12.RULES AND PRINCIPLES

SOLUTIONS

TEACHING TASK

JEE MAINS LEVEL QUESTIONS

1. 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

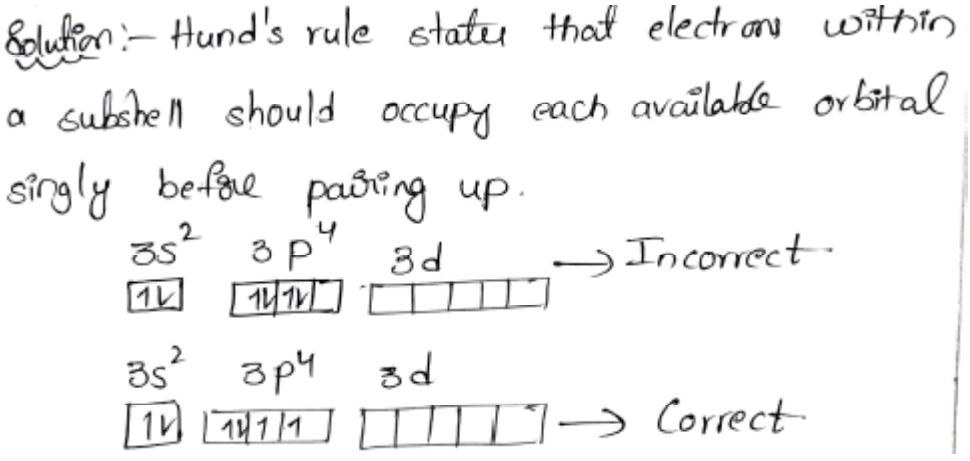
Solution:The electronic configuration s^2, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $3d^5$, $4s^1$ is the most stable and lowest-energy configuration for the element chromium (Cr), making it the ground state. An excited state would have electrons in a higher-energy orbital, and ionic forms would have a different number of electrons.

2. 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



3. Select the pairs of ions which have same electronic configuration ?

(FA & SA- 5 Marks / 8 Marks)

A) Cr^{3+}, Fe^{3+} B) Fe^{3+}, Mn^{2+} C) Fe^{3+}, Co^{3+} D) Se^{3+}, Cr^{3+}

Answer:B

Solution:A)Cr^{3+} (21 e^-), Fe^{3+}(23 e^-) $\rightarrow$ Different

B)Fe^{3+}(23 e^-), Mn^{2+}(23 e^-) → Same electronic configuration → [Ar] $3d^5$

C) Fe^{3+} (23 e^-), Co^{3+} (24 e^-) → Different

D)Se^{3+}(31 e^-), Cr^{3+} (21 e^-) → Different

4. 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+}: Has 4 unpaired d-electrons in its electron configuration.
Zn^{2+}: Has 0 unpaired d-electrons.
Ni^{3+}: Has 2 unpaired d-electrons.
Cu^+: Has 0 unpaired d-electron.

5. 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:Copper (Cu) has atomic number Z=29.
Its ground state electronic configuration is:$[Ar]\ 4s\ ^1 3d^{10}$
Cu^{2+} means removal of 2 electrons:
First electron removed from 4s
Second electron removed from 3d
So:Cu^{2+}=$[Ar]\ 3d^9$

6. Which of the following statements about electronic configuration rules is correct?

A) According to Aufbau principle, electrons occupy the highest energy orbital first.
B) According to Pauli exclusion principle, an orbital can hold a maximum of 3 electrons with parallel spins.
C) According to Hund's rule, electrons occupy degenerate orbitals singly first with parallel spins.
D) According to Hund's rule, all orbitals of a subshell are always completely filled before pairing.

Answer:C

Solution:A) False — electrons occupy lowest energy first.
B) False — max 2 electrons per orbital, opposite spins.
C) True — Hund's rule: singly fill degenerate orbitals with parallel spins first.
D) False — pairing happens only after each orbital gets one electron.

7. 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: Hund's rule states that electrons fill degenerate orbitals singly before pairing, maximizing the number of unpaired electrons.
Manganese (Z=25) has 5 unpaired electrons in 3d due to this rule.

8. The ion that has different number of electrons in the ultimate and penultimate shells **(FA & SA- 3 Marks / 4 Marks)**

A) Na^+ B) K^+ C) Cl^- D) Ca^{2+}

Answer:A

Solution:

Ion	Configuration	Ultimate Shell (n value)	Penultimate Shell (n–1 value)
Na^+	$1s^2\ 2s^2\ 2p^6$	n=2 ($8e^-$)	n=1 ($2e^-$)
K^+	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	n=3 ($8e^-$)	n=2 ($8e^-$)
Cl^-	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	n=3 ($8e^-$)	n=2($8e^-$)
Ca^{2+}	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	n=3 ($8e^-$)	n=2 ($8e^-$)

Only Na^+ has different numbers of electrons in the ultimate (8) and penultimate (2) shell

9. If Pauli's exclusion principle is not known, the electronic arrangement of lithium atom 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 exclusion principle, all 3 electrons in Li could go into 1s orbital.

10. Aufbau principle fails to explain the configuration of element with atomic number **(FA & SA- 2 Marks)**

A) 18 B) 21 C) 24 D) 27

Answer:C

Solution:Aufbau principle fails for Cr (Z=24), which has configuration [Ar] $4s^1\ 3d^5$ instead of [Ar] $4s^2\ 3d^4$ due to extra stability of half-filled d-subshell.

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

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

A)  B) 

C)  D) 

Answer:A,D

Solution:N (Z = 7) $\rightarrow$ $1s^2\ 2s^2\ 2p^3$.

In the 2p subshell the three electrons occupy the three degenerate p-orbitals singly with parallel spins (Hund's rule). Option A &B shows 1s and 2s paired and 2p as three single parallel spins — the correct ground-state arrangement

12. 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

Solution:

A — True. Chromium shows the well-known exception: [Ar] $3d^5$ $4s^1$ due to extra stability of half-filled d subshell.

B — True. Magnetic quantum number m_l ranges from -l to +l, so negative values are allowed.

C — True. Neutral Ag has 47 electrons; with an odd total, one spin orientation will have 24 electrons and the opposite orientation 23 — the statement is consistent.

D — False. In HN_3 (hydrazoic acid) the sum of oxidation numbers of three N atoms is -1 (since H is +1), so average oxidation per N is -1/3; no N has overall oxidation state -3 in HN_3

Statement Type:

A) Both the statements ar TRUE and Statement -II is the correct explanation of STATEMENT - I
B) Both the statements are TRUE and Statement -II is not the correct explantion of Statement -I
C) Statement -I is TRUE and Statement -II is FALSE
D) Statement -Iis FALSE and Statement -II is TRUE

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

Answer:A

Solution:

Statement I is true: electronic configuration is commonly written as nl^x (e.g. $2p^3$).

Statement II correctly defines the symbols n (principal quantum number) and l (subshell label), which explains the notation

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

Answer:A

Solution:Statement I is true: chromium's ground-state configuration is [Ar] $3d^5$ $4s^1$.

Statement II correctly explains why: a half-filled set of orbitals (parallel spins) gives extra stability, driving the 4s $\rightarrow$3d electron redistribution

Comprehension Type:

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

15. Aufbau is a German word and its meaning

A) Building up B) Energy C) Shell D) Subshell

Answer:A

Solution:"Aufbau" means "building up" — the principle of filling orbitals from lower to higher energy.

16. The next subshell after $3p^6$

A) $4s^2$ B) $3d^{10}$ C) $4p^6$ D) $5s^2$

Answer:A

Solution:According to the Aufbau (n + l) rule, the filling order is:

$1s \rightarrow 2s \rightarrow 2p \rightarrow 3s \rightarrow 3p \rightarrow 4s \rightarrow 3d \rightarrow 4p \rightarrow 5s$ ...

So, after $3p^6$, the next subshell filled is $4s^2$

Integer type:

17. Any single p-orbital can accomadate upto .....

Answer:2

Solution:Each orbital (whether s, p, d, or f) can hold a maximum of 2 electrons, according to the Pauli Exclusion Principle.

A p-subshell has 3 orbitals (p_x, p_y, p_z), so total capacity = 6 electrons,but any single p-orbital = 2 electrons

Matrix Matching Type:

18.

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

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 (Z = 24) has the electron configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

Let's count the orbitals used:

1s → 1 orbital
2s → 1 orbital
2p → 3 orbitals
3s → 1 orbital
3p → 3 orbitals
4s → 1 orbital
3d → 5 orbitals
Total orbitals = 1+1+3+1+3+1+5=15

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 principal quantum number and lower orbital energy → 4p electrons are more tightly bound than 5s, 4d or 5d.

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

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

Answer:D

Solution:Chromium (Cr) → Atomic number = 24
Electronic configuration = [Ar] $3d^5\ 4s^1$
$3d^5$ → each of the 5 d orbitals has 1 unpaired electron → 5 unpaired electrons
$4s^1$ → 1 unpaired electron
So, total = 5 + 1 = 6 unpaired electrons

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 element where an electron begins to enter the d-subshell is Scandium (Sc).
Scandium → Atomic number = 21
Electronic configuration = [Ar] $4s^2 3d^1$

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 (Z = 19), the order of energy levels follows the Aufbau principle:

$1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p < \ldots$

6. The ion that is most stable

A) Fe^+ B) Fe^{2+} C) Fe^{3+} D) Fe^{4+}

Answer:C

Solution:Fe (Z=26) has configuration [Ar] $4s^2$ $3d^6$.

Fe^{3+}: [Ar] $3d^5$ → half-filled d-subshell → extra stability (Hund's rule).

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

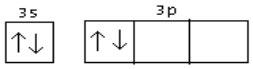
A) Auf-bau principle B) Pauli's rule

C) Hund's rule D) Bohr Bury principle

Answer:C

Solution: Nitrogen ($1s^2$ $2s^2$ $2p^3$) has three electrons in the three 2p orbitals with parallel spins (one in each orbital) ? this follows Hund's rule of maximum multiplicity.

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

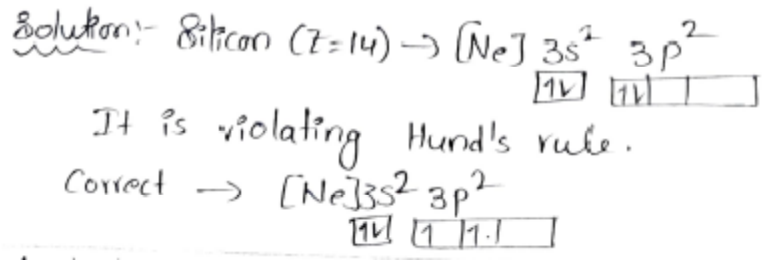


The rule violated is

A) Auf-bau principle B) Paul's rule

C) Hund's rule D) All

Answer:C



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] $3d^5$ → 5 unpaired electron

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 (Z = 11) has the electron configuration: $1s^2\ 2s^2\ 2p^6\ 3s^1$

The noble gas core before sodium is neon (Ne, Z = 10), so the condensed configuration is: $[Ne]3s^1$

JEE MAINS LEVEL QUESTIONS

1. The configuration [Ar] $3d^{10}$ $4s^2$ $4p^4$ is similar to that of **(FA & SA- 2 Marks)**

A) boron B) oxygen C) sulphur D) aluminium

Answer:B,C

Solution:- Given $[Ar]3d^{10}4s^2 4p^4 \rightarrow ns^2np^4$ Configuration.

VI A group element.

A) Boron (Z=5) $\rightarrow 1s^2 2s^2 2p^1 \rightarrow$ III A group.

B). Oxygen (Z=8) $\rightarrow 1s^2 2s^2 2p^4 \rightarrow$ VI A group.

C) Sulphur (Z=16) $\rightarrow 1s^2 2s^2 2p^6 3s^2 3p^4 \rightarrow$ VI A group.

D) Aluminium (Z=13) $\rightarrow 1s^2 2s^2 2p^6 3s^2 3p^1 \rightarrow$ III A group.

2. 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:After np orbitals are filled, the next in Aufbau order is (n+1)s, then (n+1)p, then (n-1)f, then (n+1)d, etc.

3. Total number of electrons having n+l = 3 in Cr (24) atom in its ground state is:

(FA & SA- 3 Marks / 4 Marks)

A) 8 B) 10 C) 12 D) 6

Answer:A

Solution:Atomic number of Cr = 24

Electronic configuration of Cr (ground state) = $1s^2\ 2s^2\ 2p6\ 3s^2\ 3p6\ 3d^5\ 4s^1$

We need to find:Total number of electrons having (n + l) = 3

2p (n + l = 2 + 1 = 3)

3s (n + l = 3 + 0 = 3

$2p^6 \rightarrow$ 6 electrons

$3s^2 \rightarrow$ 2 electrons

Total = 6 + 2 = 8 electrons

4.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:In hydrogen (one-electron atom), all orbitals having the same principal quantum number (n) have exactly the same energy.

That means:3s = 3p = 3d (degenerate orbitals)

5. The number of sub-energy levels present in any main energy level is equal to

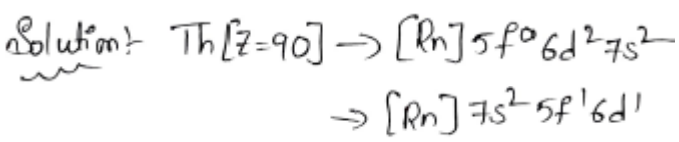
A) n B) n + 1 C) n - 1 D) n^2

Answer:A

Solution:For a given principal quantum number n, the possible values of the azimuthal quantum number l are:
l=0,1,2,...,(n-1)
So the number of sub-energy levels (different l values) is n.

6. Electronic configuration of Th(Z = 90) **(FA & SA- 5 Marks / 8 Marks)**
A) $[Rn]7s^2 6d^1 5f^1$ B) $[Rn]7s^2 6d^1 5f^2$ C) $[Rn]7s^2 5f^1 6d^1$ D) $[Rn]7s^2 5f^1 6d^2$

Answer:C



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

Answer:B

Solution:Z = 112 → $[Rn]5f^{14}6d^{10}7s^2$

8. 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:Chemical properties of an element are determined by the arrangement of its electrons, especially the valence electrons, and their behavior during chemical bonding.

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

Answer:A

Solution:After the 5p orbital is full, the electron filling moves to the next higher principal energy level's s-orbital, which is 6s

10. Which of the following orbitals will be filled first according to the Aufbau principle?
A) 3d B) 4s C) 4p D) 3p

Answer:D

Solution:According to the Aufbau principle, the order of filling is:
3p → 4s → 3d → 4p
Among the options, 3p is filled first.

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

11. Choose the correct configurations among the following :
A) Cr (Z = 24) : [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

Solution:

$Cr \rightarrow [Ar]4s^1 3d^5$

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

$Pd \rightarrow [\mathrm{Kr}]\ 4d^{10}\ 5s^0$ or $[\mathrm{Kr}]\ 4d^{10}$

$Pt \rightarrow [Xe]4f^{14}5d^9 6s^1$

12.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: true — principal quantum numbers n = 1 to 7 are recognized (seven principal levels).

B: true — n = 2 has 4 orbitals (1 × 2s + 3 × 2p) → max 8 electrons.

C: false — M level (n = 3) can hold up to $2n^2 = 18$ electrons, not 32.

D: true (as usually taught) — 4s is lower in energy than 3d for filling order (4s fills before 3d in Aufbau order)

13. 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:Pauli exclusion, Hund's rule, and Aufbau principle all govern how electrons are arranged.

Statement Type:

A) Both statement I and II are correct and statement II is correct explanation of statement I.

B) Both statement I and II are correct and statement II is not correct explanation of statement I.

C) Statement I is correct and statement II is incorrect.

D) Statement I is incorrect and statement II is correct.

explantion of Statement -I

14. **Statement I** : Atomic number of niotrogen is 7.

Statement II : Accordance with Hunds rule, each of the three 2p orbitals will be singly occupied with electrons having parallel spins.

Answer:B

Solution:Statement I: True

Statement II: According to Hund's rule, each of the three 2p orbitals is singly occupied with electrons having parallel spins. – True

But Statement II does not explain Statement I.
Hund's rule explains how electrons fill orbitals, not how atomic number is determined

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

Answer:B

Solution:Statement I: True
Statement II: True
But Statement II does not explain Statement I.
Pauli's rule explains how many electrons can fit in an orbital —"it does not explain energy ordering (which is decided by Aufbau principle & n + l rule

Comprehension Type:

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.

16. 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:The electron configuration of La (Z=57) is $[Xe]6s^25d^1$

17. 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:Chemical properties depend on both behavior of electrons and arrangement of electrons (especially valence electrons).

Integer type:

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

Answer:14

Solution:The f-subshell has l = 3, so number of orbitals = 2l + 1 = 7.
Each orbital holds 2 electrons $\rightarrow$ maximum electrons = 7 × 2 = 14.

Matrix Matching Type:

19.

List-I	**List-II**
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) Aufbau Principle	c) Maximum no. of unpaired with spin parallel
D) Pauli's exclusion principle	d) $2e^-$ with opposite spin

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

Solution:

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) Aufbau Principle — a) n + 1 Rule

D) Pauli's exclusion principle — d) $2e^-$ with opposite spin

KEY

				TEACHING TASK					
			JEE MAINS LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
B	C	B	B	D	C	B	A	C	C
			JEE ADVANCED LEVEL QUESTIONS						
11	12	13	14	15	16	17	18		
A,D	A,B,C	A	A	A	A	2	a-C,b-A,c-B,d-D		
				LEARNERS TASK					
			CONCEPTUAL UNDERSTANDING QUESTIONS (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
B,C	A	A	B,C,D	A	C	B	C	A	D
			JEE ADVANCED LEVEL QUESTIONS						
11	12	13	14	15	16	17	18	19	
A,B	A,B,D	A,B,C	B	B	A	C	14	A-c, B-b, C-a, D-d	