TURBO

Created by students, for students

Structure of Atom

Class 11 Chemistry • Complete Formula Sheet

Sr.	Concept	Formulas	How to Use / Other Information
		Subatomic Particles	
1	Electron	Absolute mass = 9.11×10^{-28} g Relative mass = $\frac{1}{1836}$ amu Charge = -1.6×10^{-19} C Discovered by: J.J. Thomson (1897)	**Key points:** - Negatively charged particle - Found in cathode rays - e/m ratio measured by Millikan
2	Proton	Absolute mass = 1.66×10^{-24} g Relative mass = 1 amu Charge = $+1.6 \times 10^{-19}$ C Discovered by: Goldstein (1886)	**Key points:** - Positively charged particle - Found in nucleus - H^+ ion is a proton
3	Neutron	Relative mass = 1.0083 amu Charge = 0 (neutral) Discovered by: Chadwick (1932)	**Key points:** - No charge - Found in nucleus - Mass slightly ¿ proton
		Bohr's Atomic Theory	
4	Energy of Electron in nth orbit	$E_n = -\frac{2\pi^2 Z^2 e^4 m}{n^2 h^2}$ erg/electron $= -\frac{2.178 \times 10^{-18} Z^2}{n^2}$ J	**How to use:** - Z = atomic number - n = principal quantum number - Energy is negative (electron bound to nucleus) **Example:** For H (Z=1), n=1: $E_1 = -2.178 \times 10^{-18}$ J
5	Radius of nth Bohr Orbit	$r_n = \frac{n^2 h^2}{4\pi^2 m e^2 Z} = 0.53 n^2$ Å	**How to use:** - For hydrogen (Z=1): $r_n = 0.53n^2$ Å - Radius $\propto n^2$ **Example:** n=1: r = 0.53 Å n=2: r = 2.12 Å
6	Energy Change in Transition	$\Delta E = E_{n_2} - E_{n_1}$ $= 2.178 \times 10^{-18} \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ J	**How to use:** - When electron jumps from n_2 to n_1 (where $n_2 > n_1$) - Energy is released (emitted) - If n_1 to n_2: energy absorbed **Example:** H atom: n=3 to n=2 $\Delta E = 2.178 \times 10^{-18} \left[\frac{1}{4} - \frac{1}{9}\right]$ J
7	Frequency of Radiation	$\nu = \frac{\Delta E}{h}$ Wave number: $\bar{\nu} = \frac{1}{\lambda} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$	**Constants:** - h = 6.626×10^{-34} J·s - $R_H = 109{,}677$ cm^{-1} (Rydberg constant) **Use:** To find wavelength of emitted light
		Quantum Numbers	

Sr.	Concept	Formulas	How to Use / Other Information
8	Principal Quantum Number (n)	n = 1, 2, 3, 4, ... Shell capacity = $2n^2$ Energy: $E \propto \frac{1}{n^2}$ Angular momentum: $mvr = \frac{nh}{2\pi}$	**Meaning:** - Determines shell/energy level - Decides distance from nucleus **Max electrons:** K (n=1): 2, L (n=2): 8, M (n=3): 18, N (n=4): 32
9	Azimuthal Quantum Number (l)	l = 0, 1, 2, 3, ... (n-1) For l = 0, 1, 2, 3: subshells are s, p, d, f Max electrons = $2(2l+1)$ Angular momentum = $\frac{h}{2\pi}\sqrt{l(l+1)}$	**Meaning:** - Determines subshell - Decides shape of orbital **Max electrons:** s (l=0): 2, p (l=1): 6, d (l=2): 10, f (l=3): 14
10	Magnetic Quantum Number (m)	m = $-l$ to $+l$ (through 0) Total values = $2l+1$ Total orbitals in shell = n^2	**Meaning:** - Determines orientation of orbital - Number of orbitals in subshell **Examples:** s (l=0): m=0 (1 orbital) p (l=1): m=-1,0,+1 (3 orbitals) d (l=2): 5 orbitals, f (l=3): 7 orbitals
11	Spin Quantum Number (s)	s = $+\frac{1}{2}$ or $-\frac{1}{2}$ Spin angular momentum = $\frac{h}{2\pi}\sqrt{s(s+1)}$	**Meaning:** - Clockwise: $+\frac{1}{2}$ ($\uparrow$) - Anticlockwise: $-\frac{1}{2}$ ($\downarrow$) - Max 2 electrons per orbital (opposite spins)
Electronic Configuration Rules			
12	Aufbau Principle	Electrons fill orbitals in order of increasing energy: 1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d...	**Memory aid:** Use (n+l) rule - Lower (n+l): fills first - If same (n+l): lower n fills first **Example:** 3d (n+l=5) fills after 4s (n+l=4)
13	Pauli Exclusion Principle	No two electrons can have all four quantum numbers identical	**Consequence:** - Max 2 electrons per orbital - Must have opposite spins **Example:** In 3s orbital: Electron 1: n=3, l=0, m=0, s=$+\frac{1}{2}$ Electron 2: n=3, l=0, m=0, s=$-\frac{1}{2}$
14	Hund's Rule	Pairing starts only after all orbitals are singly occupied	**How to apply:** - In p, d, f: fill all orbitals with one electron first - Then start pairing **Example:** C (6e): $1s^2$ $2s^2$ $2p^2$ 2p: $\uparrow\uparrow$ $_{(}not\hat{}\,_{-)}$
de Broglie & Heisenberg			
15	de Broglie Wavelength	$\lambda = \frac{h}{mv} = \frac{h}{p}$ For circular orbit: $n\lambda = 2\pi r$	**How to use:** - Shows wave nature of electron - h = 6.626×10^{-34} J·s **Example:** Electron (m = 9.1×10^{-31} kg, v = 10^6 m/s) $\lambda = \frac{6.626\times10^{-34}}{9.1\times10^{-31}\times10^{6}}$ m
16	Heisenberg Uncertainty Principle	$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$ or $\Delta x \cdot \Delta v \geq \frac{h}{4\pi m}$	**Meaning:** - Cannot know exact position AND momentum simultaneously - Δx = uncertainty in position - Δp = uncertainty in momentum
Nodes in Orbitals			

Sr.	Concept	Formulas	How to Use / Other Information
17	Radial Nodes	Number of radial nodes = n − l − 1	**Examples:** 2s (n=2, l=0): 2-0-1 = 1 radial node 3p (n=3, l=1): 3-1-1 = 1 radial node 3d (n=3, l=2): 3-2-1 = 0 radial nodes
18	Angular Nodes	Number of angular nodes = l	**Examples:** s (l=0): 0 angular nodes p (l=1): 1 angular node d (l=2): 2 angular nodes f (l=3): 3 angular nodes
19	Total Nodes	Total nodes = n − 1 = (n − l − 1) + l	**Quick check:** 2s: 2-1 = 1 node 3p: 3-1 = 2 nodes 4d: 4-1 = 3 nodes
		Hydrogen Spectrum	
20	Spectral Series	**Lyman:** $n_2 \to n_1 = 1$ (UV) **Balmer:** $n_2 \to n_1 = 2$ (Visible) **Paschen:** $n_2 \to n_1 = 3$ (IR) **Brackett:** $n_2 \to n_1 = 4$ (Far IR) **Pfund:** $n_2 \to n_1 = 5$ (Far IR)	**Formula:** $\bar{\nu} = R_H \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$ Where $R_H = 109,677$ cm^{-1} **Example:** Balmer: n=3 to n=2 $\bar{\nu} = 109,677 \left[\frac{1}{4} - \frac{1}{9}\right]$ cm^{-1}
		Isotopes, Isobars, Isotones	
21	Isotopes	Same atomic number (Z), different mass number (A) Same protons, different neutrons	**Examples:** $^{35}_{17}$Cl and $^{37}_{17}$Cl $^{1}_{1}$H, $^{2}_{1}$D, $^{3}_{1}$T $^{16}_{8}$O, $^{17}_{8}$O, $^{18}_{8}$O **Property:** Same chemical properties
22	Isobars	Same mass number (A), different atomic number (Z)	**Examples:** $^{40}_{18}$Ar and $^{40}_{20}$Ca $^{14}_{6}$C and $^{14}_{7}$N
23	Isotones	Same number of neutrons (A-Z), different Z and A	**Examples:** $^{30}_{14}$Si and $^{31}_{15}$P (both have 16 neutrons)
24	Isoelectronic Species	Same number of electrons, different nuclear charges	**Examples:** O^{2-}, F^-, Ne, Na^+, Mg^{2+}, Al^{3+} (all have 10e) N_2, CO, CN^- (all have 14e) **Property:** Same electron configuration
25	Average Atomic Mass	For isotopes with abundances: Avg. mass = $\frac{\sum(\text{mass}\times\text{abundance})}{\sum \text{abundance}}$	**Example:** Cl has ^{35}Cl and ^{37}Cl in 3:1 ratio Avg = $\frac{35\times3+37\times1}{4}$ = 35.5 amu

TURBO *Your complete JEE/NEET formula companion*