

**Quantum number, Electronic configuration and Shape of orbitals****211. (a) Aufbau principle**

**Aufbau principle** states that **electrons fill lower energy orbitals first, then higher energy orbitals.**

This explains the order of filling of orbitals in an atom.

**212. (a)** In particular shell, the energy of atomic orbital increases with the value of  $l$ .

**213. (b) Cu and Ag**

**Explanation:**

**Aufbau principle** states that electrons are filled in orbitals in order of increasing energy (according to the  $n+l$  rule).

But some atoms show **exceptional electronic configurations** due to extra stability of half-filled or fully filled orbitals.

Examples:

**Chromium (Cr,  $Z = 24$ ):** Expected:  $[\text{Ar}] 3d^4s^2 \rightarrow$  Actual:  $[\text{Ar}] 3d^5s^1$

**Copper (Cu,  $Z = 29$ ):** Expected:  $[\text{Ar}] 3d^9s^2 \rightarrow$  Actual:  $[\text{Ar}] 3d^{10}s^1$

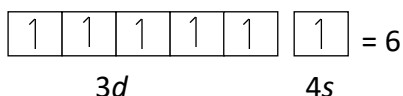
**Silver (Ag,  $Z = 47$ ):** Expected:  $[\text{Kr}] 4d^9s^2 \rightarrow$  Actual:  $[\text{Kr}] 4d^{10}s^1$

**214. (c)** Aufbau principle explains the sequence of filling of orbitals in increasing order of energy.

**215. (a)** According to Aufbau principle electron are filling increasing order of energy. Therefore the electronic configuration  $1s^2 2s^2 2p^6$  obeys Aufbau principle.



216. (d) Electronic configuration of the  $Cr_{24}$  is  $[Ar]4s^13d^5$  or



217. (b) According to the Aufbau principle electron filling minimum to higher energy level.
218. (b) Cu and Ag

### Aufbau principle exceptions

**Aufbau principle:** electrons fill orbitals from lower to higher energy.

**Exceptions** occur in some transition elements due to extra stability of **half-filled ( $d^5$ ) and fully-filled ( $d^{10}$ ) d-subshells.**

**Common exceptions:**

**Chromium (Cr, Z = 24):**  $[Ar] 3d^5 4s^1$  instead of  $[Ar] 3d^4 4s^2$

**Copper (Cu, Z = 29):**  $[Ar] 3d^{10} 4s^1$  instead of  $[Ar] 3d^9 4s^2$

**Silver (Ag, Z = 47):**  $[Kr] 4d^{10} 5s^1$  instead of  $4d^9 5s^2$

219. (b) According to Aufbau principle electron are filled in various atomic orbital in the increasing order of energy
- $$1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < 5s < 4d < 5p < 6s < 4f < 5d < 6p < 7s.$$
220. (d) According to Aufbau's rule.

221. (b) Non degenerate

**p-orbitals:**  $l = 1 \rightarrow 3$  orbitals ( $p_x, p_y, p_z$ )

**In absence of magnetic field:** all three are **degenerate**  $\rightarrow$  same energy

**In presence of magnetic field (Zeeman effect):** the degeneracy is **lifted**



Each orbital has different **magnetic quantum number** ( $m_l = -1, 0, +1$ )  $\rightarrow$  energies split

222. (b) We know that for  $d$ -electron  $l = 2$ .

$$\mu = \sqrt{l(l+1)} \frac{h}{2\pi}; \mu = \sqrt{2(2+1)} \frac{h}{2\pi}$$

$$\mu = \sqrt{2(2+1)} \frac{h}{2\pi}; \mu = \sqrt{6} \frac{h}{2\pi}.$$

223. (a) Number of nodal centre for  $2s$  orbitals  $(n - 1) = 2 - 1 = 1$ .

224. (d) Since  $s$ -orbital have  $l = 0$

$$\text{Angular momentum} = \sqrt{l(l+1)} \times \frac{h}{2\pi} = 0 \times \frac{h}{2\pi} = 0.$$

225. (d) Azimuthal quantum number ( $l$ ) = 3 shows the presence of  $f$  orbit, which contain seven orbitals and each orbital have 2 electrons. Hence  $7 \times 2 = 14$  electrons.

226. (a)  $3d^3 \rightarrow$  three orbitals each with 1 electron  $\rightarrow$  all unpaired

227. (b) According to Aufbau principle.

228. (a) Atomic number of deuterium = 1;  $1D^2 \rightarrow 1s^1$

