\ /\ a/30 = 1$	ratio 2
Y	$\frac{a}{20}$	$a/20\ /\ a/30 = 3/2$	3

Hence E.F is X_2Y_3.

Q.26 **(1)**

$C_xH_y + \left(x + \frac{y}{4}\right) O_2 \longrightarrow XCO_2 + \frac{y}{2} H_2O$ (g)

(g) (g)

$$\frac{\left(1 + x + \frac{y}{4}\right)}{\left(x + \frac{y}{2}\right)} = \frac{600}{700}$$

$x + 7 = \frac{5y}{4}$

by option (1)

Q.27 **(4)**

Mole fraction of H_2O = 1 – 0.25 = 0.75

$$\frac{x_{C_2H_5OH}}{X_{C_2H_5OH}+X_{H_2O}} = \frac{n_{C_2H_5OH}}{n_{C_2H_5OH}+n_{H_2O}} \text{ or wt. \% = }$$

$$\frac{0.25\times 46}{0.25\times 46+0.75\times 18}\times 100 = 46\%.$$

Q.28 E.F of glucose = CH_2O

E.F of (CH_3COOH) = CH_2O

$\because$ M.F = n × E.F (where n =1,2,3.....).

Q.29 $194 \times \frac{28.9}{100}$

= 56.06 g

No. of Nitrogen $= \frac{56.06}{14} = 4$

Q.30 **(3)**

$CO_2 = 132\text{ g} = \frac{132}{44}$ mole = 3 mole

$H_2O = 54\text{ g} = \frac{54}{18}$ mole = 3 mole

$\Rightarrow$ C atoms = 3 mole

H atoms = 6 mole

by option C

Q.31 **(1)**

Same emprical formula

$\Rightarrow$ same compostion by mass

Q.32 **(1)**

$Fe_2O_3 = \frac{2\times 56}{3\times 16} = \frac{7}{3}$

$FeO = \frac{56}{16} = \frac{7}{2}$

$\therefore$ $Fe_2O_3 : FeO = \frac{7}{3}\times\frac{7}{2} = 3:2$

Q.33 **(3)**

A : B : C $\Rightarrow$ 1 : 3 : 5

b $\Rightarrow$ x : y = 32 : 84 by mass

= 1 : 3 by mole

C $\Rightarrow$ x : y = 16 : 5 $\Rightarrow$ 16 : 70

Q.34 $x \times \frac{3.4}{100} = 32$

x = 941.76.

Q.35 Urea (NH_2COH_2)

M.wt of Urea = 60

% of N $= \frac{28}{60}\times 100 = 46\ \%.$

Q.36 **(2)**

0.8v + (54.2 – v) × 1 = 49.6

$V = \frac{4.6}{0.2} = 23$ ml

% ethanol $= \frac{23\times 0.8}{49.6}\times 100 = 37.1\%$

Q.37 **(1)**

amount of butter $= \frac{2\times 10^{-3}}{5.5\times 10^{-6}} = 363.6$ gm

Q.38 **(2)**

Let initial = xg ; $\frac{0.15x-5}{x-5} = \frac{8}{100} \Rightarrow x = \frac{460}{7}$ g

$\frac{0.4x}{x-5}\times 100 = 43.29\%$

Q.39 **(3)**

$$\frac{\Delta x}{x} = \frac{\Delta y}{y}$$

$\Rightarrow$ $y' = y + \Delta y = \frac{16.006}{16}\times 107.868$

Q.40 **(4)**

$$\text{Mavg} = \frac{8.082\times 12\times 0.234+7.833\times 12\times 0.766}{1}$$

Q.41 **(3)**

0.79 × 24 + x + 26 + (21 – x) × 25 = 24.31

x = 0.1

$\therefore$ % Mg^{26} = 10%

Q.42 **(2)**

M_2O_3 0.30 × (2M + 48) = 48

0.6 M = 0.7 × 48

M = 7 × 8 = 56

Q.43 (4)

Q.44 $BaCO_3 \longrightarrow BaO + CO_2$

$\frac{9.85}{197}$

mole–mole analysis

$$\frac{\frac{9.85}{197}}{1} = \frac{\text{mole of BaO}}{1}$$

Hence $\frac{9.85}{197} = \frac{vol}{22.4}$ (at STP)

Vol $= \frac{1120}{1000}$ = 1.12 Lit.

Q.45 **(1)**

$CaC_2 + H_2O \longrightarrow Ca(OH)_2 + C_2H_2 \longrightarrow C_2H_4$ ... (1)

$nC_2H_4 \longrightarrow -\!\!\left(CH_2\text{–}CH_2\right)\!\!-_n$ ... (2)

From equation (1)

mole of CaC_2 = mole of C_2H_4

$\frac{64 \times 10^3}{64}$ = mole of C_2H_4

From equation (2)

$$\frac{\text{mole of } C_2H_4}{n} = \frac{\text{mole of polymer}}{1}$$

$$\frac{10^3}{n} = \frac{\text{wt of polymer}}{n\,(28)}$$

Wt. of polymer = 28 × 10^3 g = 28 Kg

Q.46 **(1)**

Use reaction $C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O$.

In 24 hr. moles of sucrose consumed = $\frac{34}{342} \times 24$.

∴ In 24 hr. moles of O_2 required = $\frac{34}{342} \times 24 \times 12$.

(according to stoichiometry).

Mass of O_2 required = $\frac{34}{342} \times 24 \times 12 \times 32$ = 916.2 g.

Q.47 $C_xH_y + O_2 \longrightarrow CO_2 + H_2O$

POAC on c

$x \times \frac{500}{22400} = 1 \times \frac{2.5}{22.4}$

x = 5

POAC on H

$y \times \frac{500}{22400} = 2 \times \frac{3}{22.4}$

y = 12

Hence hydrocarbon is C_5H_{12}.

Q.48 **(1)**

	$2\,SO_2$ +	$O_2 \longrightarrow$	$2\,SO_3$
Initial mole	10	15	0
Final mole	(10 – 2x)	(15 – x)	2x

∵ Given 2x = 8

∴ x = 4

∴ Mole of SO_2 left = 10 – 2 × 4 = 2

Mole of O_2 left = 15 – 4 = 11

Q.49 $2NH_3 + \frac{5}{2}O_2 \longrightarrow 2NO + 3H_2O$

from mole-mole analysis

$$\frac{n_{NH_3}}{2} = \frac{n_{O_2}}{5/2}$$

$$\frac{\frac{6.8}{17}}{2} = \frac{n_{O_2}}{\frac{5}{2}}$$

n_{O_2} = 0.5 mole.

Q.50 **(4)**

$C + \frac{1}{2}O_2 \longrightarrow CO$ .... (1)

Initial mole $\frac{x}{12}$ $\quad \frac{y}{32}$ $\quad$ 0

Final mole 0 $\quad \frac{y}{32} - \left(\frac{x}{12}\right)\frac{1}{2}$

$CO + \frac{1}{2}O_2 \longrightarrow CO_2$.... (2)

For no solid residue C should be zero in eq. (1)

For that $\frac{y}{32} - \frac{x}{12} \times \frac{1}{2} > 0$

$$\frac{y}{32} > \frac{x}{24}$$

$$\frac{y}{x} > \frac{32}{24} \qquad \frac{y}{x} > 1.33$$

Q.51 $C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

From Gay lussac's law

C_2H_4 & O_2 are in 1:3 vol.ratio

i.e O_2 will be 60 ml.

Q.52 **(2)**

$(C + S) \longrightarrow CO_2 + SO_2$

$$n_{SO_2} = \frac{n_{CO_2}}{2}$$

Let wt. of C = x
So, wt. of S = 12 – x

$$\frac{12-x}{32} = \frac{1}{2}\left(\frac{x}{12}\right)$$

x = 5.14 g.

Q.53 Moles of Na_2CO_3 = $\frac{21.2\times10^3}{106}$ = 200

So moles of CO_2 = 200
& so moles of $CaCO_3$ reqd = 200
∴ wt of $CaCO_3$ reqd = 200 × 100 = 20 kg.

Q.54 **(2)**

Let mol of Fe undergoing formation of FeO = x
Let mol of Fe undergoing formation of Fe_2O_3 = 1 – x

then, $Fe + \frac{1}{2}O_2 \longrightarrow FeO$
$x \quad x/2 \quad x$

$2Fe + \frac{3}{2}O_2 \longrightarrow Fe_2O_3$
$1-x \quad \frac{3}{4}(1-x) \quad \frac{1-x}{2}$

As given, $\frac{x}{24}+\frac{3}{4}(1-x) = 0.65$
= Total moles of oxygen

x = 0.4 = moles of FeO

$\frac{1-x}{2}$ = 0.3 = moles of of Fe_2O_3

$$\Rightarrow \frac{\text{Mole of FeO}}{\text{Mole of } Fe_2O_3} = \frac{4}{3}$$

Q.55 **(2)**

$C_6H_5OH + 7O_2 \longrightarrow 6CO_2 + 3H_2O(\ell)$
30 ml
6 × 30 = 180 ml of CO_2 is produced
Volume used initially
= 30 + 210 = 240
(for C_6H_5OH) (for O_2)
change in volume = 240 – 180 = 60 ml

Q.56 **(3)**

$N_xO_y + y\,H_2 \longrightarrow yH_2O\,(\ell) + x/2\,N_2(g)$

$$\frac{x/2}{y} = \frac{10}{30}$$

$$\frac{x}{y} = \frac{2}{3}$$

Q.57 $CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$

$\frac{100}{64}$ (excess)

From mole-mole analysis

$\frac{100}{64} = \frac{n_{C_2H_2}}{1}$ (here n = mole)

vol. = $n_{C_2H_2}$ × 22.4 (at N.T.P)

= $\frac{100}{64}$ × 22.4 = 35 lit.

Q.58 **(1)**

On balacing Na atoms on both sides of reaction, we get :
y = 6x.
∴ x : y = 1 : 6 (only A option matches).

Q.59 **(2)**

C = 84/12 = 7 mole
H_2 = 12 g = 6 mole
O_2 = 56/22.4 = 5/2 mole
$12C + 11H_2 + 11/2\,O_2 \longrightarrow C_{12}H_{22}O_{11}$
L.R. = O_2
11/2 mole O_2 produce 1 mole sucrose
5/2 mole O_2 will for 5/11 mole sucrose
mass of sucrose = 5/11 × (mol. mass)
= 5/11 × 342
= 155.45 g

Q.60 On balancing the reaction,

$C_4H_{10} + \frac{13}{2}O_2 \longrightarrow 4CO_2 + 5H_2O$

$$\frac{\text{Mole of } C_4H_{10}}{1} = \frac{\text{Mole of } CO_2}{4\times1}$$

Hence mole of CO_2 = 4 × mole of C_4H_{10}
4 × 0.15 = 0.60.

Q.61 **(3)**

$C_2H_4O_2 + 2O_2 \longrightarrow 2CO_2 + 2H_2O$
n mole 2n mole for max. energy
60 n gram 2n × 32 gram
⇒ 60 n gram 64 n gram
⇒ 60 n + 64 n = 620 ⇒ n = 5
produced CO_2 = 2n = 10 mole
CO_2 mass produced = 10 × 44 = 440 gram

Q.62 **(3)**

C_4H_{10} = 80 ml
CH_4 = xml CO = y ml
x + y = 120 ml
$C_4H_{10} \longrightarrow 4\,CO_2$,

80 ml 320 ml,

$CO \longrightarrow CO_2$

y ml y ml

$CH_4 \longrightarrow CO_2$

x ml x ml

total CO_2 volume

= 320 + x + y ml

= 320 + 120

= 440 ml

Q.63 **(3)**

$CO = x$ ml ; $CO_2 = y$ ml, $N_2 = z$ ml

x + y + z = 200

....(i)

$CO + 1/2\ O_2 = CO_2$

x o Contraction = x/2

o x

CO_2 No reaction ; $N_2 + O_2 \longrightarrow$ no reaction

change in volume = x/2 = 40

x = 80 ml

$x + y = 200 \times \dfrac{50}{100} = 100$

...(ii)

y = 20 ml ; z = 100 ml

Q.64 **(1)**

Let volume is V ml

$H_2SO_4 + 2\ NaOH \longrightarrow Na_2SO_4 + 2H_2O$

mmole 0.2 V 40 x 0.1

m. moles of H_2SO_4 remains = $0.2\ V - \dfrac{40 \times 0.1}{2}$

$$\frac{0.2V - \dfrac{40\ x\ 0.1}{2}}{V + 40} = \frac{6}{55} \quad V = 70\ mL$$

Q.65 $3BaCl_2 + 2Na_3PO_4 \longrightarrow Ba_3(PO_4)_2 + 6\ NaCl$

mole 0.5 0.1

$\dfrac{0.5}{3}$ $\dfrac{0.1}{2}$ (L.R is Na_3PO_4)

Now from mole– mole analysis

$$\frac{\text{mole of } Na_3PO_4}{2} = \frac{\text{mole of } Ba_3(PO_4)_2}{1}$$

$= \dfrac{0.1}{2}$ = mole of $Ba_3(PO_4)_2$

⇒ mole of $Ba_3(PO_4)_2$ = 0.05 mol.

Q.66 $2P + Q \longrightarrow R$

8 5

8/2 5/1 (L.R is P)

from mole-mole analysis

$\dfrac{8}{2} = \dfrac{n_R}{1}$ (here n= mole)

n_R = 4 mole of R.

Q.67 **(1)**

1 mol of x will give = $\dfrac{5}{2}$ = 2.5 mol

But % yield = $\dfrac{1.25}{2.5} \times 100$ = **50%**

Q.68 **(1)**

(1) Explanation : $2\ Ag + S \rightarrow Ag_2\ S$

2 × 108 g of Ag reacts with 32 g of sulphur

10 g of Ag reacts with $\dfrac{32}{216} \times 10 = \dfrac{320}{216} > 1$ g

It means 'S' is limiting reagent

32 g of S reacts to form 216 + 32 = 248 g of Ag_2S

1 g of S reacts to form = $\dfrac{248}{32}$ = 7.75 g

Alternately

n_{eq} of Ag = $\dfrac{10}{108}$ = 0.0925

n_{eq} of S = $\dfrac{1}{16}$ = 0.0625 (n_{eq} = number of equivalents)

Since n_{eq} of S is less than n_{eq} of Ag

⇒ 0.0625 eq of Ag will react with 0.0625 eq of S to form 0.0625 eq of Ag_2S

Hence , amount of Ag_2S = n_{eq} × Eq. wt. of Ag_2S = 0.0626 × 124 = 7.75 g

Q.69 $2H_2 + O_2 \longrightarrow 2H_2O$

mole $\dfrac{4}{2}$ $\dfrac{4}{32} = \dfrac{1}{8}$

$\dfrac{4/2}{2}$ $\dfrac{1/8}{1}$ (O_2 is L.R.)

From mole–mole analysis

$$\frac{\dfrac{1}{8}}{1} = \frac{n_{H_2O}}{2}$$

$n_{H_2O} = \dfrac{1}{4}$

$\text{Mass}_{H_2O} = \dfrac{1}{4} \times 18 = 4.5$ g.

Q.70 $A + 2B \rightarrow C$

5 8

$\frac{5}{1}$ $\frac{8}{2}$ (B is L.R)

From mole–mole analysis

$$\frac{8}{2} = \frac{n_C}{1}$$

n_C = 4 mole of C.

Q.71 **(1)**

Limiting reactant is A

Ideally with 2 moles of A, D formed = 3 moles

But yield = 25%

So, moles of D formed

= 3 × 0.25 = **0.75 mol**

Q.72 $2H_2 + O_2 \longrightarrow 2H_2O$

Given moles $\left(\frac{8}{2}\right)$ $\left(\frac{16}{32}\right)$

4 0.5

So O_2 is the limiting reagent

moles used of H_2 = 1

So unreacted moles = 6 gm.

Q.73 LR → HCl, so Mole of $H_2 = \frac{\text{Mole of HCl}}{2}$

$$= \frac{0.52}{2} = 0.26$$

Q.74 (1)

(1) L.R. $\longrightarrow$ Al

(2) Mole of $AlCl_3$ = mole of Al = 1.0

(3) Mole of Cl_2 used = 1.5

Hence left mole = 3 – 1.5 = 1.5.

Q.75 (1)

$I_2 + 2CI_2 \longrightarrow ICI + ICI_3$

Given mass 25.4 gram 14.2 gram 0

0 0.1 mole 0.2 mole 0

0 0 0

0.1 0.1

Q.76 (1)

$Ag + HMO_3 \xrightarrow{NaCI} AgCI$

21.6 14.35

mole $\frac{21.6}{108} = 0.2$

Ag Atom remain conseved

So No. of mole of Ag = No. of mole of Ag CI

So. No. of mole of AgCI = 0.2

Weight of AgCI = 28.7

% Yield = $\frac{14.35}{28.7} \times 100$ = 50 %.

Q.77 **(2)**

$M_2(CO_3)_n + 2HCl \rightarrow nCO_2 + 2MCl_n + H_2O$

balancing O atom

3n = 2n + 1

n = 1

Q.78 (1)

$M_1V_1 + M_2V_2 = M_R[V_1 + V_2]$

$1 \times 500 + 1 \times 500 = M_R[500 + 500]$

$M_R = 1.$

Q.79 (3)

$$0.050 \times 2 = \frac{0.10 \times 2 \times V - 50 \times 0.10 \times 1}{V + 50}$$

⇒ V = 100 ml.

Q.80 **(1)**

$$\text{Molality} = \frac{X_B}{X_A \times M_A} \times 1000$$

m_B = 75 m

$$m = \frac{M \times 1000}{d \times 1000 - M \times M_1}$$

M = 30

Q.81 **(1)**

$$NaOH = \frac{125ml \times 1 \times \frac{8}{100}}{40} \text{ mole}$$

$$HCl = \frac{125 \times \frac{10}{100}}{36.5} = 0.34 \text{ mole}$$

HCl > NaOH

Acidic

Q.82 **(1)**

Both have equal volume = V

$$HCl = \frac{\left(v \times \frac{10}{100}\right) \times d_{HCl}}{36.5} \text{ mole;}$$

$$NaOH = \frac{\left(v \times \frac{10}{100}\right) \times 1.5\ d_{HCl}}{40} \text{ mole}$$

NaOH mole > HCl mole

Basic Solution

Q.83 **(3)**

$$\text{Molarity} = \frac{6.02\times10^{22}}{6.02\times10^{23}} \times \frac{1}{1/2} = 0.2$$

Q.84 **(1)**

Molar fraction & molality is independent of temperature.

Q.85 **(4)**

$$M = \frac{\%\text{ by weight}\times10\times d}{Mw_2} = \frac{36.5\times10\times1.2}{36.5} = 12$$

M

$$m = \frac{36.5\times1000}{36.5\times(100-36.5)} = \frac{1000}{63.5} = 15.7 \text{ m}$$

Q.86 $[NO_3^-] = \frac{0.1V+0}{2V} = \frac{0.1}{2} = 0.05$ M

Q.87 **(2)**

1000 mL solution contain 2 mole of ethanol or 1000 × 1.025 g solution contain 2 mole of ethanol

wt. of solvent = 1000 × 1.025 – 2 × 46

$$m = \frac{2}{1000\times1.025-2\times46} \times 1000$$

$$m = \frac{2}{933} \times 1000 = 2.143$$

Q.88 **(3)**

$$\text{Molarity} = \frac{6.02\times10^{22}}{6.02\times10^{23}} \times \frac{1}{1/2} = 0.2$$

Q.89 $M = \dfrac{\frac{2.8}{56}}{100} \times 1000 = \dfrac{1}{2}$ M

Q.90 **(1)**

100 gm oleum gives H_2SO_4 = 112 gm

12.5 gm will give $H_2SO_4 = \frac{112}{100}\times12.5$ = 14 gm

No. of moles of $H_2SO_4 = \frac{14}{98}$

Conc. of H^+ ions $= \dfrac{\frac{14}{98}\times2}{100} = 2.85 \times 10^{-3}$ M

Q.91 **(2)**

Let, $n_{H_2O} = n_{NaCl} = n$

$$m = \frac{\text{Mole of solute}}{\text{wt. of solvent (kg)}} = \frac{n}{n\times18} \times 1000$$

$$= \frac{1}{18}\times1000 = 55.55 \text{ m.}$$

Q.92 $\frac{250\times0.5+0}{750}\times N_A = 6 \times 6.023 \times 10^{23} = 3.76 \times 10^{22}$

Q.93 **(2)**

Q.94 **(3)**

V_1 ml 0.2 M NaOH, V_2 ml 0.1 M $CaCl_2$

(+ve ion) = 0.2 V_1 = 0.1 V_2 mole

(–ve ion) = 0.2 V_1 + 0.1 ×2V_2

= 0.2V_1 + 0.2 V_2 mole

by equation

$$(+ve) = (-ve) - (-ve) \times \frac{40}{100}$$

$$= (-ve) \times \frac{60}{100}$$

$$\Rightarrow 0.2 V_1 + 0.1 V_2 = 0.2 (V_1 + V_2) \times \frac{6}{10}$$

$\Rightarrow 2V_1 + V_2 = 1.2 V_1 + 1.2 V_2$

$\Rightarrow 0.8 V_1 = 0.2 V_2 \Rightarrow 4V_1 = V_2$

V_1 = 200 ml, V_2 = 800 ml

Q.95 m = 0.2 mole / kg

weight of solvent = 1000 gram

weight of solute = 0.2 × 98 = 19.6 gram

Total weight of solution = 1000 + 19.6 = 1019.6

ml.

Q.96 **(1)**

Mole fraction of A i.e. $X_A = \frac{n_A}{\text{Total moles}}$

So $X_{H2O} = \frac{n_{H_2O}}{\text{Total moles}}$

Now $\frac{X_A}{X_{H_2O}} = \frac{n_A}{n_{H_2O}}$

and molality $= \frac{n_A\times1000}{n_{H_2O}\times18} = \frac{X_A\times1000}{X_{H_2O}\times18}$

$= \frac{0.2\times1000}{0.8\times18}$ = **13.9 Ans.**

Q.97 **(3)**

Molarity = $\frac{98\times10\ \times1.84}{\text{Gmm}}$ = 18.4 M

{$\therefore$ M = $\frac{(\%\text{w/w})\times(\text{d})\times10}{\text{Mol.mass of solute}}$ } (d in g/ml.)

Q.98 **(2)**

Weight of KOH = 2.8 gram

Volume of solution = 100 ml

M = $\frac{2.8\times1000}{56\times100}$ = $\frac{28}{56}$ = 0.5 M

Q.99 **(3)**

Molarity of Cl^- = 3 (molarity of $FeCl_3$) = 3 $\left(\frac{M}{30}\right)$ = $\frac{M}{10}$.

Q.100 **(1)**

$M_1V_1 + M_2V_2 = M_R [V_1 + V_2]$

$1 \times 500 + 1 \times 500 = M_R [500 + 500]$

$M_R = 1$

Q.101 **(3)**

$M_{\text{final}} = \frac{M_1V_1 + M_2V_2}{V_1 + V_2 + V_{\text{water}}}$; $0.25 = \frac{0.6\times250+0.2\times750}{250+750+V_{\text{water}}}$; So V_{water} = 200 mL.

Q.102 **(2)**

Mole = M × V

$100 \times 10^{-3} = 0.8 \times V$

V = 0.125

Q.103 **(4)**

Moles of Cl^- in 100 ml of solution = $\frac{2}{58.5}+\frac{4}{111}\times 2+\frac{6}{53.5}$ = 0.2184

Molarity of Cl^- = $\frac{0.2184}{100}$ × 1000 = 2.184.

Q.104 **(4)**

Conc. of cation = $\frac{400+300+200}{400}$

Conc. of anion = $\frac{200+300+400}{400}$

$\therefore$ Ratio of the conc. = 1

JEE-ADVANCED
OBJECTIVE QUESTIONS

Q.1 **(1)**

46x + 30(100–x) = 34 × 100

Let % by mole of NO_2 be x.

Q.2 **(3)**

$M_{avg} = 24.31 = \frac{79\times24+(21-x)\times25+x\times26}{100}$

x = 10

Q.3 **(2)**

The weight % of available Cl_2 from the given sample of bleaching powder on reaction with dil acids or CO_2 is called available chlorine.

$$CaOCl_2 + H_2SO_4 \rightarrow CaSO_4 + H_2O + Cl_2$$

Max. % of available of Cl_2 = $\frac{71}{127}$ × 100 = 55.9 %.

Q.4 (1)

Average atomic mass

$= \frac{\%\text{ of I isotope}\times\text{ its atomic mass}+\%\text{ of II isotope}\times\text{ its atomic mass}}{100}$

$= \frac{75.53\,x\,34.969+24.47\,x\,36.96}{100}$

= 35.5 amu.

Q.5 (3)

$\therefore$ 1 mol of $C_6H_{12}O_6$ has = 6 N_A atoms of C

$\therefore$ 0.35 mol of $C_6H_{12}O_6$ has

= 6 × 0.35 N_A atoms of C

= 2.1 N_A atoms

= 2.1 × 6.022 × 10^{23} **= 1.26 × 10^{24} carbon atoms**

Q.6 (1)

$\because$ mol. wt. of $CaCl_2$ = 111 g

$\because$ 111 g $CaCl_2$ has = N_A ions of Ca^{+2}

$\therefore$ 222g of $CaCl_2$ has $\frac{N_A\times222}{111}$ = 2N_A ions of Ca^{+2}

Also $\because$ 111 g $CaCl_2$ has = 2N_A ions of Cl^-

$\therefore$ 222 g $CaCl_2$ has = $\frac{2N_A\times222}{111}$ ions of Cl^-

= 4N_A ions of Cl^- .

Q.7 (1)

$\because$ 1.429 gm of O_2 gas occupies volume = 1 litre.

$\therefore$ 32 gm of O_2 gas occupies = $\frac{32}{1429}$

= 22.4 litre/mol.

Q.8 **(2)**

$P_4 + O_2 \xrightarrow{\quad} P_4O_6 + P_4O_{10}$

31 (g) 32 (g)

According to question weight of P is conserved so

Let Mole of $P_4O_6 = a$

Mole of $P_4O_{10} = b$

Initial weight of P = Final weight of P.

$31 = [a \times 4] \times 31 + [b \times 4] \times 31$

$4a + 4b = 1]$ (1) × 3

Initial weight of oxygen = Final weight of oxygen

$32 = [a \times 6] \times 16 + [a \times 10] \times 16$

$3a + 5b = 1]$ (2) × 4

$12a + 20b = 4$

$12a + 12b = 3$ So $b = \frac{1}{8}$

$8b = 1$

Similarly $a = \frac{1}{8}$

So weight of $P_4O_6 = \frac{1}{8} \times 220$

$= 27.5$ $P_4O_{10} = \frac{284}{8} = 35.5.$

Q.9 **(1)**

$I_2 + 10\,HNO_3 \rightarrow 2\,HIO_3 + 10NO_2 + 4H_2O$

Moles of iodine $= \frac{5}{254}$

Moles of $HNO_3 = \frac{5}{254} \times 10$

Mass of $HNO_3 = \frac{5 \times 10}{254} \times 63 = 12.4$ g

Q.10 (1)

20 g KCl present in 100–20 = 80 g of H_2O

Wt. of KCl in 60 g water $= \frac{20}{80} \times 60 = 15$ gram

Q.11 **(2)**

$2NaCl + Ag_2SO_4 \rightarrow 2AgCl + Na_2SO_4$

Initially

No. of moles of $Ag_2SO_4 = 2 \times 2 = 4$

No. of moles of NaCl = 4 × 1

AgCl formed = 4 moles

No. of moles of Ag^{2+} left = 4 × 2 – 4 = 4

No. of moles of Cl^- left = 0

No. of moles of Na^+ = 4

No. of moles of SO_4^{-2} = 4

Sum of molar conc. $= \frac{12}{6} = 2$ M

Q.12 **(1)**

$CaCl_2 + NaCl = 10$ g

Let weight of $CaCl_2 = x$ g

$CaCl \rightarrow CaCO_3 \rightarrow CaO$

1 mol 1 mol 1 mol

$\frac{x}{111}$ mol $\frac{x}{111}$ mol $\frac{x}{111}$ mol

Mole of CaO $= \frac{1.62}{56}$

$\therefore \frac{x}{111} = \frac{1.62}{56}$

x = 3.21 g

% of $CaCl_2 = \frac{3.21}{10} \times 100 = 32.1$ %

Q.13 (2)

$P_4S_3 + 8O_2 \rightarrow P_4O_{10} + 3SO_2$

440 g 384 g

(mass)

$\frac{440}{220} = 2$ 12

(mole)

O_2 is limiting reagent

so moles of P_4O_{10} produced $= \frac{12}{8}$

mass of P_4O_{10} produced $= \frac{12}{8} \times 284 = 426$ g

Q.14 **(1)**

$3\,Mg + 2NH_3 \rightarrow Mg_3N_2 + 3H_2$

48 34

(mass) 2 2

(mole)

Mg is limiting reagent

So moles of $Mg_3N_2 = \frac{2}{3}$

mass of $Mg_3N_2 = \frac{2}{3} \times 100 = \frac{200}{3}$

Q.15 **(3)**

Relative no. of atoms C : H : O

$\frac{9}{12} : \frac{1}{1} : 0.25$

3 4 1

Empirical formula mass = 36 + 4 + 16 = 56

$n = \frac{108}{50} = 2$

Molecules formula = 2 (Empirical formula)

$= 2\,(C_3H_4N)$

$= C_6H_8N_2$

Q.16 (4)

100 kg impure sample has pure $CaCO_3$ = 95 kg

$\therefore$ 200 kg impure sample has pure

$CaCO_3 = \frac{95 \times 200}{100} = 190$ kg.

$CaCO_3 \rightarrow CaO + CO_2$

$\because$ 100 kg $CaCO_3$ gives CaO = 56 kg.

$\therefore$ 190 kg $CaCO_3$ gives CaO $= \frac{56 \times 190}{100}$

= 106.4 kg.

Q.17 **(1)**

$NaH_2PO_4 + Mg^{2+} + NH_4^+ \rightarrow Mg(NH_4)PO_4 \cdot 6H_2O$

$\xrightarrow{\text{heated}} Mg_2P_2O_7$

Since P atoms are conserved , applying POAC for P atoms,

moles of P in NaH_2PO_4 = moles of P in $Mg_2P_2O_7$

1 × moles of NaH_2PO_4 = 2 × moles of $Mg_2P_2O_7$

($\because$ 1 mole of NaH_2PO_4 contains 1 mole of P and 1 mole of $Mg_2P_2O_7$ contains 2 moles of P)

$$\frac{\text{wt. of } NaH_2PO_4}{\text{mol. wt. of } NaH_2PO_4}$$

$$= 2 \times \frac{\text{wt. of } Mg_2P_2O_7}{\text{mol. wt. of } Mg_2P_2O_7}$$

$$\frac{\text{wt. of } NaH_2PO_4}{120} = 2 \times \frac{1.054}{222}.$$

Wt. of NaH_2PO_4 = 1.14 g.

Q.18 (2)

$2O_3 \rightarrow 3O_2$

2 3

$x \quad \frac{3}{2}x$

$\frac{3}{2}x - x = 9$ [29 – 20 = 9]

x = 18

x = 90% $[O_3]$

O_2 = 10%

Q.19 (1)

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

1 2

x 2x

x + 2x + 8x = 1

11x = 1

$x = \frac{1}{11}$

$CH_4 = \frac{1}{11}, \; X_{O_2} = \frac{2}{11}, \; x_{N_2} = \frac{8}{11}$

Q.20 **(1)**

v.s. = N × 5.6

or 11.2 = N × 5.6

or N = 2eq/L

= 2 × 17 g/L

= 34 g/L

$= \frac{34\text{g}}{1000\,\text{ml}} \times 100 = 3.4\%$ (wt/vol)

Q.21 **(4)**

Total wt. of NaOH = 30 + 90 = 120

Total vol. of solution = 100 + 100 = 200

$M = \frac{120}{40} \times \frac{1000}{200} = 15$

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MCQ/COMPREHENSION/COLUMN MATCHING

Q.1 **(A,B,C)**

Mole of NH_3 = 1.7 = 0.1

Mole H atom = 0.3

Total atoms = 0.4 × 6.02 × 10^{23} = 2.408 × 10^{23}

$\% H = \frac{3 \times 1}{17} \times 100 = 17.65\%$

Q.2 (A,B)

(A) and (B) Explanation : M. Wt. = 0.001293 × 22400 = 28.96

M.Wt. = d × volume of 1 mole of gas at STP

$V.\,D = \frac{28.96}{2} = 14.48$

So (A) and (B) are correct answer.

Q.3 **(A,B,C)**

Let volume of solution = 1000 mL

$[Ba^{2+}]$ = 5 M ; $[Cl^-]$ = 10 M

$[Na^+]$ = 10 M

$[Cl^-]$ = 10 M

1000 ml solution = 1949 g solution

solute $\Rightarrow$ $BaCl_2$, NaCl & Na_2X

$BaCl_2$ = 5 mole = 1040 g

NaCl = 588 g ; Na_2X = mole of Na_2X × 142

Solvent = 1949 – (1040 + 588 + $142n_{Na2}X$)

= 321 – 142 n Na_2X

$$m_{Na2X} = \frac{n_{Na_2X}}{321-142n_{Na_2X}}\times 1000 = 2$$

n_{Na_2X} = 0.5

Q.4 **(B,C,D)**

$C + O_2 \longrightarrow CO_2$

Mass 27 88

Moles $\frac{27}{12}$ $\frac{88}{32}$

C is limiting reagent

Moles of CO_2 produced = moles of C = $\frac{27}{12}$ = 2.25

∴ Volume of CO_2 at STP = 2.25 × 22.4 = 50.4 L

Ratio of C and O in CO_2 = 12 : 32 = 3 : 8

Moles of unreacted O_2 = 2.75 – 2.25 = 0.5

∴ Volume of unreacted O_2 at STP = 0.5 × 22.4 = 11.2 L

Q.5 **(A,C)**

0.5 x n = $\frac{216}{108}$ = mol of Ag

n = 4

M.wt = 58 + [165]n g/mol = 718 g/mol

Q.6 **(A,C)**

Convert all the wt. in mole and use limiting reagent concept find out the mole produced of NH_3.

In (A) & (C) it comes equal to 10 moles

A & C

Q.7 **(B,C)**

(i) $K_4Fe(CN)_6 + 3H_2SO_4 \longrightarrow 2K_2SO_4 + FeSO_4 + 6HCN$

1 mole 5 mole

Limiting reagent 1/1 5/3

(1–1) (5–3 × 1)2 × 1 1 × 1 6 × 1

0 mole 2 mole 2 mole

1 mole 6 mole

Limiting reagent in step (i) is $K_4[Fe(CN)_6]$

(ii) $6HCN + 12H_2O \longrightarrow 6HCOOH + 6NH_3$

6 mole (excess) 0 0

0 6 mole 6 mole

(iii) (a) $6NH_3 + 3H_2SO_4 \longrightarrow 3(NH_4)_2SO_4$

6 mole 2 mole 0

Limiting reagent 6/6 2/3

$(6-\frac{2}{3}\times 6)$ $(2-\frac{2}{3}\times 3)$ $(3\times\frac{2}{3})$

2 mole 0 mole 2 mole

(b) $6HCOOH \xrightarrow{H_2SO_4} 6CO + 6H_2O$

6 mole 0 mole 0 mole

0 mole 6 mole 6 mole

Limiting reagent in step (i) is $K_4[Fe(CN)_6]$

$(NH_4)_2SO_4$ = 2 mol

CO gas = 6 mol

Q8 **(A,B,C)**

(Mw of Na_2CO_3 = 106, Mw of HCl = 36.5, Mw of NaCl = 58.5)

Moles of Na_2CO_3 = $\frac{106}{106}$ = 1.0 mol

Moles of HCl = $\frac{109.5}{36.5}$ = 3.0 mol

(A) Since for 1 mol of Na_2CO_3, 2 mol of HCl is required.

So, HCl is in excess (3 – 2) = 1.0 mol

Therefore, Na_2CO_3 is the limiting quantity.

(B) Weight of NaCl formed = (1.0 mol Na_2CO_3) $\left(\frac{2\text{ mol NaCl}}{\text{mol }Na_2CO_3}\right)\left(\frac{58.5\text{g NaCl}}{\text{mol NaCl}}\right)$ = 1 × 58.5 = 117.0 g NaCl

(C) 1 mol of Na_2CO_3 = 1 mol of CO_2 = 22.4 L at NTP

Q.9 **(A,C)**

$CaCl_2 \rightarrow CaCO_3 \rightarrow CaO$ $\frac{1.12}{56}$ = 0.02 mole CaO

∴ Moles of $CaCl_2$ = 0.02 Mole

Mass of $CaCl_2$ = 0.02 × 111 = 2.22 g

∴ % of $CaCl_2$ = $\frac{2.22}{4.44}$ × 100 = 50 %

Q.10 **(B,D)**

$3A + 2B \longrightarrow A_3B_2$

Initial mole 3 3 0

Final mole 0 3–2 1

$A_3B_2 + 2C \longrightarrow A_3B_2C_2$

Initial mole 1 1 0

Final mole $1-\frac{1}{2}$ 0 $\frac{1}{2}$

Q.11 (A,B,D)

(A) Weight of $CaCO_3$ = (0.22 g CO_2)

$$\left(\frac{1\,\text{mol CO}_2}{44\text{ g CO}_2}\right)\left(\frac{1\,\text{mol CaCO}_3}{\text{mol CO}_2}\right)\left(\frac{100\text{g CaCO}_3}{\text{mol CaCO}_3}\right)$$

$= \frac{0.22\times100}{44}$ = 0.5 g $CaCO_3$

(B) Moles of $CaCO_3$ = moles of Ca = $\left(\frac{0.22}{44}\right)$ = 0.005 mol

Weight of Ca = 0.005 × 40 = 0.2 g Ca

(D) % of Ca = $\frac{0.2}{1.0}$ × 100 = 20% Ca

Hence (C) is wrong.

Q.12 (A,B,C,D)

	Silica	H_2O	Impurities
% in original clay ⇒	40	19	100 – (40 + 19) = 41
% after partial drying ⇒	a	10	100 – (a + 10) = 90 – a

On heating, only water evaporates from clay, whereas silica and impurities are left as it is. Therefore, % ratio of silica and impurities remains unchanged, i.e.

$\frac{40}{a} = \frac{41}{90-a}$, ∴ a = 44.4%

% of impurities after partial drying = (90 – a) = (90 – 44.4) = 45.6%

Q.13 **(A,C)**

Mw of $CaCO_3$ = 100, Mw of Na_2CO_3 = 106

Mw of HNO_3 = 63 g mol^{-1}

$Na_2CO_3 + CaCO_3 \longrightarrow CaCO_3 + 2NaCl$

(a) moles of $CaCO_3$ = $\frac{10}{100}$ = 0.1 mol

moles of Na_2CO_3 = moles of $CaCO_3$ ≡ 2 × moles of NaCl

Weight of Na_2CO_3 = 0.1 × 106 = 10.6 g

% purity Na_2CO_3 = $\frac{10.6}{21.2}$ = 100 = 50%

(b) wrong

(c) correct

(D) moles of NaCl = 2 × 0.1 = 0.2 mol

Q.14 **A, B**

Q.15 **A,B**

Q.16 **(B,D)**

Molality of Cl^- = $\frac{2\times1000\times2}{(1000\times1.09)-190} = 4.44$

Q.17 (A,B)

Q.18 (A,C,D)

[Mw of KI, $(NH_4)_2SO_4$, $CuSO_4$, $CuSO_4.5H_2O$ and Al^{3+}, respectively, are, 166, 132, 160, 250 and 27 g mol^{-1}]

Q.19 If 100 ml of 1M H_2SO_4 solution is mixed with 100 ml of 9.8%(w/w) H_2SO_4 solution (d = 1 g/mL) then :

(A) concentration of solution remains same

(B) volume of solution become 200 mL

(C) mass of H_2SO_4 in the solution is 98 g

(D) mass of H_2SO_4 in the solution is 19.6 g

(A,B,D)

(A) Molarity of second solution is = $\frac{10\times d\times x}{M}$ = 1 M

(B) Volume = 100 + 100 = 200 mL

(D) Mass of H_2SO_4 = $\frac{200\times1}{1000}$ × 98 = 19.6 g.

Q.20 (A,B,D)

Vml 0.1 M NaCl

Vml 0.1 M $FeCl_2$

$[Na^+] = \frac{V\times0.1}{V+V}$ = 0.05 M

$[Fe^{2+}] = \frac{V\times0.1}{V+V}$ = 0.05 M

$[Cl^-] = \frac{V\times0.1+V\times0.1\times2}{V+V}$ = 0.15 M

Comprehension # 1 (Q. 21 to 23)

Q.21 **(C)**

11.2 g of N_2 ⇒ $\frac{11.2}{28}$ = 0.4 mole

∴ air = 0.5 mole ⇒ 0.5 × 22.4 = 11.2 Ltr air

Q.22 **(B)**

1 mole of air ⇒ 0.8 mole of N_2 = 0.8 × 28 g N_2

⇒ 0.2 mole of O_2 = 0.2 ×32 g O_2

∴ % w/w O_2 = $\frac{w_{O_2}\times100}{w_{O_2}+w_{N_2}} = \frac{0.2\times32\times100}{0.2\times32+0.8\times28}$ = 22.2%

Q.23 **(B)**

Density of air at NTP

1 mole of air = 0.8 mole N_2 + 0.2 mole O_2

= 0.8 × 28 + 0.2 × 32 = 28.8 g = 22.4 Ltr volume.

D = $\frac{m}{V} = \frac{22.8}{22.4}$ = 1.2857 g/L

Comprehension # 2 (Q. 24 to 26)

Q.24 **(A)**

Q.25 **(B)**

Q.26 **(B)**

Comprehension # 3 (Q. 27 to 29)

Q.27 (B)

Q.28 (C)

Q.29 (B)

Comprehension # 4 (Q. 30 to 31)

Q.30 (B)

$$x = \frac{20/80}{\frac{20}{80}+\frac{30}{98}} = \frac{0.25}{0.25+0.31} = \frac{0.25}{0.56} = 0.45$$

Q.31 (C)

Mass of H_2O added

= moles of SO_3 in (100g) × 18

$$= 2 \times \frac{20}{80}\times 18$$

= 4.5 × 2 = 9

Labelling = 100 + 9 = 109%

Comprehension # 5 (Q. 32 to 34)

Q.32 **(A)**

$$\% \text{ (w/w) of } = \frac{\text{Total mass of solute}}{\text{Total mass of solution}} =$$

$$\frac{60\times 0.4+100\times 0.15}{60+100}\times 100 = 24.4\%.$$

Q.33 **(B)**

Mass of solute = 60 × 0.4 + 100 × 0.15 = 24 + 15 = 39 g

Mass of solvent = 160 – 39 = 121 g

$$\text{Molality} = \frac{\left(\frac{39}{58.5}\right)}{121\times 10^{-3}} = 5.509 = 5.5 \text{ m.}$$

Q.34 **(B)**

Mass of solute = 39 g

$$\text{Volume of solution} = \frac{160}{1.6} = 100 \text{ mL}$$

$$\therefore \text{ Molarity} = \frac{\left(\frac{39}{58.5}\right)}{100\times 10^{-3}} = 6.67 \text{ M}$$

Q.35 A-Q ; B-P, R ; C-P,R ; D-P

16 g CH_4 = 1 mole of CH_4 = 5 mole of atoms

= $5N_A$ = $6.023 \times 10^{23} \times 5$

= 22.4 lit (At STP)

1 g H_2 = 1/2 mole of H_2 = 1 mole of atoms

= 6.023×10^{23} atoms = 11.2 lit

22 g CO_2 = 1/2 mole of CO_2 = 3/2 mole of atoms

= $1/2 \times 6.023 \times 10^{23}$ atom

= 11.2 lit (At STP)

9 g H_2O = 1/2 mole H_2O = 3/2 mole of atoms

= $3/2 \times 60.03 \times 10^{23}$ atoms

Q.36 (A) R, (B) P, (C) Q

$$\% \text{ of Y} = \frac{89\times 3}{(89\times 3)+(5\times 27)+(12\times 16)} \times 100$$

$$= \frac{267\times 100}{594} = 44.95\%$$

$$\% \text{ Al} = \frac{5\times 27}{594}\times 100 = 22.73$$

$$\% \text{ O} = \frac{12\times 16}{594}\times 100 = 32.32\%$$

Q.37 A-Q, B-R, C-P, D-T

(A) N_2 + $3H_2$ → $2NH_3$

1 (mass) 1

(1/28) (mole) (1/2)

$$\text{Mass of } NH_3 = \left(2\times\frac{1}{28}\right) \times 17 = 1.214 \text{ g}$$

(B) $CaCO_3$ → CaO + CO_2

1g

10^{-2} mole 10^{-2} mole 10^{-2} mole

mass of CaO = 10^{-2} × 56 = 0.56 g

(C) $2H_2$ + O_2 → $2H_2O$

1g 1g

1/2 mole 1/32 2/32

$$\text{mass of } H_2O = \frac{2}{32}\times 18 = 1.125 \text{ g}$$

(D) C + $2H_2$ → CH_4

1g 1g

1/12 mole 1/2 1/12

mass of CH_4 = 1.33 g

Q.38 (A - p,q,r,s; (B - p,s; (C - q,r) ; (D - q)

(A) $Zn(s) + 2HCl\,(aq) \longrightarrow ZnCl_2(s) + H_2\,(g)$

Initial mole 2 2 0 0

final mole (2-1=1) 0 1 1

$$\text{Excess reagent left} = \frac{2-1}{2} \times 100 = 50\%$$

Volume of H_2 = 22.4 lit.
Solid product obtained = 1 mole
Limiting reagent is HCl.

(B) $AgNO_3(aq) + HCl \longrightarrow AgCl(s) + HNO_3(g)$

Initial mole $\frac{170}{170}=1$ $\quad \frac{18.25}{36.5}=\frac{1}{2} \quad 0 \quad 0$

$1-\frac{1}{2}=\frac{1}{2} \quad 0 \quad \frac{1}{2} \quad \frac{1}{2}$

Excess reagent = $\frac{1-\frac{1}{2}}{1} \times 100 = 50\%$

Volume of gas = 11.2 lit.

Solid product = $\frac{1}{2}$ mole

Limiting reagent is HCl.

(C) $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

Initial mole $\frac{100}{100}=1 \quad 0 \quad 0$

$0 \quad 1 \quad 1$

Excess reagent not present
Volume of gas = 22.4 lit. at STP
Solid product is 1 mole

(D) $2KClO_3(s) \longrightarrow 2KCl + 3O_2(g)$

Initial mole 2/3 0 0
0 2/3 2

No excess reagent left
Volume of gas = 44.8 lit.

Solid product is $\frac{2}{3}$ mole.

Q.39 (A) Q; (B) P; (C) S; (D) R

(A) 10 mole present in 1000 mL of solution
400 g in [1000 × 1.2]
400 g in 1200 g
solvent = 1200 - 400 = 8000\

1200 solution ⇒ 800 g solved
800 solution ⇒1200

100 solution = $\frac{1200}{800}\times 100$ = 150 gram

(B) 40 g in 100 mL of solution
40 in 160 g of solution
40 g in 160–40 = 120 g solution

(C) 8 × 100 in 1000 g of solvent
800 g in 1000 g of solvent

100g solvent = $\frac{1000}{800}\times 100$ = 125

(D) Moles of x = 0.6
Moles of y = 0.4
Mass of x = 0.6 × 20 = 12
Mass of y = 0.4 × 25 = 10

12x g ⇒ y ⇒ 10 g
120x g ⇒ y ⇒ = 100 g

Q.40 (A - p,s); (B - s); (C - p,q); (D - r)

(A) Molarity of cation = $\frac{M_1V_1 + M_2V_2}{V_1 + V_2}$ = $\frac{0.2\times 100 + 0.1\times 400}{500}$ = $\frac{0.6}{5}$ = 0.12

Molarity of Cl^{-} = $\frac{3(0.2)100 + 0.1\times 400}{500}$ = $\frac{0.6+0.4}{5}$ = 0.2

(B) Molarity of cation = $\frac{50\times 0.4 + 0}{100}$ = 0.2

Molarity of Cl^{-} = $\frac{0.4\times 50 + 0}{100}$ = 0.2

(C) Molarity of cation = $\frac{2(0.2)30 + 0}{100}$ = 0.12

Molarity of SO_4^{2-} = $\frac{30\times 0.2}{100}$ = 0.06

(D) 24.5 g H_2SO_4 in 100 mL solution

Molarity = $\frac{\frac{25.4}{98}}{0.1}$ = 2.5

∴ Concentration of cation = 2 × 2.5 M
Concentration of SO_4^{2-} = 2.5 M.

Q.41 (A - q,s); (B - p, s); (C - p, q, r); (D - q, r)

(A) C : H : O = $\frac{51.17}{12} : \frac{13.04}{1} : \frac{34.78}{16}$ = 4 : 12 : 2

or 2 : 6 : 1

∴ Empirical formula = C_2H_6O & molar mass = 46 g/mol

∴ Mol formula = C_2H_6O

$C_2H_6O + 3O_2 \longrightarrow 2CO_2 + 3H_2O$

1 mole 44.8 L at STP
0.25 mole (11.2 L at STP)

(B) Mass of C in organic compound = mass of C in CO_2 = $\frac{0.44}{44}$ × 12 = 0.12 g

Mass of H in organic compound = Mass of H in H_2O

$$= \frac{0.18}{18} \times 2 = 0.02 \text{ g}$$

$\therefore$ Mass of O in organic compound = 0.3 – (0.12 + 0.02) = 0.16 g

$$\therefore \text{C : H : O} = \frac{0.12}{12} : \frac{0.02}{1} : \frac{0.16}{16} = 0.01 : 0.02 : 0.01 = 1 : 2 : 1$$

$\therefore$ Empirical formula = CH_2O, but it contains 2 O atom per molecule

$\therefore$ Molecular formula = $C_2H_4O_2$

1 mole of $C_2H_4O_2$ contains 4 N_A hydrogen atoms.

$$C_2H_4O_2 + 2O_2 \longrightarrow 2CO_2 + 2H_2O$$

1 mole 44.8 L

0.25 mole 11.2 L

(C) C : H = 42.857 : 57.143

= 3 : x (given)

On solving, x = 4 $\therefore$ molecular formula = C_3H_4

1 mole of C_3 H_4 contains $4N_A$ hydrogen atoms.

Empirical formula is same as molecular formula

$$C_3H_4 + 4O_2 \longrightarrow 3CO_2 + 2H_2O$$

$$n_{CO_2} > n_{H_2O}$$

(D) C: H = $\frac{10.5}{12} : \frac{1}{1} = \frac{7}{8} : 1 = 7 : 8$ $\therefore$ Empirical formula = C_7H_8

Mol wt. = 2 × VD = 2 × 46 = 92

$\therefore$ Mol formula = Empirical formula = C_7H_8

$$C_7H_8 + 9O_2 \longrightarrow 7CO_2 + 4H_2O$$

$$n_{CO_2} > n_{H_2O}$$

NUMERICAL VALUE BASED

Q.1 5

Mole of SO_4^{2-} 4 × 1.25 = 5 g ion.

Q.2 78

C : O : S = 3 : 2 : 4

Hydrogen is = 7.7%

$\therefore$ 100 – 7.7 = 92.3 % contains C,O & S

$$\% \text{ C} = \left(\frac{3}{3+2+4}\right) 92.3 \;;$$

$$\% \text{ O} = \frac{2}{9} \times 92.3 \;; \qquad \% \text{ S} = \frac{4}{9} \times 92.3$$

Elements	%	% / Atomic mass	Simple ratio	Simplest whole no.
H	7.7	7.7	6	6
C	30.76	30.76/12 = 2.56	2	2
O	20.51	20.15/16 = 1.28	1	1
S	41.02	41.02/32 = 1.28	1	1

$\therefore$ empirical formula C_2H_6OS

minimum molar mass = 24 + 6 + 16 + 32 = 78

Q.3 4

Balanced chemical equation is

$$4nXeF_6 + -\!\!\left(CH_2–CH_2\right)\!\!-_n \longrightarrow -\!\!\left(CF_2–CF_2\right)\!\!-_n + 4nHF + 4nXeF_4$$

$$n_{\text{teflon}} = \frac{100}{100n} = \frac{1}{n}$$

$$\therefore \qquad n_{XeF_6} \text{ required } = \frac{1}{n} \times 4n = 4 \text{ moles}$$

Q.4 11

$$A + \frac{1}{2} B_2 \longrightarrow AB \text{ , 100 Kcal}$$

x x/2 x

$$A + 2B_2 \longrightarrow AB_4 \text{ , 200 Kcal}$$

(1–x) 2(1–x) (1–x)

100 x + 200 (1–x) = 140

200 – 100 x = 140

$$x = \frac{60}{100} = 0.6$$

$$n_{B_2} \text{ used} = \frac{x}{2} + 2(1–x) = \frac{1}{2} \text{ x } 0.6 + 2\,(1– 0.6) =$$

0.3 + 2 x 0.4 = 1.1 mol

Ans = 1.1 × 10 = 11

Q.5 59.28

(Atomic weight of Al and Cr = 27 and 52, M.wt. of Cr_2O_3 = 152)

$$\text{Moles of Al} = \frac{49.8 \text{ g}}{27 \text{ g Al}} = 1.84 \text{ mol}$$

$$= \frac{1.84}{2} = 0.92 \text{ mol of } Cr_2O_3$$

$$\text{Moles of } Cr_2O_3 = \frac{200 \text{ g}}{152 \text{ g } Cr_2O_3} = 1.31 \text{ mol}$$

Since 2 mol Al is required for 1 mol of Cr_2O_3.

So, Al is the limiting reagent and Cr_2O_3 is in excess.

Moles of Cr_2O_3 is excess

= (1.31 – 0.92) = 0.39 mol

Weight of excess Cr_2O_3 = 0.39 × 152 = 59.28 g Cr_2O_3

Q.6 28

$$F_2 + 2NaOH \longrightarrow \frac{1}{2} O_2 + 2NaF + H_2O$$

Mole 50×10^3 $2[50 \times 10^3]$

$$2NaF + CaO + H_2O \longrightarrow CaF_2 + 2\,NaOH$$

$2\times [50 \times 10^3]$ 50×10^3 Mole

Weight of lime (CaO) = $50 \times 10^3 \times 56$

= 2800 kg.

Feed amount of lime = 10,000

% Utilisation = $\frac{2800}{10,000}$ × 100 = 28%

Q.7 2

From one mole of initial mixture, some FeO must have reacted with oxygen and got converted into Fe_2O_3.

$$\begin{array}{lll} & 4FeO + O_2 \longrightarrow & 2Fe_2O_3 \\ \text{Initial moles} & \frac{3}{5} & \frac{2}{5} \\ \text{Final moles} & \frac{3}{5} - x & \frac{2}{5} + \frac{x}{2} \end{array}$$

But, final moles ratio is 2 : 3.

$$\therefore \quad \frac{\left(\frac{3}{5} - x\right)}{\left(\frac{2}{5} + \frac{x}{2}\right)} = \frac{2}{3}$$

$\therefore$ x = $\frac{1}{4}$

$\therefore$ Moles of FeO reacted = x = $\frac{1}{4}$

$\therefore$ Moles of O_2 required = $\frac{1}{4}$ (x) = $\frac{1}{16}$ = 0.0625

$\therefore$ Mass of O_2 required = 0.0625 × 32 = 2 g

Q.8 4

$n_{Cl_2} = \frac{112}{22.4} = 5$

n_{KOH} = 1 × 10 = 10

$$\begin{array}{lllll} Cl_2 + & 2KOH \xrightarrow{60\%} & KCl & + & KClO + H_2O \\ 5 & 10 & 5 \times 0.6 & & 5 \times 0.6 \\ & & = 3 & & = 3 \end{array}$$

$$\begin{array}{llll} 3KClO \xrightarrow{50\%} & 2KCl & + & KClO_3 \\ 3 & \frac{2}{3} \times 3 \times 0.5 & & \frac{1}{3} \times 3 \times 0.5 \\ & = 1 & & = 0.5 \end{array}$$

$$\begin{array}{ll} 4KClO_3 \xrightarrow{80\%} & 3KClO_4 + KCl \\ 0.5 & 0.8 \times \frac{0.5}{4} = 0.1 \end{array}$$

$(n_{KCl})_{total}$ = 3 + 1 + 0.1 = 4.1 moles ≈ 4 moles.

Q.9 50

Use POAC for carbon atom.

$C + O_2 \longrightarrow CO_2 + CO$

POAC on 'C' atom, 1 (mole of C) = 1 (mole of CO_2) + 1 (mole of CO)

$\frac{240}{12}$ = mole of CO_2 + $\frac{280}{28}$

Mole of CO_2 = 20 – 10 = 10

Mole % of CO_2 = $\frac{10}{20}$ ×100 = 50%.

Q.10 42

Let x be the mass of $CaCO_3$ hence mass of $MgCO_3$ = 92 – x

$$\begin{array}{ccc} CaCO_3 & + & MgCO_3 \\ \frac{x}{100}\downarrow & & \frac{92-x}{84}\downarrow \\ CaO + CO_2 & & MgO + CO_2 \\ \frac{x}{100} & & \frac{92-x}{84} \end{array}$$

mass of residue = 48 g

$\Rightarrow \quad \frac{x}{100} \times 56 + \frac{92-x}{84} \times 40 = 48$

$\Rightarrow \quad \frac{x}{100} + \frac{92-x}{84} = \frac{6}{7}$

$\Rightarrow$ x = 50

$\therefore$ mass of $MgCO_3$ = 92 – 50 = 42 g.

Q.11 8

Balance the equation by any method

$4Zn + 10HNO_3 \longrightarrow 4Zn(NO_3)_2 + 3H_2O + NH_4NO_3$

$\therefore$ a + b + c = 4 + 3 + 1 = 8

Q.12 27

Let wg water in added to 16 g CH_3OH

molality = $\frac{16 \times 1000}{W \times 32} = \frac{500}{W}$

$\frac{500}{W} = \frac{x_A \times 1000}{(1 - x_A)m_B} = \frac{0.25 \times 1000}{0.75 \times 18}$

W = 27 g.

Q.13 18

Molarity = $\frac{10 \times 1.8 \times 98}{98}$ = 18 M

Q.14 10

Use M = $\frac{\%\text{ by weight} \times 10 \times d}{Mw_2}$

$M_1V_1 = M_2V_2$

$\frac{90 \times 10 \times 0.8}{46} \times V = \frac{10 \times 10 \times 0.9}{46} \times 80$

V = 10 mL

Q.15 2

Molarity of HCl = $\frac{\text{Total moles of HCl}}{\text{Total volume}}$

= $\frac{5\times2}{2+3}$ = 2 M

Q.16 4

$MCl_x + x\,AgNO_3 \xrightarrow{\quad} xAgCl + M\,(NO_3)_x$

$$\frac{Mole\ of\ MCl_x}{1} = \frac{Mole\ of\ AgNO_3}{x}$$

$0.1 = \frac{1}{x}\ (0.5 \times 0.8)$

$x = \frac{0.4}{0.1} = 4$

Q.17 $\%\ CO_2 = \frac{2}{2+1+2} \times 100 = 40\%.$

KVPY
PREVIOUS YEAR'S

Q.1 (B)

0.1M HCl, V volume

H^+ moles = 0.1V

0.2 MH_2SO_4, V volume

(B) H^+ moles = 0.2 × 2 × V = 0.4 V

Total moles of H^+ = 0.4 V + 0.1 V = 0.5 V

$$\left[H^+\right] = \frac{\text{Moles}}{\text{Vol.}} = \frac{0.5V}{2V} = 0.25\,M/L$$

Q.2 (B)

$$\text{Molarity} = \frac{\text{Moles of Solute}}{\text{Vol. of Soiution}} = \frac{0.35}{1.3} = 0.269$$

Q.3 (B)

$KAI\ (SO_4)\ x.\ 12H_2O,\ x = 2$

Q.4 (C)

$$Ca + \frac{1}{2}O_2 \to CaO$$

$$Ca = \frac{20}{40} = \frac{1}{2}\text{moles}$$

$$\text{CaO formed} = \frac{1}{2}\text{moles}$$

$$w = \frac{1}{2}\times 56 = 28\,gm$$

Q.5 (B)

3.42 gm sacrose in 100 gm solution

$d = 1\ gm\ ml^{-1}$

$$\because d = \frac{\text{mass}}{\text{volume}}$$

$$\text{volume of solution} = \frac{100}{1} = 100\,ml$$

$$\text{Molarity} = \frac{n}{v}\times 1000$$

$$\text{Molarity} = \frac{3.42}{342\times100}\times1000 = 0.1$$

Q.6 (*)

Percentage of C_2F_4 of Molar mass 100

$$= \frac{1}{100}\times\frac{1}{100}\times100 = 0.01\%$$

Percentage of C_2F_4 of Molar mass 102

$$= \frac{99}{100}\times\frac{99}{100}\times100 = 98.01\%$$

Percentage of C_2F_4 of Molar mass 101

101 = 100 – (0.01 + 98.01) = 1.98%

Q.7 (D)

$C + O_2 \to CO_2$

$$\frac{2.4}{12} = 0.2\text{ mole of carbon}$$

$\therefore$ 0.2 mole of C need 0.2 mole of O_2

So vol. of 0.2 mole O_2 at STP = 0.2 × 22.4 =4.48 L

Q.8 (C)

The correct way of reporting the average value should have exactly the same number of digit after decimal which has least digit after decimal among the data given

Q.9 (C)

$$C_4H_8(g) \to 4CO_2(g) + 4H_2O(g)$$

$\frac{22.4L}{22.4}$ 89.6 L 72gm

= 1 mole =4 mole =4 mole

n_{o_2} consumed = 6

$\therefore\ V_{o_2}$ = 6 × 22.4 = 134.4 L

Q.10 (C)

$M_{H_2SO_4} = 0.5$

$V_{H_2SO_4} = 0.2$

$N_{H_2SO_4} = 0.1$

no of mole of 'S' atom = 0.1

∴ no of 's' atom = 0.1 A_0

$= \frac{A_0}{10}$

Q.11 (C)

$2Xe + 4F_2 \rightarrow XeF_2 + XeF_6$

Initial Mole 2 8 0 0

∴ nikes if Xe F_2 formed = 0.5

moles of XeF_6 formed = 0.5

∴ moles ratio = 1 : 1

Q.12 (A)

% Nitrogen $\frac{\text{Wt of N}}{\text{Wt of }(NH_4)_2SO_4}$ ⇒

$\%N = \frac{28}{132}\times 100$ = 21.21%

Q.13 (C)

$2pb^{2+} + 2ASO_4^{3-} \rightarrow pb_3\left(AsO_4\right)_2$

$n = M \times V$ $\quad$ $n = \frac{2}{3}\times 2\times 10^{-3}$

$= 0.1\times\frac{20}{1000} = 0.00133$ $\quad$ $= 2 \times 10^{-3}$

$\eta_{AS} = \eta_{ASO_4^{3-}} = 0.00133$

W_{AS} = 0.00133 × 74.9 = 0.0996

% of AS = $\frac{0.0996}{1.85}\times 100 = 5.4\%$

Q.14 (B)

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$

% of C = $\frac{12}{84}\times 100 = 14.28\%$

This Question can be done by checking % of carbon 14.2% comes only in $NaHCO_3$

Q.15 (A)

$2LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$

$\frac{1}{24}$ $\quad$ $\frac{1}{24\times 2}$

No. of moles of CO_2 = $\frac{1}{48}$

mass of CO_2 = $\frac{1}{48}\times 44 = 0.916g$

Q.16 (B)

$M + O_2 \rightarrow MO$

1.25 1.68

$\Rightarrow \frac{1.25}{E} = \frac{1.68}{E+8}$ ⇒ E = 23.25

n-factor = $\frac{69.7}{23.25} \approx 3$

∴ Empirical formula = M_2O_3

Q.17 (B)

$$Mav. = \frac{M_1n_1 + M_2n_2}{n_1 + n_2}$$

$$35.45 = \frac{35n_1 + 37n_2}{n_1 + n_2}$$

∴ $n_1 : n_2 = 3 : 1$

Q.18 (A)

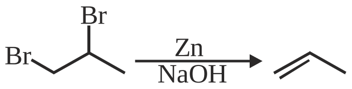
Volume of H_2O = 250ml,

Weight of water = 250 gm,

Number of male of H_2O = $\frac{250}{18}$

Number of molecule of H_2O = $\frac{250}{18}\times N_A$ = 83.6 × 10^{23}

Q.19 (B)



Mole = $\frac{20.2}{20.2}$ = 0.1 $\quad$ Mole = $\frac{3.58}{42}$ = 0.085

% yield = $\frac{0.085}{0.1}\times 100 = 85\%$

Q.20 **(D)**

Sol. 0.233 gm $BaSO_4$ has 1 millimole $BaSO_4$ and hence has 1millimole S

∴ organic compound (X) also has 1millimole S % of S in 0.102 gm of organic compound (X)

$= \frac{0.032}{0.102}$ × 100 = 31.37%

 102 gm of this organic compound has 32 gm S

This has same % of S

Q.21 (C)

Q.22 **(B)**

Water gas (CO : H_2 is 1 : 1) = 1 litre
Air = 9 litre

1 litre water gas at STP ⇒ $\frac{1}{22.4}$ moles of gas at STP

No. of moles of CO = $\frac{1}{2} \times \frac{1}{22.4}$ moles.

= No. of moles of CO_2 produced after ignition
= 0.022.

JEE MAINS

PREVIOUS YEAR'S

Q.1 129.3478gm

Mass of Na^+ in 50ml = 70 × 50 = 3500 mg
23000mg of Na^+ is present in 85000 mg $NaNO_3$

$\therefore$ 3500 mg Na^+ will be present in $\frac{85000}{23000} \times 35000$

= 129347.8mg
= 129.3478 gm.

Q.2 (2)

$n_{co_2} = \frac{2.64}{44} = 0.06$ $n_c = 0.06$

Weight of carbon = 0.06 × 12 = 0.72 gram

$n_{H2O} = \frac{1.08}{18} = 0.06$

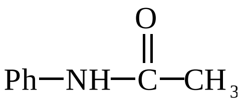
$n_H = 0.06 \times 2 = 0.12$
Weight of H_2 = 0.12 gram
$\therefore$ Weight of oxygen in $C_xH_yO_z$
= 1.8 × 0.72 – 0.12
= 0.96 gram

% weight of oxygen = $\frac{0.96}{1.8} \times 100$

= 53.3 %

Q.3 243×10^{-2}

$Ph - NH_2 \xrightarrow{Ac_2O \text{ or } CH_3COCl, \text{ Pyridine}}$



$Ph-NH-\overset{\overset{O}{\|}}{C}-CH_3$

(C6H7N)   Acetanilide (C8H9NO)
1.86 g
Molar mass = 93   Molar mass = 135
* 93 g aniline produces 135 g acetanilide

1.86 g aniline produces $\frac{135 \times 1.86}{93} = 2.70$ g

* At 90% efficiency of reaction it produces

$= \frac{2.70 \times 90}{100} = 2.43$ g

Ans. 243×10^{-2}

Q.4 8

$$C_xH_y + \left(x + \frac{y}{4}\right)O_2 \longrightarrow X\ CO_2\ c\left(\frac{y}{2}\right)H_2O(\ell)$$

Volume-Volume   V   6V 4V
Analysis

$$\frac{V_{C_xH_y}}{1} = \frac{V_{CO_2}}{x}$$

$$\frac{v}{1} = \frac{4v}{x} \qquad x = 4$$

$$\frac{V_{C_xH_y}}{1} = \frac{V_{O_2}}{x + \frac{y}{4}}$$

$$\frac{V}{1} - \frac{6V}{x + \frac{y}{4}}$$

$$x + \frac{y}{4} = 6$$

$$4 + \frac{y}{4} = 6$$

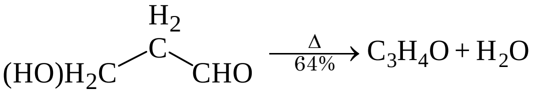
$$\frac{y}{4} = 8$$

y = 8
Formula C_4H_8

Q.5 **(18)**

$C_2H_6 \rightarrow 3H_2O$
0.1   0.3 = 0.3 × 6 × 10^{23} = 18 × 10^{22}
mol   mol
No. of molecules = 0.3 × 6.023 × 10^{23}
= 18.069 × 10^{22}

Q.6 **(16)**

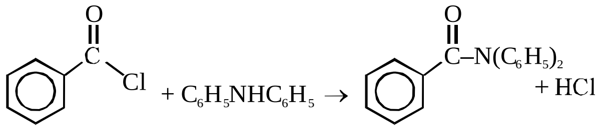


$\frac{x}{74}$ mol $\qquad \frac{x}{74} \times 0.64 = \frac{7.8}{56}$

x = 16.10

; 16.00

Q.7(77)



1 mole	1 mole	1 mole
= 140.5 gm	= 169 gm	= 273 gm

∴ 0.140 gm $\frac{169}{140.5} \times 0.140$

L.R. = 0.168 gm < 0.388 gm

excess

∴ Theoretical amount of given product formed

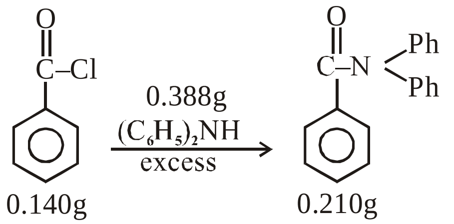
$= \frac{273}{140.5} \times 0.140 \; 0.272$gm

But its actual amount formed is 0.210 gm.

Hence, the percentage yield of product.

$= \frac{0.210}{0.272} \times 100 \; 77.20 \; 77$

OR



Mole of Ph – CoCl = $\frac{0.140}{140}$ = 10^{-3} mol

Mole of  $Ph\text{–}\overset{\overset{O}{\|}}{C}\text{–}N(Ph)_2$, that should be obtained

by mol-mol analysis = 10^{-3} mol.

Theoritical mass of product = $10^{-3} \times 273 = 273 \times 10^{-3}$g

Observed mass of product = 210×10^{-3}g

%yield of product = $\frac{210 \times 10^{-3}}{273 \times 10^{-3}} \times 100$ =76.9%=77

Q.8 **(1)**

PV = nRT

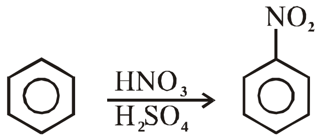
$$1.0 \times \frac{20}{1000} = \frac{N}{6.023 \times 10^{23}} \times 0.083273$$

∴ Number of Cl_2 molecules, N = 5.3×10^{20}

Hence, Number of Cl-atoms = 1.06×10^{21}

$\approx 1 \times 10^{21}$

Q.9 **(80)**



1 mole	1 mole
78gm	123gm
3.9gm	$\frac{123}{78} \times 3.9 = 6.15$gm

But actual amount of nitrobenzene formed is 4.92 gm and hence.

Percentage yield = $\frac{4.92}{6.15} \times 100 = 80\%$

Q.10 **(525)**

$3\,Pb\,(NO_3)_2 + Cr_2\,(SO_4)_3 \rightarrow 3PbSO_4 + 2Cr(NO_3)_3$

35 ml $\quad$ 20 ml

0.15 M $\quad$ 0.12 M

= 5.25 m.mol = 2.4 m.mol 5.25 m.mol

$= 5.25 \times 10^{-3}$ mol

therefore moles of $PbSO_4$ formed = 5.25×10^{-3}

$= 525 \times 10^{-5}$

Q.11 (3)

$H_3PO_3 + 2NaOH \rightarrow Na_2HPO_3 + 2H_2O$

50 ml $\quad$ 1M

1M $\quad$ V = ?

$$\Rightarrow \frac{n_{NaoH}}{n_{N_3PO3}} = \frac{2}{1}$$

$$\Rightarrow \frac{1 \times V}{50 \times 1} = \frac{2}{1} \boxed{V_{NaOH} = 100ml}$$

$H_3PO_2 + 2NaOH \rightarrow NaH_2PO_3 + H_2O$

100 ml $\quad$ 1M

2M $\quad$ V = ?

$$\Rightarrow \frac{n_{NaoH}}{n_{H_3PO3}} = \frac{1}{1} \Rightarrow \frac{1 \times V}{2 \times 100} = \frac{1}{1} \boxed{V_{NaOH} = 200ml}$$

Q.12 (3)

44 gm CO_2 have 12 gm carbon

So, 420 gm $CO_2 \Rightarrow \frac{12}{44} \times 420$

$$\Rightarrow \frac{1260}{11} \text{ gmcarbon}$$

$$\Rightarrow 114.545 \text{ gram carbon}$$

$$\text{So, \% of carbon} = \frac{114.545}{750} \times 100$$

; 15.3%

$18 \text{ gm } H_2O \Rightarrow 2 \text{ gm } H_2$

$$210 \text{ gm } \Rightarrow \frac{2}{18} \text{x } 210$$

$= 23.33 \text{ gm } H_2$

$$\text{So, \% H} \Rightarrow \frac{23.33}{750} \times 100 = 3.11\% \approx 3\%$$

Q.13 (3)

Q.14 (1)

Q.15 **(226)**

Q.16 [4]

Q.17 (2)

JEE-ADVANCED PREVIOUS YEAR'S

Q.1 (3)

$$\text{Average titre value} = \frac{25.2 + 25.25 + 25.0}{3} = \frac{75.45}{3}$$

= 25.15 = 25.2 mL

number of significant figures will be 3.

Q.2 (5)

The balance chemical equation is

$3Br_2 + 3Na_2CO_3 \longrightarrow 5NaBr + NaBrO_3 + 3CO_2$

Q.3 (C)

$$\text{Mole} = \frac{120}{60} = 2$$

mass of solution = 1120 g

$$V = \frac{1120}{1.15 \times 1000} = \frac{112}{115} \text{ L}$$

$$M = \frac{2 \times 115}{112} = 2.05 \text{ mol/litre}$$

Q.4 (8)

29.2% (w/w) HCl has density = 1.25 g/ml

Now, mole of HCl required in 0.4 M HCl = 0.4 × 0.2 mole = 0.08 mole

if v mol of orginal HCl solution is taken

then volume of solution = 1.25 v

mass of HCl = (1.25 v × 0.292)

$$\text{mole of HCl} = \frac{1.25v \times 0.292}{36.5} = 0.08$$

$$\text{so, } v = \frac{36.5 \times 0.08}{0.29 \times 1.25} \text{mol} = 8 \text{ mL}$$

Q.5 (8)

Given 3.2 M solution

∴ moles of solute = 3.2 mol

Consider 1 L Solution.

∴ volume of solvent = 1 L

$P_{solvent} = 0.4 \text{ g.mL}^{-1}$

$\therefore m_{solvent} = P \times V = 400 \text{ g}$

$$\therefore \text{ molality} = \frac{3.2 \text{ mol}}{0.4 \text{ kg}} = 8 \text{ molal}$$

Q.6 (9)

Given, molality = Molarity

And assuming no volume change in forming solution

Density of solvent = 1 gml^{-1}

And density of solution (given) = 2 gml^{-1}

Implies, solvent and solute are present in equal qualities

$$\therefore \chi_{solute} = 0.1 = \frac{\frac{1}{M_{solute}}}{\frac{1}{M_{solvent}} + \frac{1}{M_{solute}}} \Rightarrow \frac{M_{solute}}{m_{solvent}} = 9$$

Q.7 (6)

$8KMnO_4 + 3Na_2S_2O_3 + H_2O$ ’! $8MnO_2 + 3Na_2SO_4 + 3K_2SO_4 + 2KOH$

No. of sulphur containing products is 3 + 3 = 6

Q.8 (2992)

$$\underset{\substack{1584g \\ =12mol}}{\left(NH_4\right)_2 SO_4} + Ca\left(OH\right)_2 \rightarrow \underset{\substack{gypsum(M=172) \\ 12mol}}{CaSO_4.2H_2O} + \underset{24mole}{2NH_3}$$

$$\underset{952g=4mol}{NiCl_2.6H_2O} + \underset{24mol}{6NH_3} \rightarrow \underset{\substack{(M=232) \\ 4mol}}{\left[Ni\left(NH_3\right)_6\right]Cl_2} + 6H_2O$$

Total mass = 12 × 172 + 4 × 232 = 2992 g

Q.9 (2.98 or 2.99)

$$X_{urea} = 0.05 = \frac{n}{n + 50}$$

19n = 50

n = 2.6315

$$V_{sol} = \frac{(2.6315 \times 60 + 900)}{1.2} = 881.5789 \text{ ml}$$

$$\text{Molarity} = \frac{2.6315 \times 1000}{881.5789} = 2.9849$$

Molarity = 2.98M

Q.10 (6.15)

$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$

$$\text{Moles of Al takes} = \frac{5.4}{27} = 0.2$$

$$\text{moles of } H_2SO_4 \text{ taken} = \frac{50 \times 5.0}{1000} = 0.25$$

$$\text{As } \frac{0.2}{2} > \frac{0.25}{3}, H_2SO_4 \text{ is limiting reagent}$$

$$\text{Now, moles of } H_2 \text{ formed} = \frac{3}{3} \times 0.25 = 0.25$$

$$\therefore \text{ Volume of } H_2 \text{ gas formed} = \frac{nRT}{P}$$

$$= \frac{0.25 \times 0.082 \times 300}{1} = 6.15L$$

States of Matter

EXERCISES-I

Elementary

Q.1 (3)

Boyle's law is $V \propto \frac{1}{P}$ at constant T

Q.2 (4)

PV = RT = K (Constant) (Boyle's law)

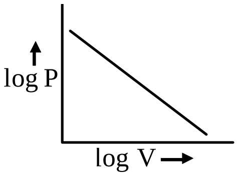
Taking log both side

log P + log V = log k

log P = –log V + constant

y = mx + c

so



Q.3 (1)

$$P = \frac{nRT}{V} = \frac{2 \times 0.0821 \times 546}{44.81} = 2 \text{ atm}.$$

Q.4 (3)

Q.5 (2)

Molecular weight = *V.d.* × 2 = 11.2 × 2 = 22.4

Volume of 22.4 *gm* Substance of NTP = 22.4 *litre*

1 *gm* substance at NTP = $\frac{22.4}{22.4}$ *litre*

11.2 *gm* substance of NTP = 11.2 *litre*

Q.6 (3)

Initial N_2 + $3H_2 \longrightarrow 2NH_3$

1 3

final – – 2

ratio = $\frac{4}{2} = \frac{2}{1}$.

Q.7 (4)

Q.8 (1)

$$r_g = \frac{1}{5}.r_{H_2}$$

$$\frac{M_g}{M_{H_2}} = \left[\frac{r_{H_2}}{r_g}\right]^2 = (5)^2 = 25 \; ; \; M_g = 2 \times 25 = 50$$

Q.9 (3)

$$d \propto M \Rightarrow \frac{d_1}{d_2} = \frac{M_1}{M_2} \; ; \; \frac{3d}{d} = \frac{M}{M_2} \; ; \; M_2 = \frac{M}{3}.$$

Q.10 (1)

$$V_{rms} = \sqrt{\frac{3RT}{M}}, V_{av} = \sqrt{\frac{8RT}{\pi M}} \; ; \; \frac{V_{rms}}{V_{av}} = \sqrt{\frac{3\pi}{8}}$$

$$= \sqrt{\frac{66}{56}} \Rightarrow \frac{1.086}{1}$$

Q.11 (3)

Q.12 (1)

$$V_{av} : V_{rms} : V_{\text{most probable}} = V : U : \alpha$$

$$\sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{3RT}{M}} : \sqrt{\frac{2RT}{M}}$$

$$\alpha : V : U = \sqrt{2} : \sqrt{\frac{8}{\pi}} : \sqrt{3} \qquad = 1 : 1.128 : 1.224$$

EXERCISES-II

JEE-MAIN
OBJECTIVE QUESTIONS

Q.1 (3)

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}$$

Q.2 (4)

n,T → const

PV = const

Q.3 (4)

n → constant

v → fixed

∴ P & T→ const

Q.4 (2)

V = 2 litre

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}$$

$$\Rightarrow \frac{2}{4} = \frac{273}{T(\text{inK})}$$

⇒ T = 546 K ⇒ T = 273°C

Q.5 (2)

$n_1 + n_2 = n_f \quad \frac{PV}{RT} = n$

$$\frac{1000 \times 500}{RT} + \frac{800 \times 1000}{RT} = \frac{P_f \times 2000}{RT}$$

P_f = 650 torr.

Q.6 (2)

n = const.

no of molecules = const

same number of molecules

Q.7 (A)

Two flask initally at 27º and 0.5 atm, have same volume and 0.7 mole thus each flask has 0.35 mole

Let n mole of gas are diffuse from II to I on heating the flask at 127ºC

Mole in I flask = 0.35 + n, Mole in II flask = 0.35 – n

If new pressure of flask is P then

for I flask P × V = (0.35 + n) × R × 300 ; for II flask P × V = (0.35 – n) × R × 400 n = 0.5

mole in I flask = 0.40mole in II flask = 0.30

0.5 × 2V = 0.7 × 0.0821 × 300 (initially)V = 17.24 Lt.

P × 17.24 = 0.30 × 0.0821 × 400 (finally) P = 0.57 atm.

Q.8 (3)

$$\frac{10}{V_2} = \frac{273}{373}$$

Q.9 (3)

$P = CRT; T = \frac{P}{RC} = \frac{1 \times 12}{1 \times 1} = 12$ K.

Q.10 (1)

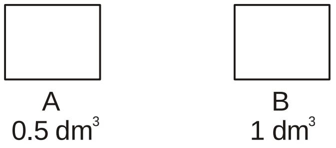
$$\frac{15}{30} = \frac{75}{M_B}$$

$M_B = 150.\ (V.D.)_B = \frac{150}{2} = 75.$

Q.11 (4)

R is depend upon unit of measurement

Q.12 (3)



PV = nRT

$PV = \frac{W}{MM} RT$

$\Rightarrow P \times M_m = \rho RT$

$$\frac{P_A \times MM_A = \rho_A RT}{P_B \times MM_B = \rho_B RT}$$

$$\frac{P_A}{P_B} \times \frac{1/2MM_B}{MM_B} = \frac{3}{1.5}$$

$\frac{P_A}{P_B}$ = 4 Ans.

Q.13 (2)

PV = nRT

$$\frac{P_1V_1 = nRT_1}{P_2V_2 = nRT_2}$$

$\Rightarrow \frac{P}{2P} \times \frac{5}{V_2} = \frac{300}{600} \Rightarrow V_2$ = 5 litre

Q.14 (1)

P_i = x atm n, V → const

$P_f = x + \frac{0.4}{100} x$

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$

$T_i = T \quad \Rightarrow$

$$\frac{x}{x + \frac{0.4}{100} x} = \frac{T}{T + 1} \qquad T_f = T + 1$$

T = 250 K

Q.15 (C)

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{3}{320} = \frac{2.7}{T_2}$$

$\Rightarrow T_2$ = 288 K = 15°C

Q.16 (2)

$\rho \propto \frac{P}{T}$.

Q.17 (A)

P,T,V → const

$n_{SO_2} \rightarrow nO_2$

$\therefore WO_2 = \frac{1}{2} WSO_2$

Q.18 (C)

P,n → const

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}$$

$$\Rightarrow \frac{10\,Lt}{V_2} = \frac{273}{373}$$

$\Rightarrow sV_2 = 13.66$ Lt.

Q.19 (4)

$$\frac{p_{H_2}}{p_{C_2H_6}} = \frac{n_{H_2}}{n_{C_2H_6}} = \frac{30}{2} = \frac{15}{1}.$$

Q.20 (4)

Weight of H_2 = 20 g in 100 g mixture ; Weight of O_2 = 80 g

$\therefore$ Moles of $H_2 = \frac{20}{2} = 10$;

$\therefore$ Moles of $O_2 = \frac{80}{32} = \frac{5}{2}$

$\therefore$ Total moles $= 10 + \frac{5}{2} = \frac{25}{2}$

$\therefore P'_{H_2} = P_T$ x mole fraction of $H_2 = 1 \text{ x} \frac{10}{25/2} = 0.8$ bar

Q.21 (B)

Since A and A_2 are two states in gaseous phase having their wt ratio 50% i.e. 1 : 1

moles of A $= \frac{96}{2} \times \frac{1}{48} = 1$Moles of $A_2 = \frac{96}{2} \times \frac{1}{96} = \frac{1}{2}$

Total mole = 3/2

P = nRT/V.

Q.22 (1)

$P = XP_T$

$$\frac{P_1}{P_2} = \frac{3/10P_T}{2/9P_T}$$

$$= \frac{P_1}{P_2} = \frac{2.7}{2}$$

$$\Rightarrow \frac{P_1 - P_2}{P_1} \times 100 = \frac{\frac{2.7}{2}P_2 - P_2}{P_2} \times 100$$

$\Rightarrow$ 26 %

Partial pressure of O_2 is changed by about 26%

Q.23 (C)

Initial $N_2 \quad + \quad 3H_2 \longrightarrow 2NH_3$

1 3

final – – 2

ratio $= \frac{4}{2} = \frac{2}{1}$.

Q.24 (4)

$$r \propto \frac{1}{\sqrt{M}}$$

Q.25 (2)

$$\frac{20}{60} \times \frac{30}{V} = \sqrt{\frac{32}{64}}.$$

Q.26 (3)

$$r \propto \frac{1}{\sqrt{M}}$$

So NH_3 diffuses with faster rate.

Q.27 (2)

$$\frac{r_1}{r_2} = \frac{t_2}{5} = \sqrt{\frac{M_2}{2}}$$

Q.28 (4)

Given $\frac{r_A}{r_B} = \frac{16}{3}$; $\frac{w_A}{w_B} = \frac{2}{3}$

we have $\frac{r_A}{r_B} = \frac{n_A}{n_B}\sqrt{\frac{M_B}{M_A}}$

$$\frac{16}{3} = \frac{w_A}{M_A}\frac{M_B}{w_B}\sqrt{\frac{M_B}{M_A}}$$

$$\frac{16}{3} = \frac{2}{3}\left(\frac{M_B}{M_A}\right)^{3/2} \Rightarrow \left(\frac{M_B}{M_A}\right)^{3/2} = 8$$

$$\Rightarrow \frac{M_B}{M_A} = 4$$

$\therefore$mole ratio $= \frac{8}{3}$

Q.29 (2)

$$\frac{r_x}{r_y} = \sqrt{\frac{d_y}{d_x}} \Rightarrow \frac{3}{1} = \sqrt{\frac{dy}{dx}}$$

$$\frac{dy}{dx} = 3^2 = \frac{9}{1}$$ Ans.

Q.30 (1)

$$\frac{r_{N_2}}{r_{H_2}} = \sqrt{\frac{MM_{H_2}}{MM_{N_2}}}$$

$$= \sqrt{\frac{2}{28}} = \sqrt{\frac{1}{14}}$$

$$1 : \sqrt{14} : \sqrt{7}$$

Q.31 (4)

$$C_3H_6O \longrightarrow CO_2$$
$$3 \times nC_3H_6O = nCO_2$$

Q.32 (2)

$$\frac{u_1}{u_2} = \sqrt{\frac{T_1 \times M_2}{T_2 M_1}}$$

Q.33 (B)

$$V = \sqrt{\frac{3P}{d}}$$

Q.34 (1)

$m_A = 2\ m_B$
$u_A = 2\ u_B$
$n_A = n_B$
$v_A = v_B$

$$\frac{P_A V_A}{P_B V_B} = \frac{\frac{1}{3} m_A n_A u_A^2}{\frac{1}{3} m_B n_B u_B^2}$$

Q.35 (A)

$$K.E_{O_2} = \frac{\frac{3}{2} \times \frac{N}{32} \times R \times 150}{\frac{3}{2} \times \frac{N'}{32} \times R \times 300} = \frac{x}{2x}$$

$$\Rightarrow K.E_{O_2} = \frac{N \times 1}{N' \times 2} = \frac{1}{2}$$

$\boxed{N = N'}$ Therefore, (A) option is correct.

Q.36 (B)

Average KE = $\frac{3}{2} \times \frac{8.314 \times 300}{6.023 \times 10^{23}} = 6.21 \times 10^{-21}$ J/ molecule.

Q.37 (D)

$$K.E. = \frac{3}{2} nRT$$

Q.38 (2)

$$v \propto \sqrt{T}$$

Q.39 (3)

$$\frac{(V_{rms})_1}{(V_{rms})_2} = \sqrt{\frac{T_1 M_2}{M_1 T_2}}$$

Q.40 (1)

K.E. = 3/2 nRT
$n_1T_1 = n_2T_2$

$$T_1 = \frac{0.4 \times 400}{0.3}$$

T_1 = 533 K

Q.41 (3)

$$U_{rms} = \sqrt{\frac{3RT}{M}} = \frac{5 \times 10^4}{10 \times 10^4}$$

$$= \frac{\sqrt{\frac{3RT_1}{M}}}{\sqrt{\frac{3RT_2}{M}}} = \frac{1}{4} = \frac{T_1}{T_2}$$

$T_2 = 4T_1$
T_2 = 4 times T_1

Q.42 (B)

$$\frac{5 \times 10^4}{10 \times 10^4} = \frac{\sqrt{\frac{3RT_1}{M}}}{\sqrt{\frac{3RT_2}{M}}}$$

$T_1 = 4\ T_2$
If T_1 is 4 times
by heating the gas, pressure is made four times.

Q.43 (2)

$$U_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{T_1}{M_1} = \frac{T_2}{M_2}$$

$$\frac{T_1}{32} = \frac{300}{20}$$

$T_1 = 480$ K

Q.44 (B)

$$U_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3 \times 1.2 \times 10^5}{4}}$$

= 300 ms

Q.45 (A)

H_2 gas will be having longest mean-free path.

Q.46 (B)

$$C_xH_y + O_2 \longrightarrow CO_2 + H_2O$$

$x \times n_{C_xH_y} = n_{CO_2}$ (POAC on C)

$x \times 500 = 2500$ ($x = 5$)

$y \times nC_x H_y = 2 \times n_{H_2O}$ (POAC on H)

$y \times 500 = 2 \times 3000$ $y = 12$

Formula = C_5H_{12}

Q.47 (A)

$$C_xH_y \quad + \quad O_2 \longrightarrow x_{CO_2} + \frac{y}{2} + H_2O$$

15 ml $\frac{357 \times 21}{100}$ ml 75 ml

$\left(x + \frac{y}{4}\right) \times 15 = 75$ $x + \frac{y}{4} = \frac{75}{15}$

$x + \frac{y}{4} = 5$ $x + \frac{y}{4} = 5$

$3 + \frac{y}{4} = 5$ $15x + 15x + 282 = 327$

$y = 8$ $x = 3$

Formula = C_3H_8

Q.48 (B)

$$\mathbf{C_xH_y} + \left(x + \frac{y}{4}\right)\mathbf{O_2} \longrightarrow XCO_2 + \frac{y}{2} H_2O$$

7.5 ml 36 ml

$36 - 7.5\left(x + \frac{y}{4}\right) + 7.5x = 28.5$

$36 - 7.5\left(15 + \frac{y}{4}\right) + 7.5x = 28.5$

$y = 4$

$x = 2$

So formula = C_2H_4

Q.49 (2)

$$C_xH_y + \left(x + \frac{y}{4}\right)O_2 \longrightarrow xCO_2 + \frac{y}{2} H_2O$$

$$\frac{x + \frac{y}{4}}{x} = \frac{7}{4}$$

$\frac{y}{4x} = \frac{3}{4}$ $\frac{y}{x} = \frac{3}{1}$

Q.50

$$C_4H_{10} + \frac{13}{2} O_2 \longrightarrow 4\,CO_2 + 5\,H_2O$$

x ml n-butane

y ml isobutane

Volume of $O_2 = x \times \frac{13}{2} + y \times \frac{13}{2}$

Q.51 (1)

$T_C = \frac{8a}{27Rb}$

$T_B = \frac{a}{Rb}$

$T_i = 2T_B$

$T_C < T_B < T_i$

Q.52 (D)

$\uparrow T_C = \frac{8a\uparrow}{27Rb\downarrow}$

It sould be z.

Q.53 (3)

Factual question

Q.54 (3)

Factual question

Q.55 (3)

Ease of liquification $\propto$ a

Q.56 (2)

Boiling point $\propto$ a

Q.57 (A)

Required % = $\frac{4}{3} \times \frac{\pi \times (2 \times 10^{-8})^3 \times 6 \times 10^{23}}{22400} \times 100.$

= 0.09 %

Q.58 (1)

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT.$$

Q.59 (1)

$(P)(V - nb) = nRT$

$$P = \frac{nRT}{V - nb}$$

Q.60 (3)

$PV = Pb + RT$

$$\frac{PV}{RT} = 1 + \frac{Pb}{RT}$$

Q.61 (1)

$$\left(P + \frac{a}{V^2}\right)(V) = RT$$

$$PV + \frac{a}{V} = RT$$

$$\frac{PV}{RT} = 1 - \frac{a}{VRT}$$

Q.62 (1)

$$4 \times \frac{4}{3}\pi r^3 \times N_A = 24$$

JEE-ADVANCED OBJECTIVE QUESTIONS

Q.1 (C)

$PV \propto T$

Q.2 (C)

$PV = nRT$

$$PV = \frac{1}{M}RT$$

Q.3 (C)

Max capacity of balloon = 600 ml

$P_1V_1 = P_2V_2$

$500 \times 1 = 600 \times P_2$

$$P_2 = \frac{5}{6} \times 760 \text{ mm} = 633 \text{ mm}$$

Height above which balloon will burst = (760 – 633) × 100 cm

= 127 × 100 cm

= 127 m

Q.4 (B)

$$\rho = \frac{PM}{RT}$$

Q.5 (B)

$76 \times 13.6 = x \times 13.6 + 1 \times 13.6 + 3.4 \times 20 + 6.8 \times 30 + 13.6 \times 15$

$76 \times 13.6 = x \times 13.6 + 13.6 + 13.6 \times 5 + 13.6 \times 15 + 13.6 \times 15$

$76 = x + 1 + 5 + 30$

$x = 40$ cm

Q.6 (D)

$$\frac{n_{O_2}}{n_{\text{cyclopropane}}} = \frac{P_{O_2}}{P_{\text{cyclopropane}}}$$

Q.7 (D)

$N_2 \rightarrow 2N$

at t = 0 $\quad \frac{1.4}{28} = \frac{1}{20} \quad 0$

at t = t_f $\quad \frac{1}{20} - x \quad 2x$

but, $x = 30\%$ of $\frac{1}{20} = \frac{3}{200}$

Final number of mole = $\frac{1}{20} - x + 2x = \frac{1}{20} + x = \frac{1}{20} + \frac{3}{200} = \frac{13}{200}$

$$\therefore P = \frac{13}{200} \times \frac{0.0821 \times 1800}{5} = 1.92 \text{ atm.}$$

Q.8 (A)

$H_2 + 1/2O_2 \rightarrow H_2O_{(l)}$

a b

0

a–2b 0

b

Reaction is studied at constant P &T

a+b = 40 a–2b = 10

a = 30 ml b = 10ml

mole fraction of H_2 = volume fraction of H_2 =30/40 = 0.75.

Q.9 (B)

$$\frac{r_{\text{mixture}}}{r_{O_2}} = \sqrt{\frac{32}{M}} = \frac{20 \times 60}{311}$$

M = 2.16

V.D. = 4.32

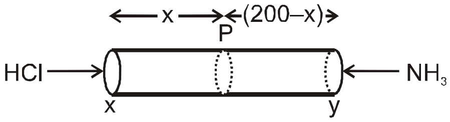
Q.10 (D)

$$\frac{t_{\text{mix}}}{t_{O_2}} = \frac{r_{O_2}}{r_{\text{mix}}} = \sqrt{\frac{M_{\text{mix}}}{32}}$$

$$\frac{234}{224} = \sqrt{\frac{M_{\text{mix}}}{32}}$$

$$M_{mix} = \frac{80\times32+x\times20}{100}$$

Q.11 (B)

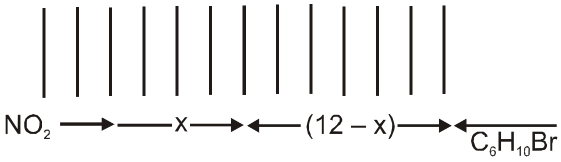


$$\frac{r_{HCl}}{r_{NH_3}} = \sqrt{\frac{17}{36.5}} \Rightarrow \frac{x}{200-x} = \sqrt{\frac{17}{36.5}} \Rightarrow x = 81.13$$

cm

Q.12 (C)

Let both gases meet at nth row



$$\frac{r_{NO_2}}{r_{C_6H_{10}Br}} = \frac{x}{12-x} = \sqrt{\frac{179}{44}} = 2$$

x = 24 – 2x

3x = 24

x = 8 = n – 1

n = 9th Row

Q.13 (C)

$$\mathbf{r} \propto \frac{1}{\sqrt{M}}$$

Q.14 (A)

Transtational K. E. =3/2 nRT

$$\frac{3}{2}\times2\times2\times300 = 1800 \text{ cal}$$

Q.15 (D)

Charles law is applicable

Q.16 (C)

It is factual question

Q.17 (B)

It is factual question

Q.18 (A)**C**

(A) $U_{M.P.S.}\uparrow$

(B) $T\uparrow$

Q.19 (B)

$$Z = \frac{(PV)_{real}}{(PV)_{ideal}}$$

Q.20 (C)

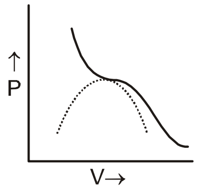
High T, low P

Q.21 (B)

I – Slope of isotherm below critical point < 0.

Slope of isotherm above critical point < 0.

Slope of isotherm at critical point = 0.



So slope of isotherm at critical point is maximum.

II – $T_C = \frac{8a}{27Rb}$

$T_C \propto a$

Larger value of T_C It means less decreases in temperature is required to liquifly the gas. Gas will liquify at higher temperature. So, easier'll be liquification.

III – When gas is below critical temperature. It is 'liquid' so vander waal equation of state is not valid.

So, Answer **(B).**

Q.22 (C)

It is factual question

Q.23 (D)

$$T_C \propto \frac{a}{b}$$

Q.24 (C)

$$V_C = 3 \times N \times \frac{4}{3}\pi r^3 \times 0.44$$

Q.25 (D)

It is factual question

Q.26 (D)

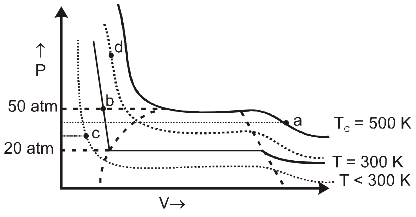
It is factual question

Q.27 (C)

If Z > 1 positive deviation

Z < 1 negative deviation

Q.28 (D)



(a) at T = 500 K, P = 40 atm corresponds to 'a' substance - gas
(b) at T = 300 K, P = 50 atm corresponds to 'b' substance - liquid
(c) at T < 300 K, P > 20 atm corresponds to 'c' substance - liquid
(d) at T < 500 K, P > 50 atm corresponds to 'd' substance - liquid

Q.1 (A, B)

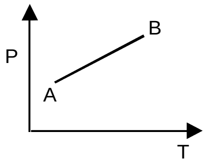
Suppose the cylinder will burst at T_2K

$$T_2 = \frac{P_2T_1}{P_1} \ (V_1 = V_2) = \frac{14.9 \times 300}{12} = 372.5 \text{ K}$$

Q.2 (A, C)

V = 8.21 L
n = 2
T = 300 K
(A) P = 6 atm
(B) $P \alpha KT \ \forall \ K = \frac{nR}{V}$

Q.3 (A, B)

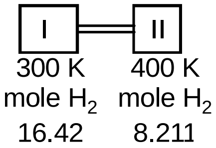


$P \alpha T$

$K = \frac{nR}{V}$

n = chang ; V = must change to maintain
n = const; V constant

Q.4 (A, D)



(A) I. P. = 3 atm by $P = \frac{nRT}{V}$
(B) Pressure just after openin doesn’t changes
(D) Pressure becomes same after some time

Q.5 (B, C)

At point A $T_A = \frac{2 \times 10}{R \times 2} = \frac{8}{R}$

At point D $T_D = \frac{2 \times 10}{2 \times R} = \frac{10}{R}$

Pressure at B

$$\frac{T_B}{T_A} = \frac{P_B}{P_A}$$

$$P_B = \frac{300}{(B/R)} \times 75R$$

Q.6 (B*) (D*)

$$r \propto \frac{1}{\sqrt{M}}$$

Q.7 (B, D)

Given $\frac{r_A}{r_B} = \frac{16}{3}$; $\frac{w_A}{w_B} = \frac{2}{3}$

we have $\frac{r_A}{r_B} = \frac{n_A}{n_B}\sqrt{\frac{M_B}{M_A}}$

$$\frac{16}{3} = \frac{w_A}{M_A}\frac{M_B}{w_B}\sqrt{\frac{M_B}{M_A}}$$

$$\frac{16}{3} = \frac{2}{3}\left(\frac{M_B}{M_A}\right)^{3/2} \Rightarrow \left(\frac{M_B}{M_A}\right)^{3/2} = 8$$

$$\Rightarrow \frac{M_B}{M_A} = 4$$

$\therefore$ mole ratio = $\frac{8}{3}$

Q.8 (B, C)

Clearly from the diagram

$$(v_{MPS})_B > (v_{MPS})_A \Rightarrow \frac{T_2}{M_B} > \frac{T_1}{M_A} \Rightarrow \frac{T_2}{T_1} > \frac{M_B}{M_A}$$

hence if $T_1 > T_2$. M_A is necessarily greater than M_B

Q.9 (A, B, C)

With increase in temperature, most probable velocity increases & fraction of molecules with velocity equal to M.P. velocity decreases. Total no. of molecules remain same.

Q.10 (A, B, D)

K.E. is a function of temperature. If temperature is constant, K.E. will be constant.

Q.11 (B, D)

$$P_C = \frac{a}{27b^2} \quad T_C^2 = \frac{64\,a^2}{27 \times 27R^2b^2}$$

$$V_C = 3b \ \frac{T_C^2}{P_C} = \frac{64\,a^2}{27 \times 27R^2b^2} \times \frac{27b^2}{a}$$

$$T_C = \frac{8a}{27Rb} \quad a = \frac{27\,R^2T_C^2}{64P_C}$$

Q.12 (A, C, D)

Q.13 (A, B)

incorrect

(A) at boyle's temperture a real gas behave as ideal irresp. of pressur

(B) At critical cond^n a real gas behave as ideal.

Q.14 (A, B, C, D)

Factual Question

Q.15 (B, D)

Initially P = 760 mm of Hg = 1 atm

$\Rightarrow$ P_A (initial) = 1 atm

$2A \longrightarrow 3B + 2C$

100

1–0.20.30.2

P_{Total} = 1.3 atm = 98.8 cm Hg

Total Pressure inaeared by 0.3 atm

diffenence in Hg level = 98.8 – 76

= 22.8 cm

= 228 mm

Comprehension # 1 (Q. No. 16 to 18)

Q.16 (B)

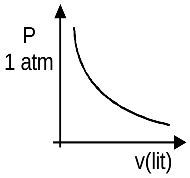
$Pe^{v/2} = nCT$

T = 500 K

n = 2 moles

P = 1 atm

on solving



$$C = \frac{1 \times e^0}{500 \times 2} = 0.001$$

Q.17 (D)

$P.\ e^{v/2} = nCT$

$$P = \frac{nC}{e^{v/2}} T$$

$$\text{Slope} = \frac{nC}{e^{v/2}}$$

C = 0.001 & V = 2L

n = 2

$$P = \frac{2}{1000} e^{-1}$$

Q.18 (A)

V = 2001 P = 1 atm T = 200 K at earth

$$n = \frac{200}{200 \times T} = \frac{1}{R}$$

$$P.\ e^{100} = \frac{1}{R} \times C \times 821$$

$$\text{On solving } P = \frac{10}{e^{100}}$$

Comprehension # 2 (Q. No. 19 to 21)

Q.19 (D)

$Z = z\, \sigma^2\, \overline{u}\, N^*$

$$N^* \ \alpha \frac{1}{V}$$

$$x \ \alpha \frac{1}{V} = A$$

$$y \ \alpha \frac{1}{2V} = \frac{A}{2}$$

Ratio = 2 : 1

None of these

Q.20 (C)

$$\text{Total no. of colusons per unit volume } \alpha \frac{(N^*)^2}{V}$$

Ratio = 1 : $\sqrt{2}$

Q.21 (A)

$H_2 \longrightarrow 2H$

$$\frac{n_x}{n_y} = \frac{n_{He}}{n_H} = \frac{x/4}{x/1} = \frac{1}{4}$$

$$\frac{V_x}{V_y} = \frac{1}{2} \Rightarrow \frac{N_x^x}{N_y^x} = \frac{1}{4} \times 2 = \frac{1}{4}$$

$$\frac{\sigma_x}{\sigma_y} = 2 \text{ (because } H_2 \text{ become H)}$$

$$\frac{U_{avgx}}{U_{avgy}} = \sqrt{\frac{(T/M)_x}{(T/M)_y}} = \sqrt{\frac{T/4}{2T/1}} = \frac{1}{2\sqrt{2}}$$

$$\frac{z_{11x}}{Z_{11y}} = \left(\frac{N_x^+}{N_y}\right)^2 \times \left(\frac{U_{avex}}{U_{avg}}\right) \times \left(\frac{\sigma_x}{\sigma_y}\right)^2$$

$$= \frac{1}{4} \times \frac{1}{2\sqrt{2}} \times 4 \frac{1}{2\sqrt{2}}$$

$Z_{11y} = 2\sqrt{2}$ $Z_{11x} = 2\sqrt{2}$ A

Comprehension # 3 (Q. No. 22 to 24)

Q.22 (D)

(I) Z = 1 → Ideal behaviour.

(II) Z > 1 → On applying pressure, volume decreases.

(III) Z < 1 → Gas can easily liquefied.

(VI) At low P, Z → 1 means gas is approaching to ideal behaviour.

Q.23 (B)

$$Z = \frac{PV_m}{RT} > 1$$

$$\frac{PV_m}{RT} = \frac{1 \times 22.4}{R \times T}$$

At same pressure = 1 atm.

$$\frac{1\times V_m}{RT} > \frac{1\times 22.4}{R\times T}$$

⇒ $V_m > 22.4$ L at STP for real gas.

For, $V_m = 22.4$ L of real gas, we have to increase the pressure.

Q.24 (D)

On moving from region (II) to region (I), pressure tends to zero. So, $Z \rightarrow 1$.

Comprehension # 4 (Q. No. 25 to 27)

Q.25 **C**

At critical point

$$\frac{\partial p}{\partial V_m} = 0 \Rightarrow -\frac{RT_C}{V_m^2} + \frac{2B}{V_m^3} - \frac{3C}{V_m^4} = 0 \Rightarrow -RT_C + \frac{2B}{V_m}$$

$$-\frac{3C}{V_m^2} = 0 \quad \Rightarrow RT_C V^2{}_m - 2BV_m + 3C = 0$$

as equation will have repeated root then D = 0 ⇒ T_C

$$= \frac{B^2}{3RC}$$

Q.26 (D)

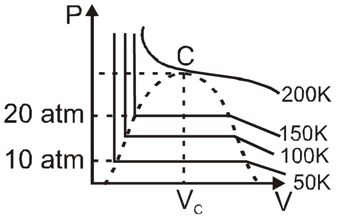
P_C, V_C and T_C are given hence 'a' and 'b' should be calculated using P_C and T_C as it is more reliable.

$$P_C = \frac{a}{27b^2}, T_C = \frac{8a}{27Rb}$$

$$\frac{P_C}{T_C} = \frac{R}{8b} \Rightarrow b = \frac{300 \text{ x } 1/12}{8 \text{ x } 50} = \frac{1}{16}$$

$$4 \text{ x } \frac{4}{3}\pi r^3 . N_A = \frac{1}{16} \Rightarrow r = \left(\frac{3}{256\pi Na}\right)^{1/3}$$

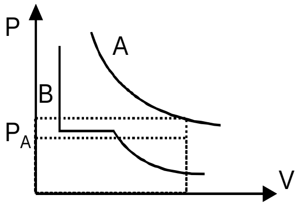
Q.27 (D)



At 100 K and pressure below 20 atm it may have liquid or gaseous state depending on the pressure.

Comprehension # 5 (Q. No. 28 to 30)

Q.28 (A)



At critical temperture gaseous behave as ideal

⇒ $T > T_A$ & $T_B > T$

$T_A < T < T_B$.

Q.29 (C)

(i) B is behaving like real gas at T K from graph

⇒ Pressure correction term can not be hegligibel

(ii) if $T>T_B$, it will behave more like ideal gas, shape would be like A.

(iii) B will show real gas behavious but A will show more likely a ideal gas behavous at $T > T_A$

Q.30 (B)

$b = 4 V_m$

$$b = 4\times N_A \times \frac{4}{3} \pi r_3$$

⇒ $V_1 = V–nb$

⇒ $nb = V–V_1$

$$b = \frac{V - V_1}{h} = 4\times N_A \times \frac{4}{3} \pi r^3$$

$$\Rightarrow r = \left[\frac{3}{16\pi}\frac{(v - V_1)}{nN_A}\right]$$

$$\text{diamatery} = 2r = \left[\frac{8\times 3(V - V_1)}{16\pi nN_A}\right]^{1/3}$$

$$d = \left[\frac{3(V - V_1)}{2\pi nN_A}\right]$$

Comprehension # 6 (Q. No. 31 to 33)

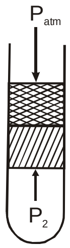
Q.31 (B)

$P_1 = 70 + 20 = 90$ cm of Hg,

$P_2 = (70 + 5)$ cm of Hg

⇒ 90 × 20 = 75 × (5 + x) ⇒ x = 19 cm.

Q.32 (C)



$P_1 =$ 75 cm of Hg, $V_1 = 24 \times A$

$$P_2 = 75 + 10 + \frac{20.4\times 10}{13.6} = 100 \text{ cm of Hg}$$

⇒ 75 × 24 = 100 × x

x = 18 cm

Q.33 (A)

Case I **Case II**

$P_1 = (P_0 + h)P_2 = (P_0 - h)$ $P_1V_1 = P_2V_2$

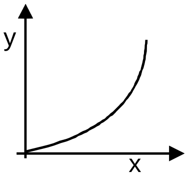
Now in both the cases, the gas is the same and temperature is also constant, hence boyles law can be applied.

$\ell_1 A (P_0 + h) = \ell_2 A (P_0 - h)$

$P_0 = \dfrac{h(\ell_1 + \ell_2)}{(\ell_2 - \ell_1)}$ cm of Hg column.

Q.34 A-r; B-s; C-p; D-q

(A) $\dfrac{1}{V^2} v/s P$



PV = nRT

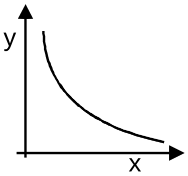
$P^2 = \dfrac{K^2}{V^2}$

$\downarrow \quad \downarrow$

$X^2 \quad y$

y = mx

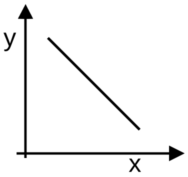
(B) PV = nRT



$\dfrac{V}{T} = \dfrac{nR}{P} = K$

V = KT

$V = \dfrac{K}{\left(\dfrac{1}{T}\right)}$

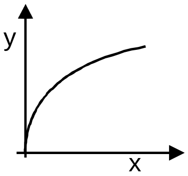


(C) PV = nRT

log P + log V = log K

(D) PV = nRT

$V = \dfrac{K}{P}$



$V^2 = \dfrac{K^2}{P^2}$

$\downarrow \qquad \downarrow$

$y^2 \qquad x$

Q.35 (A) - s ; (B) - q, s ; (C) - r ; (D) - p

(A) PV = nRT

At constant temperature

PV = K (T = constant)

Higher the value of PV, higher the temperature.

So, $T_3 > T_2 > T_1$

Since, $P_1 = P_2 = P_3$

So, $V \propto T \Rightarrow V_3 > V_2 > V_1$

$d = \frac{PM}{RT}$

Since, $P_1 = P_2 = P_3$

$d \propto \frac{1}{T} \Rightarrow d_1 > d_2 > d_3$

(B) From Graph,

$V_3 > V_2 > V_1$ and $T_1 = T_2 = T_3$

Higher the volume, lesser the pressure because temperature is same for all.

$P_1 > P_2 > P_3$

$d = \frac{PM}{RT}$

Since, $T_1 = T_2 = T_3$

So, $d \propto P \Rightarrow d_1 > d_2 > d_3$

(C) From the graph,

$P_3 > P_2 > P_1$ and $T_1 = T_2 = T_3$

Higher the pressure, lesser the volume because temperature is same for all.

$V_1 > V_2 > V_3$

$d = \frac{PM}{RT}$

Since, $T_1 = T_2 = T_3$

So, $d \propto P \Rightarrow d_3 > d_2 > d_1$

(D) From the graph,

$d_3 > d_2 > d_1$ and $P_1 = P_2 = P_3$

$d = \frac{PM}{RT} \Rightarrow d \propto \frac{1}{T}$

So, $T_1 > T_2 > T_3$

$PV = nRT$

Since, $P_1 = P_2 = P_3$

$V \propto T$

So, $V_1 > V_2 > V_3$

Q.36 (A) - q, r ; (B) - p,s ; (C) - q,r ; (D) - p,s

(A) At low pressure, b is negligible in comparison to V_m.

$$\left(P + \frac{a}{V_m^2}\right)(V_m) = RT$$

$$\Rightarrow \quad \frac{PV_m}{RT} = Z = 1 - \frac{a}{V_mRT} < 1$$

So, gas is more compressible than ideal gas.

(B) At high pressure, $\frac{a}{V_m^2}$ is negligible in comparison to P.

$\therefore P(V_m - b) = RT$

$$\Rightarrow \frac{PV_m}{RT} = Z = 1 + \frac{Rb}{RT} < 1.$$

So, gas is less compressible than ideal gas.

(C) Low density of gas means pressure is low so, at low pressure $Z = 1 - \frac{a}{V_mRT} < 1$ and gas is more compressible than ideal gas.

(D) At $0^\circ C$ H_2 and He have $a \approx 0$.

So, $Z = 1 + \frac{Pb}{RT}$ and gas is less compressible than ideal gas.

Q.37 (A-w), (B-u), (C-v),(D-p), (E-x), (F-y),(G-r),(H-q),(I-s), (J-t).

(A) PV = K (Boyle's law)

$P_1V_1 = P_2V_2 = P_3V_3$

(B) From charle's law

$V \propto T \Rightarrow \frac{V}{T} = K \Rightarrow \frac{V_1}{T_1} = \frac{V_2}{T_2}$

(C) From Graham's law

$r \propto \frac{1}{\sqrt{M}}$ and $d = \frac{PM}{RT} \Rightarrow d \propto M$.

So, $r \propto \frac{1}{\sqrt{d}}$.

(D) From Dalton's law of partial pressure at constant temperature.

$P = P_1 + P_2 + ...$

(E) Vander Waal's equation (real gas equation)

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT \text{ (For 1 mole)}$$

(F) $\frac{R}{N}$ = K (Boltzmann constant)

(G) Molar volume = 22.4 L at STP

(I) Constant temperature P – V curve is called isotherm.

(J) Graph between V and T at constant pressure called isobar.

NUMERICAL VALUE BASED

Q.1 2

$$P_1T_2 = P_2T_1 \text{ or } P_2 \frac{P_1T_2}{T_1} \text{ or } P_2 = \frac{1\times 273}{546} = \frac{1}{2}$$

hence x = 2

Q.2 2

Q.3 4

$$P_{He} = X_{He}P_{Total} = \frac{16}{4} = 4 \text{ atm}$$

Q.4 6

Q.5 5

Q.6 5

H – 14.3%, C = 85.7%

∴ Emperical formula is CH_{-2}

$$(CH_{2--})_n + \frac{(3n)}{2}O_2 \longrightarrow nCO_2 + nH_2O$$

1 mL reacts with $\frac{3n}{2}$ mL

10 mL reacts with $\frac{3n}{2}\times 10$

$$\therefore \quad \frac{3n}{2}.10 = 75$$

$$n = \frac{150}{30} = 5$$

Q.7 6 atm

$$P_1V_1 = P_2V_2 \text{ or } 2\times V = P_2 \times \frac{V}{4} \quad P_2 = 8\,\text{atm}$$

Total increase = 8-2 = 6 atm

Q.8 4

Graham's Law $r \; \alpha \frac{1}{\sqrt{M}}, \qquad \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

Q.9 8

Q.10 9

$$P = \frac{nRT}{V - nb} - \frac{an^2}{v^2} = 10 - 1 = 9$$

KVPY

PREVIOUS YEAR'S

Q.1 (D)

Since pressure of the gases are same in both the containers. Therefore the final pressure will not change.

Q.2 (D)

$$(\text{K.E.})_{\text{average}} = \frac{3}{2}kT$$

i.e., average kinetic energy depends only on temperature.

Q.3 (C)

Q.4 (D)

$\frac{3}{2}$KT = 1.6 × 10^{-19}

$\frac{3}{2}$×1.38 × 10^{-23} = 1.6 × 10^{-19}

T = 10^5 K

Q.5 (B)

$$\frac{r_{O_2}}{r_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{O_2}}}; \frac{r_{O_2}}{r_{H_2}}\sqrt{\frac{2}{32}}\; \frac{r_{O_2}}{r_{H_2}} = \frac{1}{4} \qquad r_{O_2} : r_{H_2} = 1:4$$

Q.6 (A)

Average speed (r_{avg}) $= \sqrt{\frac{8RT}{\pi M}}$

$$\frac{r_{He}}{r_{O_2}} = \sqrt{\frac{32}{4}} = 2\sqrt{2}$$

$$r_{He} = r_{o_2}2\sqrt{2}$$

Q.7 (D)

Vg at 0°C = 250 cm^3

Vg at 300°C = 500 cm^3

$$\frac{Vg\left(300^oC\right)}{Vg\left(0^oC\right)} = 2$$

Q.8 (A)

At X V= 50 L T = 200 K

$$P_X = \frac{nRT}{V} = \frac{1\times 0.0821\times 200}{50}$$

= 0.328

$$\text{At Z } P_Z = \frac{1\times 0.0821\times 200}{20} = 0.821$$

$$\text{At Y } P_Y = \frac{1\times 0.0821\times 500}{50} = \frac{0.821}{}$$

Q.9 (C)

$p \propto T\ (V, n \to \text{const})$

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$

$$\frac{1}{P_2} = \frac{300}{600}$$

P_2 = 2 atm

Q.10 (A)

$r \propto \frac{1}{\sqrt{M}}$ Rate of diffusion decrease with increase in molecular weight

Rate of diffusion order CO =N_2 > O_2 > CO_2

(28) (28) (32) (44)

Q.11 (A)

$$V_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{\left(V_{rms}\right)_{H_2}}{\left(V_{rms}\right)_{O_2}} = \frac{\sqrt{\dfrac{3\times R\times 50}{2}}}{\sqrt{\dfrac{3\times R\times 500}{28}}} = 1.18$$

Q.12 (A)

$$Z = \frac{\left(V_M\right)r}{\left(V_M\right)_i} < 1 \text{ at } p < 200 \text{ bar}$$

$\therefore (V_M)_r < (V_M)_i$

Q.13 (B)

PV = nRT

$$\Rightarrow \frac{V}{T} = \frac{nR}{P} = \text{slope}$$

$$\Rightarrow P = \frac{nR}{\text{slope}} = \frac{2\times 0.0821}{0.328} = 0.5$$

Q.14 (D)

The maximum amount of nitrogen that can be safely put in this container must, exert a pressure less than 2 atom at 298K.

i.e. maximum moles in container n = $\frac{PV}{RT}$

$$= \frac{2\times 2.24}{0.0821\times 298} = 0.18$$

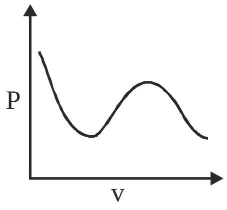
i.e. maximum weight of N_2 in container = 0.183 × 28 = 5.127 gm.

The correct answer is, (D) 4.2 grams

for safely concern, we cant't go for adding more nitrogen.

Q.15 (B)

Gas $\rightarrow$ Liquid, Valume $\downarrow$;P$\uparrow$



Q.16 **(B)**

Van -der walls goes eauation for n = 1

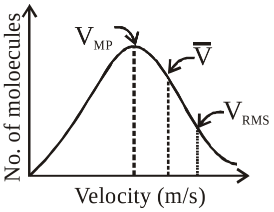
$$\left(P + \frac{a}{V_m^2}\right)\left(V_m - b\right) = RT$$

Compressibility factor (z) decreases if (b) decreases (a) increases at constant temperature.

Q.17 (D)

Since $T_1 > T_c$, the gas cannot be liquefied at T_1 T_c is the highest temperature at which the gas can be liquefied. At temperature T_2, liquid starts to appear at point B, however a small increase in pressure at point A condenses the whole system to liquid.

Q.18 **(D)**



JEE-MAIN

PREVIOUS YEAR'S

Q.1 70°C

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{35}{300} = \frac{40}{T_2}$$

$$T_2 = \frac{40\times 300}{35}$$

= 342.86 K

= 69.85°C

$\simeq$ 70° C

Q.2 1

P(V – b) = RT

PV – Pb = RT

$$\frac{PV}{RT} - \frac{Pb}{RT} = 1$$

$$z = 1 + \frac{Pb}{RT}$$

$$\frac{dz}{dp} = 0 + \frac{b}{RT}$$

$$= \frac{b}{RT} = \frac{xb}{RT}$$

x = 1

Q.3 (5)

$$V = \frac{nRT}{P} = \frac{\left(\dfrac{4.75}{26}\right)\times 0.0826\times 323}{\left(\dfrac{740}{760}\right)} \approx 5L$$

Q.4 **(150)**

Total moles of gases, n = $n_{CH_4} + n_{CO_2}$

$$= \frac{6.4}{16} + \frac{8.8}{44} = 0.6$$

Now, P = $\frac{nRT}{V} = \frac{0.6 \times 8.314 \times 300}{10 \times 10^{-3}}$

= 1.49652 × 10^5 Pa = 149.652 kPa

≈ 150 kPa

Q.5 (927)

Q.6 **(84)**

Q.7 (4)

Q.8 **(1)**

Q.9 (2)

JEE-ADVANCED PREVIOUS YEAR'S

Q.1 **A,B,C,D**

(A) Fact

(B) P = MV = $M\sqrt{\frac{3RT}{M}} = \sqrt{3MRT}$

(C) Max well distribution

(D) Fact

Q.2 7

P_{He} = 1 – 0.68 = 0.32 atm

V = ?

n = 0.1

$$V = \frac{nRT}{P} = \frac{0.1 \times 0.0821 \times 273}{0.32} = 7$$

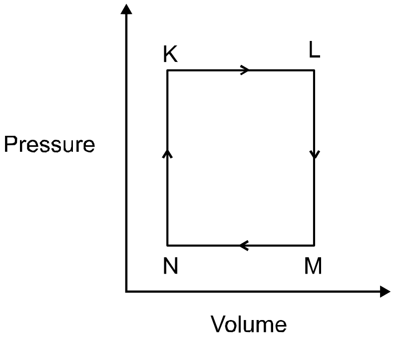
Q.3 **5**

$$\lambda = \frac{h}{\sqrt{2m(KE)}} \qquad KE \propto T$$

$$\frac{\lambda_{He}}{\lambda_{Ne}} = \sqrt{\frac{m_{Ne} KE_{Ne}}{m_{He} KE_{He}}} = \sqrt{\frac{20 \times 1000}{4 \times 200}} = 5.$$

Paragraph for Questions 4 to 5

Q.4 **C**



K → L ⇒ V↑ at constant P

Hence T↑ (Heating)

L → M ⇒ P↓ at constant V

Hence T↓ (Cooling)

M → N ⇒ V↓ at constant P

Hence T↓ (Cooling)

N → K ⇒ P↑ at constant V

Hence T↑ (Heating)

Q.5 **(B)**

L → M

M → K

Both are having constant volume therefore these processes are isochoric.

Paragraph for questions 6 and 7

Q.6 **(C)**

According to Grham's law, if all conditions are identical,

$$r \propto \frac{1}{\sqrt{M}}$$

As in this question, all conditions are identical for X and Y, it will be followed

Hence $\frac{r_x}{r_y} = \sqrt{\frac{M_y}{M_x}}$

$$\frac{d}{24-d} = \sqrt{\frac{40}{10}}$$

$$\frac{d}{24-d} = 2$$

d = 48 – 2d

3d = 48

d = 16 cm.

Q.7 **(D)**

The general formula of mean free path (λ) is

$\lambda = \frac{RT}{\sqrt{2}\pi d^2 N_A P}$ (d = diameter of molecule, p = pressure inside the vessel).

∵ d & p are same for both gases, ideally their λ are same. Hence it must be the higher drift speed of X due to which it is seeing more collisions per second, with the inert gas in comparison to gas Y. So X see comparably more resistance from noble gas than Y and hence covers lesser distance than that predicted by Graham's Law.

Q.8 **9**

Initial moles of gases = 1

$$^{238}_{92}U \longrightarrow {}^{206}_{82}Pb + 8\,^{4}_{2}He + 6\,_{-1}e^{\circ}$$

Inital moles	1 moles
Moles after decompostion	8 mole

Total gaseous moles after decompostion = 8 + 1 = 9 moles

Ratio of pressures $\frac{P_f}{P_i} = \frac{n_f}{n_i} = 9$

Q.9 C

$P(V–b) = RT$

$\Rightarrow PV – Pb = RT$

$\Rightarrow \frac{PV}{RT} = \frac{Pb}{RT} + 1$

$\Rightarrow Z = 1 + \frac{Pb}{RT}$

Hence Z > 1 at all pressures.

This means , repulsive tendencies will be dominant when interatomic distance are small.

This means, interatomic potential is never negative but becomes positive at small interatomic distances.

Hence answer is (C)

Q.10 4 times

Given diffusion coefficient is proportional to mean free path (λ) and mean speed (V_{mean})

And absolute T is increased by 4 times

And average $K_E \propto T \Rightarrow \frac{1}{2}mV^2 \propto T$

When T increased by 4 times ⇒ V_{mean} increases by 2 times (i)

Also mean free path,

$\lambda = \frac{KT}{\sqrt{2}\pi d^2 P} \Rightarrow \lambda \propto \frac{T}{P}$

Increasing T 4 times and P 2 times,

λ increases 2 times

(ii)

from (i) and (ii) implies, diffusion coefficient increases 4 times

Q.11 (2.22)

$P_1 = 5$ $P_2 = 1$

$v_1 = 1$

$v_2 = 3$

$T_1 = 400$

$T_2 = 300$

$n_1 = \frac{5}{400R}$ $n_2 = \frac{3}{300R}$

Let volume be (v + x) v = (3 – x)15 – 5x = 4 + 4x

$\frac{P_A}{T_A} = \frac{P_B}{T_B}$

$\frac{n_{b_1} \times R}{v_{b_1}} = \frac{n_{b_2} \times R}{v_{b_2}}$

$\Rightarrow \frac{5}{400(4+x)} = \frac{3}{300R(3-x)}$

$\Rightarrow 5(3 – x) = 4 + 4x$ $\Rightarrow x = \frac{11}{9}$

$v = 1 + x = 1 + \frac{11}{9} = \left(\frac{20}{9}\right) = 2.22$

Q.12 (1,2,3)

$U_{rms} = \sqrt{\frac{3RT}{M}}$

$E_{avg} = \frac{3}{2}kT$

Q.13 (B)

Graph represents symmetrical distribution of speed and hence, the most probable and the average speed should be same. But the root mean square speed must be greater than the average speed.

Redox Reaction

EXERCISES-I

ELEMENTARY

Q.1 (3)

Q.2 (2)

Q.3 (4)

Q.4 (2)

Q.5 (1)

Q.6 (2)

Q.7 (4)

Q.8 (4)

Q.9 (1)

Q.10 (3)

Q.11 **(3)**

Q.12 (4)

Q.13 (4)

Q.14 (1)

Q.15 (1)

Q.16 (1)

Q.17 (3)

Q.18 (4)

Q.19 **(2)**

Q.20 (4)

Q.21 (4)

Q.22 (3)

Q.23 (1)

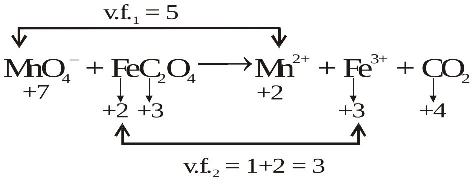
Q.24 **(3)**

Q.25 (4)

$$\underset{\text{O.N.}=0}{8\,\text{Al}} + 3\,\text{Fe}_3\text{O}_4 \longrightarrow \underset{\text{O.N.}=+3}{4\,\text{Al}_2\text{O}_3} + 9\,\text{Fe}$$

Total number $e^{\ominus}$ = 8(3) = 24

Q.26 (4)



$$\underset{+7}{MnO_4^-} + \underset{+2\ +3}{FeC_2O_4} \longrightarrow \underset{+2}{Mn^{2+}} + \underset{+3}{Fe^{3+}} + \underset{+4}{CO_2}$$

v.f.$_1$ = 5

v.f.$_2$ = 1+2 = 3

$n_1 vf_1 = n_2 vf_2$

$n \times 5 = 1 \times 3$

$$n_1 = \frac{3}{5}$$

Q.27 (4)

Q.28 (3)

Q.29 (3)

Q.30 (2)

Q.31 (3)

Q.32 (3)

Q.33 (4)

Q.34 (1)

Q.35 (1)

JEE-MAIN
OBJECTIVE QUESTIONS

Q.1 (4)

$H_2S_2O_7$

$+2 + 2x + (-14) = 0$

$x = +6$

Q.2 (3)

Q.3 (4)

$H_2\underline{S}O_3 = +4$

$\underline{S}O_2 = +4$
$H_2\underline{S}O_4 = +6$
$H_2S = -2$

Q.4 (1)

$K_2Cr_2O_7$
$+2 + 2x + (-14) = 0$
$2x = 12$
$x = \mathbf{+6}$
$KMnO_4$
$+1 + x + (-8) = 0$
$x = 7$

Q.5 (4)

F_2O

Q.6 (3)

Q.7 (4)

$$ZnS + HNO_3 \longrightarrow Zn(NO_3)_2 + H_2SO_4 + NO_2$$

(+2) (–2) (+5) (+2) (+6)
(+4)

Q.8 (1)

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$$

$$(H_2O_2 \longrightarrow O_2 + 2H^+ + 2e^-) \times 3$$

$$Cr_2O_7^{2-} + 8H^+ + 3H_2O_2 \longrightarrow 2Cr^{3+} + 7H_2O + 3O_2$$

The reaction practically occurs with this stoichiometry.

Q.9 (1)

In the above reaction $C_2O_4^{-2}$ acts as a reductant because it is oxidised to CO_2 as :

$C_2O_4^{-2} \rightarrow 2CO_2 + 2e^{-}$(oxidation)

$C_2O_4^{-2}$ reduces MnO_4^{-} to Mn^{+2} ion in solution.

Q.10 (3)

Let the O.N.of Co be x
O.N. of NH_3 is zero
O.N. of Cl is –1
O.N. of Br is –1
Hence, x + 6 (0) – 1 x 2 –1 = 0
∴ x = + 3

so, the oxidation number of cobalt in the given complex compound is +3.

Q.11 (3)

In the reaction $P_2O_5 \rightarrow H_4P_2O_7$

The O.N. of P in P_2O_5 is $2x + 5(-2) = 0$ or $x = +5$

The O.N. of P in $H_4P_2O_7$ is $4(+1) + 2(x) + 7(-2) = 0$

$2x = 10$ or $x = +5$

Since there is no change in O.N. of P, hence the above reaction is neither oxidation nor reduction.

Q.12 (1)

In KI_3 $\quad 1 + 3 \times (a) = 0$

$$a = -\frac{1}{3}$$

or KI_3 is $KI + I_2$

∴ I has two oxidation no. –1 and 0 respectively. However factually speaking oxidation number of I in KI_3 is on average of two values – 1 and 0.

Average O.N. = $\dfrac{-1 + 2 \times (0)}{3} = -\dfrac{1}{3}$.

Q.13 (2)

Q.14 (2)

Q.15 (3)

Q.16 (1)

Q.17 (3)

Valency factor ratio is inversely related to molar ratio.
(V.f.)HI : (V.f.)HNO_3 = 1 : 3 = 2 : 6 ∴ Molar ratio = 6 : 2

Q.18 (1)

$$MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$$

V.f. = 5 V.f. = 2

∴ Balanced equation : $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

Q.19 (1)
Q.20 (1)
Q.21 (2)

In this +2 → +5 (Oxidation)
Hence Nitric oxide act as reducing agent

Q.22 (1)

Q.23 (1)

Balance reaction is

$2KMnO_4 + 5H_2O_2 + 3H_2SO_4 \longrightarrow 2MnSO_4 + 5O_2 + 8H_2O + K_2SO_4$

∴ Sum of stoichiometric coefficients = 2 + 5 + 3 + 2 + 5 + 8 + 1 = 26

Q.24 (1)

$2MnO + 5PbO_2 + 10\ HNO_3 \longrightarrow 2HMnO_4 + 5\ Pb(NO_3)_2 + 4\ H_2O$

Q.25 (4)

Q.26 (4)

Q.27 (1)

$(\underline{N}H_4)_2\underline{Cr}_2O_7 \longrightarrow \underline{Cr}_2O_3 + \underline{N}_2 + 4H_2O$

O.S. of N = – 3 O.S. of Cr = +3

O.S. of Cr = +6 O.S. of N = 0

Q.28 (1)

Q.29 (1)

Q.30 (3)

$Fe(CO)_5$

O.S. = O

Q.31 (2)

Q.32 (3)

n factor for $Mn^{+3} = 1/2$

Q.33 (1)

Q.34 (1)

n.F. = 3

equivalent wt. of $FeC_2O_4 = M/3$

Q.35 (1)

$$\underset{+5}{BrO_3^-} \longrightarrow \underset{0}{Br_2}$$

$\therefore$ (V.f.) $BrO_3^- = 5$

$\therefore$ Eq wt = M/5

Q.**36** (1)

In this reaction H_2SO_4 is providing only 1 H^+ therefore, its n-factor = 1 and equivalent mass = $\frac{98}{1}$.

Q.37 (1)

Given $E_{metal} = 2 \times 8 = 16$

$$\frac{Weight_{oxide}}{Weight_{metal}} = ?$$

$eq_{metal} = eq_{oxide}$

$$\frac{w_{metal}}{16} = \frac{w_{oxide}}{16+8} \qquad \therefore \frac{w_{oxide}}{w_{metal}} = \frac{24}{16} = \frac{3}{2} = 1.5$$

Q.38 (4)

Eq. of NaH_2PO_3 + Eq. of $NaHCO_3$ = Eq. of NaOH

$$\frac{20 \times 0.1}{1000} \times 1 + \frac{40 \times 0.1}{1000} \times 1 = x$$

$x = 6 \times 10^{-3}$

JEE-ADVANCED OBJECTIVE QUESTIONS

Q.1 (D)

Q.2 (B)

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

$x = +2$

Q.3 (D)

$Na_2S_4O_6$ O.S = 2.5

Q.4 (B)

$2x + (-8) + 0 + 0 = -2$

$x = +3$

Q.5 (B)

Q.6 (A)

CO_3O_4 $CO_x = +2$

$CO_y = +3$

$2x + 3y - 8 = 0$

Q.7 (A)

Q.8 (B)

$Na_2W_4O_{13}.\ 10\,H_2O$

$+2 + 4x + (-26) + 0 = 0$

$x = +6$

Q.9 (C)

– 1/2= oxidation state of oxygen, so it will form superoxide

Q.10 (A)

$F_{e_{0.93}}O$

$0.93\,x + (-2) = 0$

$$x = \frac{200}{93}$$

Q.11 (A)

In the above reaction $C_2O_4^{-2}$ acts as a reductant because it is oxidised to CO_2 as :

$$C_2O_4^{-2} \rightarrow 2CO_2 + 2e(\text{oxidation})$$

$C_2O_4^{-2}$ reduces MnO_4^- to Mn^{+2} ion in solution.

Q.12 (C)

Q.13 (D)

CrO_4^{-2} $\longrightarrow$	**$Cr_2O_7^{-2}$**
$x + (-8) = -2$	$2x + (-14) = -2$
$x = +6$	$x = +6$

no. change occur in oxidation state.

Q.14 (A)

Q.15 (C)

Q.16 (B)

$HNO_3 \rightarrow NH_3$

Q.17 (B)

Balanced reaction

$$6e^{-} + C_6H_5\overset{\boxed{+3}\to \text{O. No.}}{N}O_2 + 6H^{+} \longrightarrow C_6H_5\overset{\boxed{-3}\to \text{O. No.}}{N}H_2 + 2H_2O$$

∵ To produce 93 gm (or 1 mole) aniline absorbed number of moles of electron in above reaction = 6

∴ To produce 18.6 gm (or 1 mole) aniline absorbed number of moles of electron in above reaction

$$= \frac{6}{93}\times 18.6 \Rightarrow 1.2 \qquad \text{Ans.}$$

Q.18 (C)

O.N. of. Fe in wustite is = $\frac{200}{93}$ = 2.15

It is an intermediate value in between Fe (II) & Fe (III)

Let % of Fe (III) be a, then

2 x (100 – a) + 3 x a = 2.15 x100

a = 15.05

∴ % of Fe (III) = 15.05%

Q.19 (A)

$O_2 + FeS_2 \longrightarrow FeO + SO_2$

Oxidation half reaction :

$S_2^{2-} \longrightarrow 2s^{4+} + 10e^{-}$ .... (i)

Reduction half reaction :

$4e^{-} + O_2 \longrightarrow 2O^{2-}$ .....(ii)

So, on doing 2 × (i) + 5 (ii)

∴ $2S_2^{2-} + 5O_2 \longrightarrow 4s^{4+} + 10\ O^{2-}$

$2FeS_2 + 5O_2 \longrightarrow 4SO_2 + 2FeO$

∵ Since one molecule of FeS_2 liberates 10 electrons So 2 moles of FeS_2 required to liberate 20 mole e^{-}.

Q.20 (C)

$AS_2S_3 + 28H^{+} + NO_3^{-} \rightarrow NO + 14\ H_2O + ASO_4^{-}$
$5 + SO_4^{2-}$

Equivalent wt. of $AS_2S_3 = \frac{M}{28}$

Q.21 (D)

If we assume XeF = 100

Xe = 53.3 %

F = 100 – 53.3 = 46.70

F = = = 6.1 6

formula = XeF_6

Q.22 (D)

Acidic $MnO_4^{-} \rightarrow M^{+2}$ n.F = 5

Basic $MnO_4^{-} \rightarrow MnO_4^{-2}$ n.F. = 1

Neutral $MnO_4^{-} \rightarrow MnO_2$ n.F. = 3

Equivalent wt. of in acidic basic : neutral

23.8 : 120 : 40

3 : 15 : 5

Q.23 (D)

Equivalent wt. = Molecular weight

Due to non ionization of Mohr's salt

Q.24 (A)

$K_4Fe(CN)_6 + FeCl_3 \longrightarrow KFe\,[Fe(CN)_6] + 3KCl$

n = 3 n = 3

$K_4Fe(CN)_6 + FeCl_2 \longrightarrow K_2Fe[Fe(CN)_6] + 2KCl$

n =2 n=2

$$(MV)_{K_4Fe(CN)_6} = (MV)_{FeCl_3}$$

$10 \times M_1 = M_2 \times 10$

$$(MV)_{K_4Fe(CN)_6} = (MV)_{FeCl_2}$$

$10 \times M_1 = 0.5 \times 20$

$M_{FeCl_3} = 1\ M$ Ans.

Q.25 (C)

$KMnO_4 + FeS_2 + CuS \longrightarrow Cu^{+2} + Fe^{+3} + SO_2$

n= 11 n = 6

Eq. of $KMnO_4$ = Eq. of FeS_2 + Eq. of CuS

$$\frac{N\times V}{1000} = \frac{MV_{FeS_2}}{1000}\times n + \frac{MV_{CuS}}{1000}\times n$$

$$\frac{N\times 20}{1000} = \frac{10\times 1}{1000}\times 11 + \frac{20\times 1\times 6}{1000}$$

$$N = \frac{110+120}{20} = \frac{230}{20} = 11.5\,N \quad \text{Ans.}$$

Q.26 (A)

$S \rightarrow S_2O_3^{2-} + S^{-2}$

n-factor of S = $\frac{2\times 2}{2+2} = 1$

E = $\frac{\text{Atomic weight}}{\text{V/F/n} - \text{factor}} = \frac{32}{1}$]

Q.27 (B)

m eq of $KMnO_4$ = 0.1 × 5 × V = 0.5 V

& m eq $K_2Cr_2O_7$ = 0.1 × 6 × V = 0.6 V

So, $K_2Cr_2O_7$ will oxidise more Fe^{2+}

Q.28 (B)

$\underline{M}nO_4^- + Fe(NH_4)_2SO_4 \longrightarrow Mn^{+2}$

$x=+7 \xrightarrow{n.F. = 5e^{\ominus}} x=+2$

Eq. wt of $KMnO_4$ = M/5

Q.29 (A)

m. eq. of H_2SO_4 = m. eq. of Na_2CO_3

$0.1 \times \frac{V}{1000} = \frac{0.125}{106} \times 2$

V = 23.6 mL

Q.30 (D)

Milli equivalents of FeC_2O_4 = 0.1 × 3 × 25 = 7.5

From choice (D), milli equivalents of $KMnO_4$ = 0.1 × 5 × 15 = 7.5

$\therefore$ m. eq. of FeC_2O_4 = m. eq. of $KMnO_4$

Q.31 (B)

$1.68 \times 10^{-3} \times 6 = 3.36 \times 10^{-3} \times x$

x = 3

So, oxidation number of A increases by 3.

$\therefore$ New oxidation number of A = –n + 3 = 3 – n.

Q.32 (A)

Equivalent of $KMnO_4$ = Eq. of H_2C_2OH

0.0162 × V × 5 = .022 × 2 × 25

V = $\frac{0.022 \times 2 \times 25}{.0162}$ = 13.6 ml

Q.33 (D)

Let Z undergoes change in oxidation number from n_1 to n_2 ($n_2 > n_1$) as a result of reaction with $KMnO_4$.

$\therefore$ meq of Z = meq of $KMnO_4$

$0.1 \times 25 \times (n_2 - n_1) = 0.04 \times 25 \times 5$

$\therefore n_2 - n_1 = 2$

Hence, the oxidation number of Z increases by 2.

$\therefore$ change = $(Z^{2+} \rightarrow Z^{4+})$.

Q.34 (A)

$CI^- + MnO_4^- \longrightarrow Mn^{+2} + CI_2$

Eq of Cl_2 = Eq of $KMnO_4$

2 [mole of CI_2] = $5\left[\frac{10}{158}\right]$

mole of CI_2 = $\frac{50}{2\times 158}$ = 0.15823 mole

volume of CI_2 at STP = 0.15823 × 22.4 = 3.54 L

Q.35 (B)

Q.36 (B)

Q.37 (C)

$KMnO_4 + FeS_2 + CuS \longrightarrow Cu^{+2} + Fe^{+3} + SO_2$

n= 11 n = 6

Eq. of $KMnO_4$ = Eq. of FeS_2 + Eq. of CuS

$$\frac{N\times V}{1000} = \frac{MV_{FeS_2}}{1000}\times n + \frac{MV_{CuS}}{1000}\times n$$

$$\frac{N\times 20}{1000} = \frac{10\times 1}{1000}\times 11 + \frac{20\times 1\times 6}{1000}$$

N = $\frac{110+120}{20} = \frac{230}{20} = 11.5\,N$ Ans.

Q.38 (B)

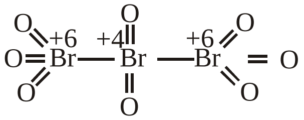
2 moles of Cu^{2+} = 1 mole of I_2 = 2 moles of hypo.

so moles of hypo used = $20 \times 10^{-3} \times 0.1$ = 2 moles = moles of copper hence

% of copper = $\frac{2\times 10^{-3} \times 63.5}{0.2}$ × 10% = 63.5%

Q.39 (1)

Likewise in Br_3O_8, each of the two terminal bnromine stoms are present in **+6** oxidation state and the middle bromine is present in **+4** oxidation state. Once again the average, that is different from reality, is + 16/3.



Structure of Br3O6 (Tribromoctaoxide)

JEE-ADVANCED

MCQ/COMPREHENSION/COLUMN MATCHING

Q.1 (C,D)

In (C) option, Cl goes from +5 to +7 and –1, while in (D) option, Cl goes from 0 to +1 and –1.

Q.2 (A,B,C)

Cr oxidises from +3 to +6 while I reduces from +5 to –1. One I atom gain 6 electron.

Q.3 (B,C)

S undergoes increase in oxidation number from +2 to +2.5, while I undergoes decrease in oxidation number from 0 to –1.

Q.4 (A,B,C)

(A) Oxidation state of K is +1 in both reactant and product.

In (B), oxidation state of Cr(+6) does not change.

In (C), oxidation states of Ca and C and O do not change.

In (D), the H_2O_2 which disproportionates is both oxidising and a reducing agent.

Q.5 (A,C,D)

$$4H_2O + \overset{+1\times3-3}{Cu_3\ P} \longrightarrow 3Cu^{2+} + H_3PO_4 + 11e^- + 5H^+] \times 6$$

$$6e^- + 14H^+ + Cr_2O_7^{2-} \longrightarrow 2Cr^{3+} + 7H_2O] \times 11$$

$$6Cu_3P + 124H^+ + 11Cr_2O_7^{2-} \longrightarrow 18Cu^{2+} + 6H_3PO_4 + 22Cr^{3+} + 53H_2O$$

Q.6 (A,B)

m.eq. of $KMnO_4$ = m.eq. of KHC_2O_4

$0.02 \times 100 \times 5 = \frac{x}{M} \times 2 \times 1000$ ....(1)

m eq. of $Ca(OH)_2$ = m. eq of KHC_2O_4

$0.05 \times 100 \times 2 = \frac{y}{M} \times 1 \times 1000$ (M = Mol. wt. of KHC_2O_4) ....(2)

Divide (1) and (2)

$$\frac{0.02 \times 100 \times 5}{0.05 \times 100 \times 2} = \frac{2x}{y} \Rightarrow 1 = \frac{2x}{y} \Rightarrow \mathbf{2x = y}$$

Q.7 (A,C)

(A) $6\,M_1V_1 = M_2V_2$ [$\because$ For $K_2Cr_2O_7$, Eq . wt. = $\frac{M.wt}{6}$]

(C) $N_1V_1 = N_2V_2$

(B) and (D) are not possible.

Q.8 (A,B,C,D)

equivalent of oxidising agent = equivalents of reducing agent.

$$Eq_{MnO_4^-} = Eq_{Fe^{2+}}$$

$$n_{MnO_4^-} \times 5 = n_{Fe^{2+}} \times 1$$

$$Eq_{Cr_2O_7^{2-}} = Eq_{Fe^{2+}}$$

$$n_{Cr_2O_7^{2-}} \times 6 = n_{Fe^{2+}} \times 1$$

$$Eq_{MnO_4^-} = Eq_{Cu_2S}$$

$$n_{MnO_4^-} \times 5 = n_{Cu_2S} \times 8$$

$$Eq_{Cr_2O_7^{2-}} = Eq_{Cu_2S}$$

$$n_{Cr_2O_7^{2-}} \times 6 = n_{Cu_2S} \times 8$$

Q.9 (A,B,C,D)

For HCl N = M

$$\text{Final molarity} = \frac{V_1 \times 1 + V_2 \times 0.25}{(V_1 + V_2)} = 0.75$$

$0.75\,(V_1 + V_2) = V_1 + V_2 \times 0.25$

$0.75\,V_1 + 0.75\,V_2 = V_1 + V_2 \times 0.25$

$0.5\,V_2 = 0.25\,V_1$

$\frac{V_1}{V_2} = 2$ (All options are possible)

Q.10 (A,C,D)

milli equivalent of $KMnO_4 = 25 \times 0.2 = 5$ meq.

(A) $Fe^{2+} \longrightarrow Fe^{3+}$

milli equivalent of $FeSO_4 = 25 \times 0.2 \times 1 = 0.2 \times 25 = 5$ (same)

(B) $H_3AsO_3 \longrightarrow H_3AsO_4$

milli equivalent of $H_3AsO_3 = 2 \times 50 \times 0.1 = 10$ (not same)

(C) $H_2O_2 \longrightarrow 2H^+ + O_2$

milli equivalent of $H_2O_2 = 25 \times 0.1 \times 2 = 5$ (same)

(D) $Sn^{2+} \longrightarrow Sn^{4+}$

milli equivalent of $SnCl_2 = 25 \times 0.1 \times 2 = 5$ (same)

Q.11 (A,B,D)

Cu_2S + I_2 → Cu^{+2} +
SO_4^{-2} + I^- .....(1)
$(n_f = 10)$ $(n_f = 2)$
CuS + I_2 → Cu^{+2} +
SO_4^{-2} + I^- .....(2)
$(n_f = 8)$ $(n_f = 2)$
I_2 + $S_2O_3^{-2}$ → I^- +
$S_4O_6^{-2}$ .....(3)
$(n_f = 2)$ $(n_f = 1)$
$(n_f = 2)$

In reaction (1) :

Meq of Cu_2S = Meq of I_2

$0.5 \times 10 \times V = 250 \times 1 \times 2$

$V = 100$ ml (of Cu_2S)

In reaction (2) :

Meq of CuS = Meq of I_2

$0.5 \times 8 \times V_{CuS} = 250 \times 1 \times 2$

$V_{CuS} = 125$ ml

$$\text{eQ.wt of } I_2 = \frac{\text{mol.wt}}{n_f} = \frac{254}{2} = 127$$

Q.12 (A,C,D)

$$\begin{array}{llll} Na_2SO_4 + & Ba(NO_3)_2 \longrightarrow & BaSO_4\downarrow + & 2\,NaNO_3 \\ 4 \times 10^{-3} & V \times 4 \times 10^{-3} & \text{ppt.} & 2 \times 4\,V \times 10^{-3} \\ 0 & 0 & & \end{array}$$

$$M = \frac{8V \times 10^{-3}}{5V} \times 10^{-3}$$

$$= \frac{8}{5} \quad \Rightarrow \quad M_{Na^+} = M_{NO_3^-} = \frac{8}{5}M$$

Q.13 (A,D)

1 mole $Na_2C_2O_4 \longrightarrow$ 1 mole CaC_2O_4 [from reaction (i)]

1 mole $CaC_2O_4 \longrightarrow$ 1 mole $H_2C_2O_4$ [from reaction (ii)]

1 mole $H_2C_2O_4 \longrightarrow$ 2 mole CO_2 [from reaction (iii)]

$\Rightarrow n_{CO_2} = 2$

$$U_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{nM}}$$

For CO_2 gas

$$U_{rms} = \sqrt{\frac{3RT}{M_{CO_2}}} = \sqrt{\frac{3PV}{2M_{CO_2}}}$$

Q.14 (A,B,D)

No. of equivalents of $S_2O_3^{2-} = 20 \times 0.3 \times 10^{-3} = 6 \times 10^{-3}$ eq.

No. of equivalents of I_2 produced $= 6 \times 10^{-3}$ eq.

No. of equivalents of $H_2O_2 = 6 \times 10^{-3}$ eq.

Wt of H_2O_2 present in 25 ml of solution $= 6 \times 10^{-3} \times 17$
($\because$ Eq. wt $H_2O_2 = 17$) $= 0.102$ g

Statement (A) is correct.

Wt of H_2O_2 in 1L of the solution $= \dfrac{0.102 \times 1000}{25} =$ 4.08 g

Statement (C) is wrong.

$\therefore$ molarity of H_2O_2 solution $= \dfrac{4.08}{34} = 0.12$ M

Statement (B) is correct.

$$\begin{array}{ll} 2H_2O_2 \longrightarrow & 2H_2O + O_2 \\ 2 \text{ mol} & 1 \text{ mol} \\ 0.12 \text{ mol} & 0.06 \text{ mol} \end{array}$$

Volume of O_2 at NTP $= 0.06 \times 22.4$ lit $= 1.344$ lit

Statement (D) is correct.

Comprehension # 1 (Q. No. 15 to 17)

Q.15 (C)

Q.16 (C)

Q.17 (B)

Comprehension # 2 (Q. No. 18to 25)

Q.18 (B)

Q.19 (A)

Q.20 (B)

Q.21 (A)

Q.22 (C)

Q.23 (A)

Q.24 (A)

Q.25 (B)

18 $Na_2[Fe(CN)_5No]$

$+2 + x + (-5) + (+1) = 0$

$x = +2$

22 $K_2O < K_2O_2 < KO_2 < KO_3$

–2 –1 –1/2 –1/3

23 Because F_2 gain and get reduced, so act as oxidising agent.

25 $\underline{Fe}SO_4.7H_2O$

$x + (-2) = 0$

$x = +2$

Comprehension # 3 (Q. No. 26 to 28)

Q.26 (C)

Q.27 (B)

Q.28 (C)

26 $10\,e^- + 2MnO_4^- \longrightarrow 2Mn^{2+}$; v.f. = 10

$\therefore$ Eq. mass of $Ba(MnO_4)_2$ $(Ba(MnO_4)_2 = \dfrac{M}{10}$

27 $Fe_{0.9}O + K_2Cr_2O_7 \longrightarrow Fe^{+3} + Cr^{+3}$

n factor of $Fe_{0.9}O = 0.9\left(3 - \dfrac{2}{0.9}\right) = 0.7$

$\therefore$ Eq mass $= \dfrac{M}{0.7} = \dfrac{10M}{7}$

28 n factor is 2 for CaC_2O_4

Eq. weight $= \dfrac{M}{2} = \dfrac{128}{2} = 64.$

Comprehension #4 (Q. No. 29to 32)

Q.29 (D)

Q.30 (B)

Q.31 (B)

Q.32 (C)

$FeCr_2O_4$ $Fe_{0.95}O$

x mol y mol

$FeCr_2O_4 \longrightarrow Fe^{+3} + CrO_4^{2-}$

$(n_f = 7)$

$Fe_{0.95}O \longrightarrow Fe^{+n}$

$(n_f = 0.85)$

$K_4[Fe(CN)_6] + Fe^{+3} \longrightarrow KFe\,[Fe(CN)_6] + K^+$

$(n_f = 3)$ $(n_f = 3)$

$K_4[Fe(CN)_6] + Fe^{+2} \longrightarrow K_2Fe\,[Fe(CN)_6] + 2K^+$

$(n_f = 2)$ $(n_f = 2)$

m moles of $K_4[Fe(CN)_6]$

reacted with $Fe^{+3} = 10 \times 1 - 0.7 = 9.3$

$= \text{m moles of } Fe^{+3}$

$x + 0.95\,y = 9.3 \times 10^{-3}$

$7x + 0.85\,y = 0.0482$

$x = 6.5319 \times 10^{-3}$

$y = 2.9138 \times 10^{-3}$

$w_{Fe_{0.95}O} = 0.2016 \text{ gm}$

$w_{FeCr_2O_4} = 1.463$

Comprehension # 5 (Q. No. 33 to 35)

Q.33 (B)

wt. of steel sample = 10 g in 250 ml of solution

$BaCl_2 + Cr_2O_7^{-2} \xrightarrow{H^+} 2BaCrO_4$

0.0549 g

Moles of $BaCrO_4$ in 10 ml $= \dfrac{0.0549}{253}$

Moles of $BaCrO_4$ in 250 ml $= \dfrac{0.0549}{253} \times 25$

Moles of $BaCrO_4$ = moles of Cr $= \dfrac{0.0549}{253} \times 25$

wt. of Cr $= \dfrac{0.0549}{253} \times 25 \times 52 \times 0.282$ g

% of Cr by wt. $= \dfrac{0.282}{10} \times 100 = 2.82\ \%$

Q.34 (A)

$2BaCl_2 + Cr_2O_7^{-2} \xrightarrow{H^+} 2BaCrO_4$

Moles of $BaCrO_4 = \dfrac{0.0549}{253}$

Moles of $Cr_2O_7^{-2} = \dfrac{0.0549}{253 \times 2}$

$MnO_4^- + Fe^{+2} \rightarrow Mn^{+2} + Fe^{+3}$ Step–I

$Cr_2O_7^{-2} + Fe^{+2} \rightarrow Cr^{+3} + Fe^{+3}$ Step–II

Total millieq of $Fe^{+2} = 1.19$

millieq of Fe^{+2} in step–II = millieq of $Cr_2O_7^{-2}$ =

$\dfrac{0.0549}{253 \times 2} \times 6 = 0.65$

Total millieq of Fe^{+2} = millieq of Fe^{+2} in step I + millieq of Fe^{+2} in step II

1.19 = I step + 0.65

millieq of Fe^{+2} in step-I

equivalent of $Fe^{+2} = 5.44 \times 10^{-4}$

Q.35 (C)

Moles of $BaCrO_4$ in 250 ml solution = moles of $BaCl_2$ =

$\dfrac{0.0549}{253 \times 2} \times 25$

wt. of $BaCl_2 = \dfrac{0.0549}{253} \times 25 \times 208 \approx 1.125$

Comprehension # 6 (Q. No. 36 to 38)

Q.36 (C)

Q.37 (D)

Q.38 (B)

36 Let V mL of H_2O_2 is taken

Normality $= \dfrac{20}{5.6}$

meq of H_2O_2 = meq of I_2 liberated = meq of $Na_2S_2O_3$

$V \text{ x } \dfrac{20}{5.6} = 200 \text{ x } 0.1 \Rightarrow \quad V = 5.6 \text{ mL}$

37 meq of H_2O_2 = meq of $K_2Cr_2O_7$

$5.6 \times \dfrac{20}{5.6} = \dfrac{x}{294} \text{ x } 6 \text{ x } 1000$

$x = \dfrac{20 \text{ x } 294}{6 \text{ x } 1000} = 0.98$

$\therefore$ Mass of $K_2Cr_2O_7$ needed is 0.98 g

38 1000 mL $H_2O_2 \longrightarrow$ liberates 20 L O_2 at STP

$\therefore$ 1 mL $H_2O_2 \longrightarrow \frac{20}{1000}$ x 1000 mL O_2

$\therefore 5.6 \longrightarrow 20 \times 5.6$ mL of O_2 = 112 mL of O_2

Comprehension # 7 (Q. No. 39 to 41)

Q.39 (BC)

Q.40 (A)

Q.41 (A)

39 $I_2 \rightarrow I^-$ (Reduction)

(O.A.)

$$S_2O_3^{-2} \rightarrow S_4O_6^{-2}$$

$+2 \qquad\qquad +2.5$ (oxidation)

(R.A.)

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$$Cr_2O_7^{-2} \xrightarrow{+6e^-} Cr_2O_3$$

equivalent wt of $(NH_4)_2 Cr_2O_7$ = M/6

Q.42 (A) – p,s ; (B) – q,r ; (C) – p,q,s ; (D) – r

(A) Eq. of base = N × V_L = 0.5 × 0.2 = 0.1

Eq. of $H_2SO_3 = \frac{4.1}{82} \times 2 = 0.1$

Millimoles of O-atoms = (Millimoles of H_2SO_3) × 3 =

$$\left(\frac{4.1}{82} \times 1000\right) \times 3 = 150$$

S is in + 4 oxidation state (Max = + 6)

It may react with an oxidising agent and it may get oxidised from + 4 to + 6.

(B) Eq of $H_3PO_4 = \frac{4.9}{98} \times 3 = 0.15$

Millimoles of O-atoms = (Millimoles of H_3PO_4) × 4 =

$$\left(\frac{4.9}{98} \times 1000\right) \times 4 = 200$$

P is in + 5 oxidation state (Max = +5)

It will not react with an oxidising agent as P is already in max O.S.

(C) Eq of $H_2C_2O_4 = \frac{4.5}{90} \times 2 = 0.1.$

Millimoles of O-atoms = (Millimoles of $H_2C_2O_4$) × 4 =

$$\left(\frac{4.5}{90} \times 1000\right) \times 4 = 200$$

C is in + 3 oxidation state (Max = + 4).

It may react with an oxidising agent and C may get oxidised from + 3 to + 4.

(D) Na_2CO_3 is itself basic in nature, so it will not react with a base.

Millimoles of O-atoms = (Millimoles of Na_2CO_3) × 3 =

$$\left(\frac{5.3}{106} \times 1000\right) \times 3 = 150.$$

C is in + 4 oxidation state (Max = + 4).

It will not react with an oxidising agent as C is already in max oxidation state.

Q.43 (A) p,q; (B) r,s; (C) r, s ; (D) p,q

(A) Container–I reacts with container–II

n factor of KI = 6

$KMnO_4$	$K_2Cr_2O_7$
1 × 5 = x × 6	1 × 6 = x × 6
$x = \frac{5}{6}$	x = 1

(B) n factor of Cu_2S = 8

$KMnO_4$	$K_2Cr_2O_7$
1 × 5 = x = 8	1 × 6 = x × 8
$x = \frac{5}{8}$	$x = \frac{6}{8} = \frac{3}{4}$

(C) n factor of $K_2C_2O_4 \cdot 3H_2C_2O_4 \cdot 3H_2O$ = 8

$KMnO_4$	$K_2Cr_2O_7$
$x = \frac{5}{8}$	$x = \frac{3}{4}$

(D) n factor of NH_4SCN = 6

$KMnO_4$	$K_2Cr_2O_7$
$x = \frac{5}{6}$	x = 1

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Q.1 3

$$N_2H_4 \rightarrow (Y) + 10e^-$$

($\because$ Y contains all N atoms)

$$\therefore N_2^{2-} \rightarrow (2N)^x + 10e^-$$

– 4 = 2x – 10

x = +3

$\therefore$ oxidation state of N in Y is + 3

Q.2 16

$$2\times(-3e^-)$$

$$CrCl_3 + H_2O_2 \longrightarrow Na_2\overset{(+6)}{Cr}O_4 + 2H_2\underset{(-4)}{O}$$

$$2\times(+1e^-)$$

(balanced skelton) $2CrCl_3 + 3H_2O_2 + 10NaOH \longrightarrow 2Na_2CrO_4 + 6H_2O + 6NaCl + 2H_2O$

$2CrCl_3 + 3H_2O_2 + 10NaOH \longrightarrow 2Na_2CrO_4 + 6NaCl + 8H_2O$

$\Rightarrow$ a = 2 b = 3 and c = 10

Q.3 10

$$(NH_4)_3PO_4 \xrightarrow[16\,ml]{KMnO_4} NO_3^- + PH_3$$

–3 +5 +5 –3

+24 – 8 = 16

50 × 0.2 M

n–factor of $KMnO_4$ in acidic medium = 5

n-factor of $(NH_4)_3PO_4$ = 16

Eq. of $(NH_4)_3PO_4$ = Eq. of $KMnO_4$

$$\frac{0.2\times 50}{1000}\times 16 = \frac{N\times 16}{1000}$$

N = 10 Ans.

Q.4 12

Balanced reaction

$$6e^- + C_6H_5\overset{\text{O. No.}}{\overset{+3}{N}}O_2 + 6H^+ \longrightarrow C_6H_5\overset{\text{O. No.}}{\overset{-3}{N}}H_2 + 2H_2O$$

∵ To produce 93 gm (or 1 mole) aniline absorbed number of moles of electron in above reaction = 6

∴ To produce 18.6 gm (or 1 mole) aniline absorbed number of moles of electron in above reaction

$$= \frac{6}{93}\times 18.6 \Rightarrow 1.2$$

$\Rightarrow 10x = 1.2 \times 10 = 12$

Q.5 7

$Fe^{+2} \longrightarrow Fe^{3+} + e^-$

$Cr_2^{6+} \longrightarrow Cr^{+6} + 6e^-$

$FeCr_2O_4 \longrightarrow Fe_2O_3\ K_2CrO_4 + 7e^-$

Q.6 30

Redox titration

Eq. of $K_2C_2O_4.3H_2C_2O_4.4H_2O$ = Eq. of $KMnO_4$

$$\frac{0.1\times V}{1000} = \frac{20\times 0.05\times 5}{1000}$$

V = 50 ml

n factor of $K_2C_2O_4.\ 3H_2C_2O_4.4H_2O$

for redox titration = 8

for acid base titration = 6

∴ for acid base titration normality of

$$K_2C_2O_4.3H_2C_2O_4.4H_2O = \frac{0.1}{8}\times 6\,N$$

Eq. of acid = Eq. of base

$$\frac{0.1\times 50}{8\times 1000}\times 6 = \frac{1}{8}\times\frac{Vml}{1000}$$

Vml = 30 ml Ans.

Q.7 6

Eq. of NaH_2PO_3 + Eq. of $NaHCO_3$ = Eq. of NaOH

$$\frac{20\times 0.1}{1000}\times 1 + \frac{40\times 0.1}{1000}\times 1$$

$= 6 \times 10^{-3}$

x = 6 Ans.]

Q.8 6

$2BrO_3^- + 10\,Br^- + 12\,HCl \longrightarrow 6Br_2 + 6H_2O + 12\,Cl^-$

$$\text{Mol of } Br_2 = \frac{21\times 2}{2} = 21\text{ m mol}$$

No. of eq. of Br_2 produced in 1st Reaction $= 21 \times \frac{5}{3} = 35$ meq.

$$\therefore\ 70 \times M \times \frac{10}{12} = 35$$

$$M = \frac{6}{10}$$

x = 6 Ans.

Q.9 90

milli equivalent of H_3PO_4 = milli equivalent of $Ba(OH)_2$

120 × 1.5 × 3 = V × 3 × 2

So, V = **90 mL**

Q.10 **2**

meq of Na_2SO_3 = meq of salt

$25 \times 0.1 \times 2 = 50 \times 0.1 \times x \quad \Rightarrow \quad x = 1$

So, oxidation number of metal decreases by 1.

∴ New oxidation number of metal = 3 – 1 = 2.

Q.11 **2**

$Ni(CO)_4 \xrightarrow{\Delta} Ni + 4CO$

$5CO + I_2O_5 \rightarrow I_2 + 5CO_2$

$2S_2O_3^{2-} + I_2 \rightarrow 2I^- + S_4O_6^{2-}$

so moles of I_2 produced = 4 moles

so moles of hypo used = 8 moles = (4 M) (2 litres).

$Ni(CO)_4 \xrightarrow{\Delta} Ni + 4CO$

$5CO + I_2O_5 \rightarrow I_2 + 5CO_2$

$2S_2O_3^{2-} + I_2 \rightarrow 2I^- + S_4O_6^{2-}$

Q.12 4

$Mg - 2\,e^- \longrightarrow Mg^{2+}$

equivalents = moles × n-factor

= 2 × 2 = 4

$Mg - 2\,e^- \longrightarrow Mg^{2+}$

= 2 × 2 = 4`

Q.13 **1**

22400 mL volume contains = 1 mole gas

$\therefore$ 224 mL volume contains = $\frac{1}{22400} \times 224 = \frac{1}{100}$ mole CO_2

Eq of CO_2 = Eq of HCl

$$\frac{1}{100} \times 2 = \frac{20}{1000} \times N$$

N = 1 N

Q.14 **21**

$$3\overset{0}{Fe} + 4H_2O \longrightarrow \overset{+8/3}{Fe_3O_4} + 4H_2$$

$$3Fe + 4H_2O \longrightarrow Fe_3O_4 + 8H^+ + 8e^-$$

V.F. of Fe = $\frac{8}{3}$.

$$E_{Fe} = \frac{\text{Atomic mass}}{\text{V.F.}} = \frac{56}{8/3} = 21.$$

Q.15 10mL

$$meq_{Ca(OH)_2} = meq_{H_3PO_4}$$

0.05 × V × 2 = 10 × 0.1 × 1

V = 10 mL

Q.16 **68**

$85 = E_{metal} + E_{OH^-}$

or $85 = E_{metal} + 17$

or $E_{metal} = 68$

Q.17 **12**

40 g, O ≡ 60 g metal

∴ 8 g, O ≡ 12 g metal (E)

Q.18 32

v.f. of SO_2 = 1 (6 – 4) = 2

∴ Eq. wt. = $\frac{M}{2} = \frac{64}{2} = 32$

Q.19 **16**

Valency factor of $K_2C_2O_4 . 3H_2C_2O_4 . 4H_2O$ is 2 + 3(2) = 8

(as we now that $KMnO_4$ oxidises only $C_2O_4^{2-}$ to CO_2)

Now equivalent of $K_2C_2O_4 . 3H_2C_2O_4 . 4H_2O$ = equivalent of MnO_4^-

$$\frac{5.08}{508} \times 8 = 1 \times 5 \times V \times \frac{1}{1000}$$

so V = **16 mL Ans.**

KVPY

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Q.1 (B)

$16H^+ + 2MnO_4^- + 5C_2O_4^{2-} \rightarrow 2Mn^{+2} + 10\,CO_2 + 8H_2O$

$MnO_4^- : C_2O_4^{2-} = 2 : 5$

$2KMnO_4 + 16\,HCl \rightarrow 2KCl + 2MnCl_2 + 5Cl_2 + 8H_2O$

$MnO_4^- : HCl = 2 : 16 = 1 : 8$

Q.2 (B)

Equivalents of metal = Equivalents of metal sulphate

$$\frac{\text{wt. of metal}}{\text{Eq.wt.of metal}} \frac{\text{wt. of metal sulphate}}{\text{Eq.wt.metal sulphate}}$$

$$\frac{2}{x} = \frac{6.8}{x + 48}$$

$6.8x = 2x + 96$

$4.8x = 96$

$$x = \frac{96}{4.8} = 20$$

Q.3 (A)

$N_1V_1 = N_2V_2$

mili eq. of hypo = 0.25 × 100

mili eq. of hypo = 25

eq. of hypo = 0.025

mole of hypo = 0.025 × 1 $\quad \because V_1 \times 1$

weight of hypo = 0.025 × 248 = 6.2 g

Q.4 (D)

$KMnO_4 + KI + H_2SO_4 \rightarrow MnSO_4 + I_2 + K_2SO_4 + H_2O$

v.f = 5 v.f = 1

∴ $(eq)_{KMnO4} = (eq)_{KI} = 1$

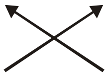
Eq. = V.F. × mole

1 = 5 × mole

Mole = 1/5

Q.5 (B)

$$1K_2\overset{(+6)}{C}r_2O_7 + 6\overset{(+2)}{F}eSO_4 + 7H_2SO_4$$
$$\rightarrow 1\overset{(+3)}{C}r_2(SO_4)_3 + 3\overset{(+3)}{F}e_2(SO_4)_3 + 1K_2SO_4 + 7H_2O$$



$(3 \times 2) = 6 \quad (1 \times 1) = 1$

i.e. answer is m = 6, n = 7, p = 3, q = 7

Q.6 (D)

$K_2CrO_4 \Rightarrow Cr^{+6}$ (highest oxidation state)

$NbCl_5 \Rightarrow Nb^{+5}$

$MnO_2 \Rightarrow Mn^{+4}$

Q.7 (C)

$Cr_2O_7^{-2} + 14H^+ + 6e^- \rightarrow 2Cr^{+3} + 7H_2O$

$\therefore$ no of electron = 6

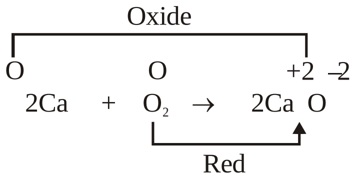
Q.8 (D)

$KMnO_4 + H_2O_2 \xrightarrow{OH^-} MnO_2 + H_2O$

Q.9 (D)

Redox reaction is the reaction in which oxidation & reduction take place simultaneously

So answer is (D)



Q.10 (B)

$NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl$ is not a oxidation-reduction reaction because there is no change in oxidation state of any element.

Q.11 (A)

	O. No.
$POCl_3$	+5
H_2PO_3	+4
$H_4P_2O_6$	+4

Q.12 (B)

$(\text{No. of eq.})_{NaOH} = (\text{No. of eq.})\ H_2SO_4$

$\Rightarrow (1 \times 1) \times y = (0.6 \times 2) \times 10$

$\Rightarrow y = 12$ ml

Now, $(\text{No. of eq.})_{acid} = (\text{No. of eq.})_{NaOH}$

$\Rightarrow N \times 5 = (1 \times 1) \times 12$

$\Rightarrow N = \frac{12}{5} = 2.4$

Q.13 (C)

Oxidation number of Cr in $Cr_2O_7^{2-} = +2x - 14 = -2$

$\Rightarrow x = +6$

Oxidation number of Cl in $ClO_3^- = x - 6 = -1$

$\Rightarrow x = +5$

Q.14 **(A)**

Molarity of $K_2Cr_2O_4 = \frac{1.225 \times 1000}{294 \times 250} = 0.0167$

$$\underset{VF=1}{Fe^{2+}} + \underset{VF=1}{\overset{+6}{Cr_2O_7^{2-}}} \longrightarrow Fe^{3+} + \overset{+6}{Cr^{3+}}$$

Mili Eq. Fe^{2+} = mili eq. of $Cr_2O_7^{2-}$

$[M \times 10]1 = [0.016 \times 25]6$

$M = 0.25$

For $FeCl_2$ concentration = 0.25 N

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Q.1 [173]

$17H_2O + 8CrO^{2-}{}_4 + 3S_2O^{2-}{}_3 \longrightarrow 6SO^{2-}{}_4 + 8Cr(OH)_4^-$
$+ 2OH^-$

Applying mole – mole analysis

$\frac{0.154 \times V}{8} = \frac{40 \times 0.25}{3} \quad \therefore V \simeq 173$ml

Q.2 (1)

Q.3 [6]

$Cr_2O_7^{2-} + 2OH^- \rightleftharpoons 2CrO_4^{2-} + H_2O$

CrO_4^{2-}

$x + (-2 \times 4) = -2$

$x = 6$

Q.4 **[24]**

$n_{eq}\ Fe^{2+} = n_{eq}\ C_r2O_7^{2-}$

or, $\left(\frac{15 \times M_{Fe^{2+}}}{1000}\right) \times 1 = \left(\frac{20 \times 0.03}{1000}\right) \times 6$

$\therefore M_{Fe^{2+}} = 0.24\ M = 24 \times 10^{-2}\ M$

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Q.1 (C)

milli mole of Hypo $= 0.25 \times 48$

$= 2 \times$ milli mole of Cl_2

milli mole of Cl_2 $= \frac{0.25 \times 48}{2} = 6$ milli mole

$=$ milli mole of $Cl_2 =$ milli mole of $CaOCl_2$

So, molarity $= \frac{6}{25}M = 0.24$ M

Q.2 (ABD)

$$6I^- + ClO_3^- + 6H_2SO_4 \rightarrow Cl^- + 6HSO_4^- + 3I_2 + 3H_2O$$

Hence, I^- is oxidised to I_2

Coefficient of $HSO_4^- = 6$

and H_2O is one of the product.
Hence (A), (B), (D)

Q.3 (B)

Correct order :

$$\underset{(+5)}{H_3PO_4} > \underset{(+4)}{H_4P_2O_6} > \underset{(+3)}{H_3PO_3} > \underset{(+1)}{H_3PO_2}$$

Question Stem for Question Nos. 4 and 5

Q.4 [1.87 or 1.88]

$$\underset{x\ \text{mole}}{Fe} + 2HCl \longrightarrow \underset{x\ \text{mole}}{FeCl_2} + H_2$$

Fe^{+2}	+	$MnO4^-$
x		12.5ml
		0.03 M
$n_f = 1$		$n_f = 5$

$$\frac{x}{10} = \frac{12.5 \times 0.03 \times 5}{1000}$$

x = 0.01875 (x = 1.88 or 1.87)
wt of Fe = 1.05g

$$\% \text{ Fe} = \frac{1.05}{5.6} \times 100 = 18.75$$

Q.5 [18.75]