5. RULES AND PRINCIPLES

TEACHING TASK

JEE MAIN LEVEL QUESTIONS

1. Which of the following best describes the Aufbau principle?
   a) Electrons fill orbitals starting from the lowest energy level to the highest.
   b) Electrons fill orbitals with increasing energy, irrespective of their position.
   c) Electrons fill orbitals randomly, based on their magnetic properties.
   d) Electrons fill orbitals based on their spatial orientation.

Answer:A

Solution:The Aufbau principle states that electrons occupy the lowest energy orbitals first before filling higher-energy ones (e.g., 1s $\rightarrow$ 2s $\rightarrow$ 2p $\rightarrow$ 3s, etc.).

2. Which element deviates from the expected Aufbau principle due to half-filled and fully-filled subshells?
   a) Calcium (Ca) b) Chromium (Cr) c) Carbon (C) d) Chlorine (Cl)

Answer:B

Solution:Cr (Z=24) has an anomalous configuration: [Ar] $3d^5$ $4s^1$ (not [Ar] $3d^4$ $4s^2$) to achieve a half-filled 3d subshell (more stable).

3. In which of the following elements does the Aufbau principle predict a different electron configuration compared to its actual observed configuration?
   a) Carbon (C) b) Nitrogen (N) c) Chromium (Cr) d) Neon (Ne)

Answer:C

Solution:Expected (Aufbau): [Ar] $3d^4$ $4s^2$

Actual: [Ar] $3d^5$ $4s^1$ (due to stability of half-filled d-subshell).

4. Aufbau principle fails to explain the configuration of element with atomic number
   A) 18 B) 21 C) 24 D) 27

Answer:C

Solution:Expected (Aufbau): [Ar] $3d^4$ $4s^2$

Actual: [Ar] $3d^5$ $4s^1$ (due to stability of half-filled d-subshell).

5. According to Pauli's exclusion principle, which of the following statements about electrons in an atom is correct?
   a) Electrons in the same orbital must have opposite spins.
   b) Electrons in different orbitals must have the same spin.
   c) Electrons in the same orbital must have the same spin.
   d) Electrons in different orbitals must have opposite spins.

Answer:A

Solution:No two electrons can have the same set of quantum numbers. Thus, paired electrons in an orbital must have opposite spins (↑↓).

6. How does the Pauli exclusion principle affect the electron configuration of an atom?
   a) It restricts the number of electrons in each shell.

b) It limits the number of electrons in each orbital.
c) It determines the shape of the electron cloud.
d) It governs the energy levels of electrons.

Answer:B

Solution:Each orbital can hold max 2 electrons with opposite spins (e.g., $1s^2$, $2p^6$).

7. If Pauli's exclusion principle is not known, the electronic arrangement of lithiumatom is

A) $1s^2\ 2s^1$ B) $1s^1\ 2s^2$ C) $1s^3$ D) $1s^2\ 2s^1\ 2p^1$

Answer:C

Solution:Without Pauli's principle, all 3 electrons could occupy the 1s orbital (violating the 2-electron limit per orbital).

8. Which of the following is true about Hund's Rule?

A) It applies only to the filling of p orbitals.
B) It governs the order in which atomic orbitals are filled.
C) It explains the stability of atoms with completely filled orbitals.
D) It contradicts the Pauli Exclusion Principle.

Answer:C

Solution:Hund's rule states that when filling degenerate orbitals (orbitals with the same energy level) within a subshell, electrons will first occupy each orbital singly with parallel spins before any orbital is doubly occupied. This configuration minimizes electron repulsion and maximizes stability.

9. According to Hund's Rule, when filling degenerate orbitals, electrons will first occupy:

A) Orbitals of the highest energy level
B) Orbitals of the lowest energy level
C) Orbitals singly with the same spin
D) Orbitals doubly with opposite spins

Answer:C

Solution: According to Hund's Rule, when filling degenerate orbitals, electrons will first occupy Orbitals singly with the same spin.

10. The electronic configuration of an element is $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $3d^5$, $4s^1$. This represents its :-

A) excited state B) ground state C) cationic form D) anionic form

Answer:B

Solution:This is the actual ground-state configuration of Chromium (Cr), which deviates from Aufbau to achieve a half-filled 3d subshell (more stable).

11. The following electron configuration of an atom in the ground state is not correct because :-

3s 3p 3d

A) the energy of the atom is not minimum
B) Pauli's exclusion principle is violated
C) Hund's rule is violated D) Aufbau principle is not followed

Answer:C

Solution: In the 3d subshell, electrons should occupy orbitals singly first (with parallel spins) before pairing. Here, 4 electrons are paired prematurely, violating

Hund's rule.

12. Select the pairs of ions which have same electronic configuration ?
    A) Cr^{3+}, Fe^{3+} B) Fe^{3+}, Mn^{2+} C) Fe^{3+}, Co^{3+} D) Se^{3+}, Cr^{3+}

Answer:B

Solution:Fe^{3+} (Z=26): [Ar] 3d5 (loses 3 electrons: 2 from $4s^2$, 1 from $3d^6$).
Mn^{2+} (Z=25): [Ar] $3d^5$ (loses 2 electrons: 2 from $4s^2$).
Both have $3d^5$ configuration.

13. Which of the following ions has the maximum number of unpaired d-electrons?
    A) Zn^{2+} B) Fe^{2+} C) Ni^{3+} D) Cu^{+}

Answer:B

Solution:Fe^{2+} (Z=26): [Ar] $3d^6 \rightarrow$ 4 unpaired electrons.
Others:
A) Zn^{2+}: $3d^{1°}$ (all paired).
C) Ni^{3+} : $3d^7 \rightarrow$ 3 unpaired.
D) Cu^{+} : $3d^{1°}$ (all paired).

14. Which of the following is electronic configuration of Cu^{2+} (Z = 29) ?
    A) [Ar]$4s^1$ $3d^8$ B) [Ar]$4s^2$ $3d^{10}$ $4p^1$ C) [Ar]$4s^1$ $3d^{10}$ D) [Ar] $3d^9$

Answer:D

Solution:Cu (Z=29): [Ar] $4s^1$ $3d^{1°}$ (exception to Aufbau).
Cu^{2+}: Loses 2 electrons (1 from 4s, 1 from 3d) $\rightarrow$[Ar] $3d^9$.

15. Which of the following statement(s) is (are) correct?
    A) The electronic configuration of Cr is [Ar] $(3d)^5$ $(4s)^1$. (Atomic number of Cr=24)
    B) The magnetic quantum number may have positive values.
    C) In silver atom, 21 electrons have a spin of one type and 26 of the opposite type. (Atomic number of Ag = 47)
    D) None of these

Answer:A,B

Solution:The electronic configuration of Cr is [Ar] $(3d)^5$ $(4s)^1$
Magnetic quantum number m_l ranges from -l to +l.
Total electrons in Ag = 47
Since each orbital can have 2 electrons of opposite spin, the electrons are roughly divided:23 electrons with one spin 24 electrons with the opposite spin

16. The presence of five unpaired electrons in 3d orbitals of manganese atom is accrding to
    A) Pauli's principle B) Hund's rule
    C) Aufbau principle D)deBroglie's theory

Answer:B

Solution:Mn (Z=25): [Ar] $3d^5$ $4s^2$.
Hund's Rule requires electrons to occupy degenerate orbitals (3d) singly with parallel spins before pairing, resulting in 5 unpaired electrons.

17. The ion that has different number of electrons in the ultimate and penultimate shells
    A) Na^{+} B) K^{+} C) Cl^{-} D) Ca^{2+}

Answer:A

Solution:A) Na^{+}
Ultimate shell (n=2): 8 electrons,Penultimate shell (n=1): 2 electrons

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JEE ADVANCED LEVEL QUESTIONS

MULTI CORRECT ANSWERS

1. Which of the following correctly describe the Aufbau principle?
   A) It states that electrons fill atomic orbitals from lowest to highest energy levels.
   B) It dictates that electrons must occupy the s orbital before any other orbital.
   C) It provides a framework for understanding the arrangement of electrons in an atom.
   D) It allows electrons to occupy orbitals of the same energy level simultaneously.

Answer:A,C

Soution:A) Correct. The Aufbau principle dictates that electrons occupy the lowest energy orbitals first (e.g., 1s $\rightarrow$ 2s $\rightarrow$ 2p $\rightarrow$ 3s).

C) Correct. It is the foundational rule for writing electron configurations.

2. Which of the following statements accurately describe Pauli's Exclusion Principle?
   a) It states that no two electrons in an atom can have the same set of four quantum numbers.
   b) It applies only to electrons in the same orbital.
   c) It is a consequence of the wave nature of electrons.
   d) It prohibits electrons from having identical spin quantum numbers in the same orbital.

Answer:A,D

Soution:a) Correct. The principle asserts that each electron has a unique combination of n, l, m_l, m_s.

d) Correct. In a single orbital, paired electrons must have opposite spins (↑↓).

3. Which of the following is the ground state electronic configuration of nitrogen:-

A) 

B) 

C) 

D) 

Answer:A,D

Soution:All the three orbitals of p should be singly filled first and during the partial filling of the orbitals all the electrons will have the spins aligned to one direction or we can say that the unpaired electrons will have the similar spin.

4. Which of the following statement (s) is (are) correct ?
   A) The electronic configuration of Cr is $[Ar]3d^5$, $4s^1$ (Atomic No. of Cr = 24)
   B) The magnetic quantum number may have a negative value
   C) In silver atom 23 electrons have spin of one type and 24 of the opposite type (Atomic No. of Ag = 47)
   D) The oxidation state of nitrogen in HN_3 is –3

Answer:A,B,C

Soution: The oxidation state of nitrogen in HN_3 is –1/3

REASON AND ASSERTION TYPE

A) Both (A) and (R) are true and (R) is the correct explanation of(A)

B) Both (A) and (R) are ture and (R) is not the correct explanation of (A)

C) (A) is true but (R) is false D) (A) is false but (R) is true

5. Assertion: The Aufbau principle states that electrons occupy the lowest energy orbital available.

   Reason: This principle is based on the idea that electrons are attracted to the positively charged nucleus and will therefore occupy the lowest energy levels first.

Answer:A

Solution:Assertion (A): Correctly states the Aufbau principle.

Reason (R): Explains that electrons fill lower energy orbitals first due to attraction to the nucleus.

6. Assertion: The Aufbau principle explains why the 4s orbital is filled before the 3d orbital in transition metals.

   Reason: The 4s orbital has a slightly lower energy level than the 3d orbital, so according to the Aufbau principle, it is filled before the 3d orbital.

Answer:A

Solution:Assertion (A): Correct. 4s fills before 3d (e.g., K: $[Ar]4s^1$, not $3d^1$).

Reason (R): Correct. 4s has slightly lower energy than 3d initially (though energy levels invert after filling).

7. Assertion: The Aufbau principle predicts that the electron configuration of carbon is $1s^2 2s^2 2p^2$.

   Reason: Carbon has six electrons, and according to the Aufbau principle, these electrons fill the 1s, 2s, and 2p orbitals in order of increasing energy, resulting in the electron configuration $1s^2 2s^2 2p^2$.

Answer:A

Solution:Assertion (A): Correct. Carbon's ground state is $1s^2 2s^2 2p^2$.

Reason (R): Correctly explains the order of filling ($1s \rightarrow 2s \rightarrow 2p$).

8. Assertion: Hund's rule is a consequence of the Aufbau principle.

   Reason: Hund's rule states that electrons occupy degenerate orbitals singly before pairing up, which is consistent with the Aufbau principle of filling orbitals from lowest to highest energy.

Answer:D

Solution:Assertion (A): False. Hund's Rule is not a consequence of the Aufbau principle; they address different aspects (orbital filling order vs. unpaired electrons).

Reason (R): True (Hund's Rule is about unpaired electrons in degenerate orbitals).

9. Assertion: Pauli's exclusion principle states that no two electrons in an atom can have the same set of quantum numbers.

   Reason: This principle arises from the fact that electrons are fermions, subject to the laws of quantum mechanics, and obeying the Pauli exclusion principle

ensures the stability of electron configurations.

Answer:A

Solution:Assertion (A): Correct. No two electrons can share all four quantum numbers.

Reason (R): Correct. Fermions (like electrons) obey Pauli's principle, ensuring atomic stability.

10. Assertion: Pauli's exclusion principle explains why electrons in an atom must have different spin states.

    Reason: Electrons are subject to the Pauli exclusion principle, which states that no two electrons in an atom can have the same set of quantum numbers, including spin, leading to the requirement for electrons to have different spin states.

Answer:A

Solution:Assertion (A): Correct. Electrons in the same orbital must have opposite spins (↑↓).

Reason (R): Correct. Pauli's principle enforces this via unique quantum numbers.

11. Assertion: The Pauli exclusion principle allows for the existence of multiple electrons in the same orbital.

    Reason: While the Pauli exclusion principle prevents two electrons in an atom from having the same set of quantum numbers, it allows for electrons with different spin states to occupy the same orbital.

Answer:A

Solution:Assertion (A): Correct. Two electrons can share an orbital if spins differ (??).

Reason (R): Correct. Pauli allows this by permitting opposite spins.

12. Assertion: Hund's rule states that electrons occupy degenerate orbitals singly before pairing up.

    Reason: Electrons repel each other due to their negative charge, and occupying degenerate orbitals singly minimizes electron-electron repulsion, leading to a lower energy configuration.

Answer:A

Solution:Assertion (A): Correct. Hund's Rule mandates unpaired electrons in degenerate orbitals.

Reason (R): Correct. Unpaired electrons minimize repulsion, lowering energy.

13. Assertion: Hund's rule is a consequence of the Pauli exclusion principle.

    Reason: The Pauli exclusion principle states that no two electrons in an atom can have the same set of quantum numbers, including spin. Hund's rule follows from this principle by maximizing the number of unpaired electrons with different spins.

Answer:D

Solution:Assertion (A): False. Hund's Rule is independent of Pauli's principle (it's about minimizing repulsion, not quantum numbers).

Reason (R): True (but irrelevant to Hund's Rule).

14. Assertion: Hund's rule explains why the electron configuration of nitrogen is $1s^2 2s^2 2p^3$.

    Reason: Following Hund's rule, the three electrons in the 2p sublevel of nitrogen occupy separate orbitals with parallel spins before pairing up.

Answer:D

Solution:A is false, because the configuration $1s^2 2s^2 2p^3$ is predicted by the Aufbau principle, not Hund's rule.

But R is true on its own.

15. Assertion: Hund's rule predicts that the 3d orbitals fill after the 4s orbitals in transition metals.

    Reason: Hund's rule states that electrons fill degenerate orbitals singly before pairing up. Therefore, in transition metals, the 3d orbitals fill after the 4s orbitals to maximize the number of unpaired electrons.

Answer:D

Solution: A is false – The order in which 4s fills before 3d is determined by Aufbau, not Hund's rule"? R is true, but doesn't explain

STATEMENT TYPE

A) Both the statements ar **TRUE**
B) Both the statements are **FALSE**
C) Statement -I is **TRUE** and Statement -II is **FALSE**
D) Statement -Iis **FALSE** and Statement -II is **TRUE**

16. **Statement-1 :** Electronic configuration any orbital can be simply represented by the notation nl^x .
    Statement-2 : n is number of the main or principal shell. l is symbol of the subshell or orbital.

Answer:A

Solution:Statement-I is correct. The notation nl^x is standard in chemistry, where:
n = Principal quantum number (shell number, e.g., 1, 2, 3).
l = Azimuthal quantum number (subshell: s, p, d, f).
x = Number of electrons in the subshell.
Example: $2p^4$ means the 2nd shell, p-subshell, with 4 electrons.
Statement-II is correct. It accurately defines n (principal shell) and l (subshell symbol like s, p, d, f)

17. **Statement-1 :** The ground state of configuration of Cr is $3d^5, 4s^1$
    Statement-2 : A set of half - filled orbitals containing 1 electron each with their spin parallel provides extra stability.

Answer:A

Solution:Statement-I is correct. Chromium (Z=24) deviates from the Aufbau principle (expected: [Ar] $3d^4\ 4s^2$) to adopt [Ar] $3d^5\ 4s^1$ due to half-filled subshell stability.
Statement-II is correct. Half-filled (e.g., d^5, p^3) or fully-filled (d^{10}, p^6) orbitals are energetically favorable due to:

Symmetric electron distribution.
Exchange energy stabilization (parallel spins minimize repulsion).

COMPREHENSION TYPE

Comprehension-I

Aufbau principle gives a sequence in which various subshell are filled up depending on the relative order of the Energies of various subshell.

18. Aufbau is a German word and its meaning
A) Building up B) Energy C) Shell D) Subshell

Answer:A

Solution:The Aufbau Principle (from German "Aufbauen" = "to build up") describes how electrons sequentially fill atomic orbitals from the lowest to highest energy levels.

19. The next subshell after $3p^6$
A) $4s^2$ B) $3d^{10}$ C) $4p^6$ D) $5s^2$

Answer:A

Solution:Following the Aufbau order, after filling $3p^6$, electrons occupy the 4s orbital before 3d (due to its slightly lower energy).

Comprehension-II

Hund's Rule is a fundamental concept in chemistry that describes the arrangement of electrons in atomic orbitals. According to this principle, electrons occupy degenerate orbitals singly before pairing up. This results in the maximum possible spin alignment for unpaired electrons, which minimizes 0the overall energy of the atom.

20. If an atom has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^3$, which principle is illustrated by this configuration?
A) Hund's Rule B) Pauli Exclusion Principle
C) Aufbau Principle D) Heisenberg Uncertainty Principle

Answer:C

Solution:The given configuration follows the sequential filling of orbitals from lowest to highest energy ($1s \rightarrow 2s \rightarrow 2p \rightarrow 3s \rightarrow 3p$), which is the core idea of the Aufbau Principle.

21. How does Hund's Rule influence the electron configuration of atoms?
A) It ensures that all orbitals are equally filled.
B) It dictates the order in which electrons fill orbitals based on their energy levels.
C) It allows electrons to fill orbitals without regard to their energy levels.
D) It maximizes the total spin of unpaired electrons.

Answer:D

Solution:Hund's Rule states that electrons fill degenerate orbitals (e.g., $2p_x$, $2p_y$, $2p_z$) singly with parallel spins before pairing. This minimizes repulsion and maximizes stability.

INTEGER TYPE

22. The electronic configuration of chromium (Z=24) is

A) $[Ar]4d^4\ 4s^2$ B) $[Ar]3d^5\ 4s^1$ C) $[Ar]3d^4\ 3s^2$ D) $[Ar]4d^5\ 4s^1$

Answer:B

Solution:Chromium (Cr, atomic number 24) deviates from the expected Aufbau configuration ($[Ar]\ 3d^4\ 4s^2$) to adopt $[Ar]\ 3d^5\ 4s^1$.

23. Any p-orbital can accomadate upto .....

Answer:2

Solution:A single p-orbital (like px, py, or pz) can hold:Maximum of 2 electrons, one with spin up (↑) and one with spin down (↓), as per Pauli Exclusion Principle.

MATRIX MATCHING TYPE

24.

Column-I	**Column-II**
a) d - sublevel contains	A) Pauli's
b) No two electron in atom can have all four quantum numbers are same	B) 14 electrons
c) f- sub shell contains	C) 10 electrons
d) p- sub shell contains	D) 6 electrons
	5) 2 electrons

Answer:a-C,b-A,C-B,d-D

Solution:

a) d - sublevel contains	C) 10 electrons
b) No two electron in atom can have all four quantum numbers are same	A) Pauli's
c) f- sub shell contains	B) 14 electrons
d) p- sub shell contains	D) 6 electrons

LEARNERS TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1. Number of orbitals used by chromium for filling its electrons is

A) 24 B) 4 C) 12 D) 15

Answer:D

Solution:Chromium (Cr, Z=24) has the configuration: [Ar] 3d5 $4s^1$.

Orbitals filled:

1s, 2s, 2p (3 orbitals), 3s, 3p (3 orbitals), 3d (5 orbitals), 4s → Total = 15 orbitals.

2. Which of the following electrons is most tightly bound by the nucleus

A) 4p B) 5s C) 4d D) 5d

Answer:A

Solution:Lower energy orbitals are closer to the nucleus and more tightly bound.

Order of penetration power (tightest binding): s > p > d > f.

Among options, 4p is the lowest energy (compared to 5s, 4d, 5d).

3. The no. of unpaired electrons in Chromium atom are

A) 2 B) 3 C) 4 D) 6

Answer:D

Solution:Cr's configuration: [Ar] $3d^5\ 4s^1$.
Unpaired electrons: 5 (3d) + 1 (4s) = 6.

4. The atomic number of an element whose differentiating electron enters in a d sub-shell
   A) 13 B) 19 C) 20 D) 21

Answer:D

Solution:The first transition metal where the differentiating electron enters the 3d subshell is Scandium (Z=21): [Ar] $3d^1\ 4s^2$.

5. In potassium, the order of energy levels is
   A) 3s > 3d B) 4s < 3d C) 4s > 4p D) 4s = 3d

Answer:B

Solution:For potassium (K, Z=19):
4s fills before 3d (Aufbau order), but 3d has higher energy than 4s once filled.

6. The ion that is most stable
   A) Fe^+ B) Fe^{2+} C) Fe^{3+} D) Fe^{4+}

Answer:C

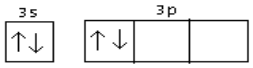
Solution:Fe (Z=26): [Ar] $3d^6\ 4s^2$.
Fe^{3+}: [Ar] $3d^5$ (half-filled d-subshell $\rightarrow$ extra stability).

7. The electronic configuration of nitrogen is $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$. This is in accordance with
   A) Auf-bau principle B) Pauli's rule
   C) Hund's rule D) Bohr Bury principle

Answer:C

Solution:Nitrogen's three unpaired electrons in 2p orbitals (↑ ↑ ↑) illustrate Hund's Rule (maximize unpaired spins).

8. The electronic configuration in the valence shell of silicon is



   The rule violated is
   A) Auf-bau principle B) Paul's rule
   C) Hund's rule D) All

Answer:C

Solution:The given electronic configuration for silicon's valence shell shows:
$3s^2\ 3p^2$ (standard) but with paired electrons in the 3p subshell (↑ ↓).
Violation of Hund's Rule:
Hund's Rule states that electrons must occupy degenerate orbitals (e.g., $3p_x$, $3p_y$, $3p_z$) singly with parallel spins before pairing.

9. The number of unpaired electrons in the Fe^{3+} ion (At no. = 26) is .....
   A) 5 B) 6 C) 2 D) 4

Answer:A

Solution:Fe^{3+}: [Ar] $3d^5 \rightarrow$ 5 unpaired electrons (half-filled d-subshell).

10. The electronic configuration of sodium is
    A)[Ne]$3s^2$ B)[Ne] $3s^1$ C)[Ar] $4s^1$ D)[Ar] $4s^2$

Answer:B

Solution:Sodium (Na, Z=11): $1s^2\ 2s^2\ 2p^6\ 3s^1$ = [Ne] $3s^1$.

JEE MAINS LEVEL QUESTIONS

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1. Which principle governs the filling of degenerate orbitals according to the Aufbau principle?
   a) Hund's rule
   b) Pauli exclusion principle
   c) Heisenberg uncertainty principle
   d) Bohr's principle of quantization

Answer:A

Solution:Hund's Rule dictates that electrons fill degenerate orbitals (e.g., $2p_x$, $2p_y$, $2p_z$) singly with parallel spins before pairing.

Aufbau Principle determines the order of orbital filling (lowest to highest energy), while Hund's Rule specifies how to fill degenerate orbitals.

2. Which of the following statements best explains why the Aufbau principle predicts the filling of 4s before 3d in transition metals?
   a) 4s has a higher energy level than 3d.
   b) 3d has a higher energy level than 4s.
   c) 4s fills first due to its lower spatial extent.
   d) 3d has a higher electron capacity than 4s.

Answer:B

Solution:Initially, 4s has lower energy than 3d (n+l rule: 4s = 4+0=4; 3d = 3+2=5).

Example: Potassium (K) fills 4s before 3d: [Ar] $4s^1$.

3. In a given atom, if two electrons have opposite spins, which of the following is true?
   a) They must be in the same orbital.
   b) They must be in different orbitals.
   c) They must have the same energy.
   d) They must have the same quantum number.

Answer:A

Solution:Pauli's Exclusion Principle requires paired electrons in the same orbital to have opposite spins

4. Which of the following scenarios violates Pauli's exclusion principle?
   a) Two electrons in the same orbital with opposite spins.
   b) Two electrons in different orbitals with opposite spins.
   c) Two electrons in the same orbital with the same spin.
   d) Two electrons in different orbitals with the same spin.

Answer:C

Solution:Pauli's principle prohibits identical quantum numbers (including spin) for two electrons in an orbital.

5. Which of the following is true about Hund's Rule?
   A) It applies only to the filling of p orbitals.
   B) It governs the order in which atomic orbitals are filled.
   C) It explains the stability of atoms with completely filled orbitals.
   D) It contradicts the Pauli Exclusion Principle.

Answer:C

Solution:Hund's Rule maximizes unpaired electrons in degenerate orbitals (e.g., half-filled p^3/d^5) for stability.

6. Hund's Rule states that electrons must first occupy:
   A) The lowest energy orbital
   B) Orbitals with the same principal quantum number
   C) Orbitals with opposite spins
   D) Orbitals singly before pairing up

Answer:D

Solution:Electrons fill degenerate orbitals singly with parallel spins to minimize repulsion.

7. According to Hund's Rule, when filling degenerate orbitals, electrons will occupy separate orbitals with parallel spins to:
   A) Maximize orbital overlap
   B) Maximize electron-electron repulsion
   C) Minimize electron-electron repulsion
   D) Maximize the total electron energy

Answer:C

Solution:Parallel spins in separate orbitals reduce Coulombic repulsion (Hund's Rule).

8. Choose the correct configurations among the following :
   A) Cr (Z = 2D) : [Ar] $3d^5\ 4s^1$ B) Cu (Z = 29) : [Ar] $3d^{10}\ 4s^1$
   C) Pd (Z = 46) : [Kr] $4d^{10}\ 4s^0$ D) Pt (Z = 78) : [Xe] $4d^{10}\ 4s^2$

Answer:A,B,C

Solution:A) Chromium (Cr, Z=24): [Ar] $3d^5\ 4s^1$

Copper (Cu, Z=29): [Ar] $3d^{1°}\ 4s^1$

C) Palladium (Pd, Z=46): [Kr] $4d^{1°}$

D) Platinum (Pt, Z=78): [Xe] $4d^{1°}\ 4s^2$

Actual Configuration: [Xe] $4f^{14}\ 5d^9\ 6s^1$.

9. The configuration [Ar] $3d^{10}\ 4s^2\ 4p^4$ is similar to that of
   A) boron B) oxygen C) sulphur D) aluminium

Answer:C

Solution:S: [Ne] $3s^2\ 3p^4$ (valence shell analogy: $ns^2\ np^4$).

10. After np orbitals are filled, the next orbital filled will be :
    A) (n + 1) s B) (n + 2) p C) (n + 1) d D) (n + 2) s

Answer:A

Solution:Aufbau order: np $\rightarrow$ (n+1)s $\rightarrow$ (n+1)p $\rightarrow$ (n+2)s, etc.

11. Total number of electrons having n+l = 3 in Cr (2D) atom in its ground state is :
    A) 8 B) 10 C) 12 D) 6

Answer:A

Solution:Orbitals with n+l=3: 3s (n=3, l=0), 2p (n=2, l=1), 2d (invalid).

Electrons: $3s^2$ (2) + $2p^6$ (6) = 8.

12. Which of the following statements in relation to the hydrogen atom is incorrect ? [AIEEE 2005]
    A) 3s, 3p and 3d orbitals all have the same energy

B) 3s and 3p orbitals are of lower energy than 3d orbital
C) 3p orbital is lower in energy than 3d orbital
D) 3s orbital is lower in energy than 3p orbital

Answer:B,C,D

Solution:The energy of the hydrogen atom, which has a single electron and is in the state of $1s^1$ will be the same for its 3s, 3p, and 3d orbitals as it is for its 15th orbital since the hydrogen atom only has one electron.

13. The number of sub-energy levels present in any main energy level is equal to
A) n B) n + 1 C) n - 1 D) n^2

Answer:A

Solution:For principal quantum number n, there are n sublevels (l=0 to n-1: s, p, d, ...).

14. Electronic configuration of Th(Z = 90)
A) $[Rn]7s^26d^15f^1$ B) $[Rn]7s^26d^15f^2$ C) $[Rn]7s^25f^16d^1$ D) $[Rn]7s^25f^16d^1$

Answer:D

Solution:Though Th(Z = 90) is an actinide element, spectroscopic studies showed its configuration to be $[Rn]7s^26d^2$

15. Electronic configuration of Atomic number Z = 112
A) $[Rn]5f^{14}6d^{10}7s^1$ B) $[Rn]5f^{14}6d^{10}7s^2$ C) $[Rn]5f^{14}6d^57s^1$ D) $[Rn]5f^{14}6d^57s^2$

Answer:B

Solution:Element 112 is Copernicium (Cn)

Period 7, Group 12,Expected to be similar to Hg (Z = 80): $[Xe]\ 4f^{14}\ 5d^{10}\ 6s^2$

So Cn (Z = 112):$[Rn]\ 5f^{14}\ 6d^{10}\ 7s^2$

16. Chemical properties of an element are dependent on
A) Behaviour of its electron B) Arrangement of electorns
C) Both A are B D) None

Answer:C

Solution:Behavior (reactivity) and arrangement (valence electrons) of electrons determine chemistry.

17. The subshell comes after $5p^6$
A) $6s^2$ B) $4f^{14}$ C) $5d^{10}$ D) $6p^6$

Answer:A

Solution:Aufbau order: $5p^6 \rightarrow 6s^2 \rightarrow 4f^{14} \rightarrow 5d^{10} \rightarrow 6p^6$.

JEE ADVANCED LEVEL QUESTIONS

MULTI CORRECT ANSWERS

1. Select all the correct statements about Pauli's exclusion principle:
a) It applies to all fermions.
b) It prohibits two particles from occupying the same quantum state simultaneously.
c) It is applicable only to electrons.
d) It is a consequence of the wave nature of particles.

Answer:A,B

Solution:a) It applies to all fermions:

The Pauli exclusion principle applies to all particles with half-integer spin, called fermions.

b) It prohibits two particles from occupying the same quantum state simultaneously: This is the core principle, stating that no two identical fermions can be in the same quantum state at the same time.

2. For the energy levels in an atom, which one of the following statement/s is/are correct ?

   A) There are seven principal electron energy levels

   B) The second principal energy level can have four orbitals and contain a maximum of eight electrons

   C) The M energy level can have a maximum of 32 electrons.

   D) The 4s sub-energy level is at a lower energy than the 3d sub-energy level.

Answer:A,B,D

Solution:A) Correct. Principal levels are labeled n=1to n=7 (K, L, M, …, Q shells).

B) Correct. The n=2 level has 1 (2s) + 3 (2p) = 4 orbitals $\rightarrow$ max 8 electrons.

D) Correct. 4s fills before 3d (e.g., potassium: [Ar] $4s^1$).

C) Incorrect. The M shell (n=3) has 9 orbitals (1s + 3p + 5d) $\rightarrow$ max 18 electrons, not 32.

3. Based on what principles of electronic configuration any atom depends?

   A) Pauli's exclusion B) Hunds rule C) Auf bau's principle D) None

Answer:A,B,C

Solution:A) Pauli's principle ensures no two electrons share all quantum numbers (limits orbital occupancy to 2 electrons).

B) Hund's rule maximizes unpaired electrons in degenerate orbitals (e.g., p^3: ↑ ↑ ↑).

C) Aufbau principle dictates the order of orbital filling (lowest to highest energy).

REASON AND ASSERTION TYPE

A) Both (A) and (R) are true and (R) is the correct explanation of(A)

B) Both (A) and (R) are ture and (R) is not the correct explanation of (A)

C) (A) is true but (R) is false D) (A) is false but (R) is true

4. Assertion: According to the Aufbau principle, electrons fill atomic orbitals in order of increasing energy.

   Reason: This principle helps to predict the electron configuration of atoms by filling the orbitals with electrons starting from the lowest energy level.

Answer:A

Solution:Assertion (A): Correct. The Aufbau principle states electrons fill orbitals from lowest to highest energy.

Reason (R): Correct. It explains how this order predicts electron configurations (e.g., 1s $\rightarrow$ 2s $\rightarrow$ 2p).

5. Assertion: The Aufbau principle explains why electrons in an atom occupy different energy levels.

   Reason: Electrons occupy the lowest energy levels first because they are attracted to the positively charged nucleus, resulting in a stable electron configuration.

Answer:A

Solution:Assertion (A): Correct. Electrons occupy different energy levels as per

Aufbau.

Reason (R): Correct. Explains that nuclear attraction drives electrons to fill lower energy levels first.

6. Assertion: The Aufbau principle allows us to predict the electron configuration of an atom.
   Reason: By following the Aufbau principle, we can determine the order in which atomic orbitals are filled with electrons, leading to the electron configuration of an atom.

Answer:A

Solution:Assertion (A): Correct. Aufbau principle predicts configurations (e.g., C: $1s^2$ $2s^2$ $2p^2$).

Reason (R): Correct. Describes the step-by-step orbital filling process.

7. Assertion: The Pauli exclusion principle is a fundamental aspect of quantum mechanics that applies to all particles with half-integer spin.
   Reason: The Pauli exclusion principle applies to particles known as fermions, which have half-integer spin, including electrons, protons, and neutrons.

Answer:A

Solution:Assertion (A): Correct. Pauli's principle applies to all half-integer spin particles (fermions).

Reason (R): Correct. Lists examples (electrons, protons, neutrons) and confirms universality.

8. Assertion: Pauli's exclusion principle dictates the filling of electron orbitals in atoms.
   Reason: This principle prevents more than two electrons from occupying the same orbital, with each electron in an orbital having a unique set of quantum numbers.

Answer:A

Solution:Assertion:

Pauli's exclusion principle is indeed the principle that governs how electrons are arranged in atomic orbitals.

Reason:

The principle states that no two electrons in the same atom can have the same set of all four quantum numbers. This means that an orbital can hold a maximum of two electrons, and these two electrons must have opposite spins (one with spin +1/2 and the other with spin -1/2).

9. Assertion: Pauli's exclusion principle explains the stability of matter and prevents the collapse of atoms.
   Reason: Without the Pauli exclusion principle, electrons would all occupy the lowest energy levels, leading to the collapse of atoms, but this principle ensures that electrons occupy different quantum states, stabilizing atoms.

Answer:A

Solution:Assertion (A): Correct. Pauli's principle prevents electron collapse into the lowest energy state.

Reason (R): Correct. Explains how unique quantum states stabilize matter.

10. Assertion: The Pauli exclusion principle applies only to electrons within an atom and not to other subatomic particles.
    Reason: The Pauli exclusion principle applies to all fermions, including

electrons, protons, and neutrons, regardless of whether they are within an atom or not.

Answer:D

Solution:Assertion (A): Incorrect. Pauli's principle applies to all fermions, not just atomic electrons.

Reason (R): Correct. Confirms the principle's universal application to fermions.

11. Assertion: Hund's rule explains why the electron configuration of carbon is $1s^2 2s^2 2p^2$ rather than $1s^2 2s^1 2p^3$.
    Reason: Hund's rule states that electrons occupy degenerate orbitals singly before pairing up. Therefore, the two electrons in the 2p sublevel of carbon each occupy separate orbitals with parallel spins before pairing up.

Answer:A

Solution:Assertion (A): Correct. Carbon's $2p^2$ configuration follows Hund's rule (↑ ↑).

Reason (R): Correct. Explains unpaired electrons in separate orbitals.

12. Assertion: Hund's rule helps determine the electron configuration of atoms with multiple electron orbitals.
    Reason: Hund's rule guides the filling of orbitals by electrons with parallel spins before pairing up, providing a systematic approach to determining electron configurations.

Answer:A

Solution:Assertion (A): Correct. Hund's rule guides degenerate orbital filling (e.g., N: $2p^3 \rightarrow$ ↑ ↑ ↑).

Reason (R): Correct. Describes the rule's systematic approach.

13. Assertion: Hund's rule predicts that the 4p orbitals will fill before the 3d orbitals in the electron configuration of potassium.
    Reason: Following Hund's rule, electrons fill degenerate orbitals singly before pairing up. Therefore, the 4p orbitals fill before the 3d orbitals in the electron configuration of potassium to maximize the number of unpaired electrons.

Answer:D

Solution:Assertion (A): Incorrect. Aufbau (not Hund's rule) dictates 4s fills before 3d in K ([Ar] $4s^1$).

Reason (R): Correct about Hund's rule but irrelevant to orbital sequence.

STATEMENT TYPE

A) Both the statements ar TRUE
B) Both the statements are FALSE
C) Statement -I is TRUE and Statement -II is FALSE
D) Statement -Iis FALSE and Statement -II is TRUE

14. **Statement-1 :** Atomic number of niotrogen is 7.
    Statement-2 : Accordance with Hunds rule, each of the three 2p orbitals will be singly occupied with electrons having parallel spins.

Answer:A

Solution:Statement-I: Correct. Nitrogen (N) has an atomic number of 7, with the electron configuration: $1s^2\ 2s^2\ 2p^3$.

Statement-II: Correct. Hund's rule dictates that the three 2p electrons occupy separate orbitals ($2p_x$, $2p_y$, $2p_z$) with parallel spins (↑ ↑ ↑) before pairing.

15. **Statement-1 :** 1s orbital possesses lower energy than 2s orbital.
Statement-2 : Pauli's exclusion principle states that an orbital can have maximum of two electrons and these must have opposite spins.

Answer:A

Solution:Statement-I: Correct. The 1s orbital (closer to the nucleus) has lower energy than the 2s orbital.

Statement-II: Correct. Pauli's principle limits an orbital to 2 electrons with opposite spins (↑↓).

COMPREHENSION TYPE

Comprehension-I

The Aufbau Principle, a fundamental concept in chemistry, describes the order in which electrons fill atomic orbitals in an atom. According to this principle, electrons occupy the lowest energy orbitals available before filling higher energy ones. This process occurs as atoms form, with each electron occupying a specific orbital within an atom's electron cloud.

16. Which of the following best summarizes the Aufbau Principle?
A) Electrons occupy orbitals based on their energy levels, with lower energy levels filled first.
B) Electrons occupy orbitals randomly, regardless of energy levels.
C) Electrons occupy orbitals based on their size, with larger orbitals filled first.
D) Electrons occupy orbitals based on their mass, with heavier orbitals filled first.

Answer:A

Solution:The Aufbau Principle states that electrons fill atomic orbitals from the lowest to the highest energy level (e.g., 1s $\rightarrow$2s $\rightarrow$ 2p $\rightarrow$ 3s, etc.).

17. How does the Aufbau Principle influence the electronic configuration of atoms?
A) It ensures that all orbitals are equally filled.
B) It dictates the order in which electrons fill orbitals based on their energy levels.
C) It allows electrons to fill orbitals without regard to their energy levels.
D) It determines the direction in which electrons move within an atom.

Answer:B

Solution:The Aufbau Principle provides a systematic sequence for filling orbitals (e.g., 4s fills before 3d in transition metals).

Comprehension-II

To write the electronic configuration of an element we just know the atomic number of an element, the order in which orbitals are to be filled and the maximum number of electrons in a shell, sub-shell or orbital.

18. What is the electronic configuration of the element La (Z = 57)
A) $[Xe]6s^25d^1$ B)$[Xe]6s^25d^2$ C)$[Xe]6s^25d^0$ D)$[Xe]6s^15d^1$

Answer:A

Solution:Lanthanum (La, Z=57) is the first element in the lanthanide series.

Its ground-state electron configuration is: [Xe] $6s^2$ $5d^1$.

19. electronic configuration of an element lies the chemical properties of an element are dependent on the
    A)behaviour its electrons B)relative arrangement of its electrons
    C) Both A & B D)None

Answer:C

Solution:A) Behavior of its electrons: Chemical reactions involve electron transfer/sharing (e.g., valence electrons).
B) Relative arrangement of its electrons: Electron configuration (e.g., $2s^2$ $2p^4$ for oxygen) dictates reactivity.

INTEGER TYPE

20. The electronic configuration of chromium (Z=24) is
    A) [Ar]$4d^4$ $4s^2$ B) [Ar]$3d^5$ $4s^1$ C) [Ar]$3d^4$ $3s^2$ D) [Ar]$4d^5$ $4s^1$

Answer:B

Solution:Chromium (Cr, atomic number 24) deviates from the expected Aufbau configuration ([Ar] $3d^4$ $4s^2$) to adopt [Ar] $3d^5$ $4s^1$.

21. Maximum number of electrons in f-sub energy level .....

Answer:14

Solution:An f-subshell has 7 orbitals (l=3, ml = -3 to +3).
Each orbital holds 2 electrons (Pauli Exclusion Principle).
Total capacity: 7 orbitals × 2 electrons = 14 electrons.

MATRIX MATCHING TYPE

	List-I	**List-II**
22.	A) Hund's Rule	a) n + 1 Rule
	B) Lowest value of 'n' is filed up first	b) minimum energy is filled up first
	C) Aufbaci Principle	c) Maximum no. of unpaired with spin parallel
	D) Pauli's exclusion principle	d) $2e^-$ with opposite spin

Answer:14

Solution:A - c,B -b,C - a,D -d

A) Hund's Rule	c) Maximum no. of unpaired with spin parallel
B) Lowest value of 'n' is filed up first	b) minimum energy is filled up first
C) Aufbaci Principle	a) n + 1 Rule
D) Pauli's exclusion principle	d) $2e^-$ with opposite spin

KEY

			TEACHING TASK						
			JEE MAIN LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
A	B	C	C	A	B	C	C	C	B
11	12	13	14	15	16	17			
C	B	B	D	A,B	B	A			
			JEE ADVANCED LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
A,C	A,D	A,D	A,B,C	A	A	A	D	A	A
11	12	13	14	15	16	17	18	19	20
A	A	D	D	D	A	A	A	A	C
21	22	23	24						
D	B	2	a-C,b-A,C-B,d-D						
			LEARNERS TASK						
			CUQ'S						
1	2	3	4	5	6	7	8	9	10
D	A	D	D	B	C	C	C	A	B
			JEE MAINS LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
A	B	A	C	C	D	C	A,B,C	C	A
11	12	13	14	15	16	17			
A	B,C,D	A	D	B	C	A			
			JEE ADVANCED LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
A,B	A,B,D	A,B,C	A	A	A	A	A	A	D
11	12	13	14	15	16	17	18	19	20
A	A	D	A	A	A	B	A	C	B
21	22								
14	A - c,B -b,C - a,D -d								