

Quantum Number

JEE (Advanced) Exercises

Single Correct Answer Type

- Spin only magnetic moment of dipositive ion of Zn is:
 - 0
 - $\sqrt{8}$ BM
 - $\sqrt{24}$ BM
 - $\sqrt{35}$ BM
- In boron atom screening on the last electron is due to:
 - Electrons of 'K' shell only
 - All the electrons of K and L shell
 - 2-Electrons of 1s and 2s each
 - All the electrons of L shell only
- The zero probability of finding the electron in p_x orbitals:
 - Two opposite sides of the nucleus along x-axis
 - In the nucleus
 - Same on all the sides around the nucleus
 - None of these
- Which electronic configuration does not follow the Pauli's exclusion principle?
 - $1s^2, 2s^2, 2p^4$
 - $1s^2, 2s^2, 2p^4, 3s^2$
 - $1s^2, 2p^4$
 - $1s^2, 2s^2, 2p^6, 3s^3$
- In which of the following orbitals, there is zero probability of finding electron in XY plane:
 - p_x
 - p_y
 - d_{xy}
 - d_{xz}
- Choose the correct set of quantum number of last electron of ${}_{29}\text{Cu}$:
 - $3, 1, 0, +\frac{1}{2}$
 - $3, 2, -3, +\frac{1}{2}$
 - $3, 2, -2, -\frac{1}{2}$
 - None of these
- Which of the following statement is Correct?
 - Total number of electrons in a subshell is $2\ell + 1$
 - $p_z, d_{x^2-y^2}$ and d_{z^2} orbitals are non-axial
 - Only s-orbitals has directional orientation while $p_z, d,$ and f -orbitals have non-directional properties
 - Spin multiplicity of N-atom is 4
- Find the sum of maximum number of electrons having +1 and -1 value of 'm' in Ti:
 - 6
 - 8
 - 10
 - 12
- Imagine a Universe in which four quantum numbers can have same possible value as in our universe except the magnetic quantum number (m) can have integral values from 0 to $\pm(\ell + 1)$. Find the electronic configuration of atomic number 20.
 - $1s^6 2s^6 2p^8$
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
 - $1s^4 2s^4 2p^6 3s^4 3p^2$
 - $1s^2 1p^6 2s^2 1d^{10}$
- Choose the correct set of quantum number of last electron entered of ${}_{29}\text{Cu}$:
 - $3, 1, 0, +\frac{1}{2}$
 - $3, 2, -3, +\frac{1}{2}$
 - $3, 2, -2, -\frac{1}{2}$
 - None of these

(a) $3, 1, 0, +\frac{1}{2}$ (b) $3, 2, -3, +\frac{1}{2}$

(c) $3, 2, -2, -\frac{1}{2}$ (d) None of these

11. Find the correct set of quantum numbers for 30th electron entered into Ga (At. No. 31):

(a) $n \quad l \quad m \quad s$
4 1 0 $-\frac{1}{2}$

(b) $n \quad l \quad m \quad s$
4 1 1 $+\frac{1}{2}$

(c) $n \quad l \quad m \quad s$
3 2 -1 $+\frac{1}{2}$

(d) $n \quad l \quad m \quad s$
4 0 0 $-\frac{1}{2}$

12. The subshell which are filled just before and just after the filling of 5p subshell are respectively:

(a) 5sd, 5d (b) 4d, 6s

(c) 4d, 4f (d) 6s, 4f

13. The value of $(n \times l \times m)$ for the last electron entered in K is:

(a) 2 (b) 3

(c) 4 (d) 0

Multiple Correct Answers Type

1. Which of the following is/are correct:

(a) In single electron species subshells of same shell are degenerate in the absence of external electric and magnetic field

(b) In multielectron atoms, orbitals of same subshell are degenerate in the absence of external electric and magnetic field

(c) 3d subshell is filled completely before 4s

(d) Energy order of subshell s in single electron species is decided by $(n + l)$ rule

2. Which of the following set of quantum numbers is/are valid for electrons of ground state electronic configuration of elements, having atomic no. up to 25.

(a) $n \quad l \quad m \quad s$
3 2 0 $+\frac{1}{2}$

(b) $n \quad l \quad m \quad s$
4 0 0 $+\frac{1}{2}$

(c) $n \quad l \quad m \quad s$
4 1 0 $-\frac{1}{2}$

(d) $n \quad l \quad m \quad s$
2 2 +1 $+\frac{1}{2}$

3. Which of the following may have same set of quantum no?

(a) Last electron of Ga and last electron of Zn

(b) Unpaired electron of S and entered electron in S^-

(c) Last electron of Sc and last e^- of Cr

(d) Unpaired electron in 2p orbital of N and unpaired electron in 2p orbital of F

4. Select the incorrect statement:

(a) In $d_{x^2-y^2}$ orbital 2 nodal planes are in xz and yz plane

(b) d_{xy} and $d_{x^2-y^2}$ have one common nodal plane

(c) One 4d orbital contains only 2 electrons of same spin

(d) One 3d orbital contains a total of 10 electrons

5. Choose the correct statement among the following:

(a) Number of orbitals in n^{th} shell are n^2

(b) Number of orbitals in a subshell are $(2l + 1)$

(c) Number of subshell in n^{th} shell are n

(d) Number of electrons in an orbital of subshell are $2(2l + 1)$

6. Select the incorrect statement(s) from the following options:

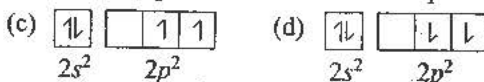
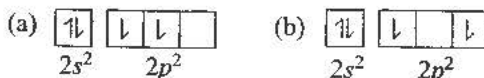
(a) The nodal plane of p_x identical with that of p_y orbital

(b) d_{yz} orbital has two nodal plane which are xz and yz planes

(c) $p_x, p_y,$ and p_z orbitals have the same value of ' l '

(d) $d_{xy}, d_{x^2-y^2},$ and d_{z^2} orbitals have the different orientation in space but have the same value of ' m '

7. Which of the following can be a stable ground state electronic configuration (only valence shell) of carbon atom?



8. Choose the correct statement among the following:

(a) Number of orbitals in n^{th} shell are n^2

(b) Number of orbitals in l^{th} subshell are $(2l + 1)$

(c) Number of subshell in n^{th} shell are n

(d) Number of electrons in an orbital of l^{th} subshell are $2(2l + 1)$

Comprehension Type

Comprehension-1: (Q. 1 to Q. 3)

The plane and point at which zero electron density exists is known as nodal plane and nodal point. Nodal plane also refers as angular node. Number of angular nodes depends on shape of orbital only and size of orbital has no role in it.

Based on the comprehension above, answer the following questions:

- Ratio of number of nodal plane in $6d_{xy}$ orbital to $3d_{xz}$ is:
 - 0
 - 1
 - 2
 - 3
- Which of the following pair of orbitals contains at least one common nodal plane:
 - p_x and p_y
 - d_{xz} and d_{z^2}
 - d_{xy} and p_z
 - d_{xz} and p_x
- Select the correct statement:
 - In d_{z^2} orbital 2 nodal planes are in xz and yz plane
 - d_{z^2} and $d_{x^2-y^2}$ have one common nodal plane
 - One $4d$ orbital contains only 2 electrons of opposite spin
 - One $3d$ orbital contains a total of 10 electrons

Comprehension-2: (Q. 4 to Q. 6)

Imagine a universe in which the four quantum number can have the following values.

$$n = 1 \text{ to } \infty$$

$$\ell = 0 \text{ to } n$$

$$m = -(\ell + 1) \text{ to } +(\ell + 1) \text{ including zero}$$

$$s = +\frac{1}{2} \text{ and } -\frac{1}{2}$$

Answer the following questions based on the above values:

- Total number of elements in the III period of periodic table is:
 - 8
 - 20
 - 30
 - 15
- If Aufbau ($n + \ell$) rule is valid then block of Zn is: [Atomic number of Zn = 30]
 - s -block
 - p -block
 - d -block
 - f -block
- Spin only magnetic moment (μ) of the element sulphur (S) is: [Atomic number of S = 16]
 - 0
 - $\sqrt{3}$ BM
 - $\sqrt{8}$ BM
 - $\sqrt{15}$ BM

Comprehension-3: (Q. 7 and Q. 8)

Imagine a universe in which the four quantum number varies as:

$$n = 1, 2, 3, \dots \infty$$

$$\ell = 0 \text{ to } n$$

$$m = -2\ell \text{ to } +2\ell$$

$$s = +\frac{1}{2} \text{ and } -\frac{1}{2}$$

By using above concept of atom, answer the following:

- Maximum electrons which can be accommodated in 3rd shell are:
 - 32
 - 18
 - 56
 - 48
- If ground state electronic configuration of ${}_{17}\text{Cl}$ is written by using above set of definition of quantum number, then last electron will enter in:
 - $3p$
 - $1d$
 - $2s$
 - $2p$

Comprehension-4: (Q. 9 and Q. 10)

Electronic configuration of penultimate shell of an element is $2s^2 2p^6$. In valence shell, 2 electrons are in s and 4 electrons are in p -subshell. If atomic mass is twice to that of atomic number, then answer the following questions: (Take: $N_A = 6 \times 10^{23}$)

- Total number of protons present in 6.4 g of the element:
 - 1×10^{24}
 - 1.2×10^{23}
 - 2×10^{24}
 - 19.2×10^{23}
- Maximum number of electrons in an atom of the given element having $\ell = 1$ and $s = -\frac{1}{2}$
 - 11
 - 6
 - 4
 - 1

Matching Column Type

1. Match the column:

1. Column-I

(a) Fe^{+2}

(b) Mn^{+4}

(c) Zn^{+2}

(d) Na^{+}

Column-II

(p) Set of quantum number for last e^-

$$n = 2, \ell = 1, m = 1, s = +\frac{1}{2}$$

(q) Magnetic moment (μ) = zero

(r) Spin multiplicity (SM) = 4

(s) Total number of exchange pair in $3d$ -subshell = 10

(t) Paramagnetic

Integer Answer Type

- Find maximum number of electrons in 'A1' in which $\frac{l \times m}{n} = 0$. [At. no. of A1 = 13]
- Find total number of orbitals in 'S' atom, for which $|m| \leq 1$ and contains at least one electron. [At. no. of S = 16]
- Total number of '5s' electrons in 'Pd' is _____. [At. no. of Pd = 46]
- Total no. of exchange pair possible in $3d^8$ electronic configuration is _____.
[If answer is in double digits, then add all the digits, till obtain the single digit]
- Find the $(n + l)$ value for the last electron entered into Hf.
- Find |total spin| of $3d$ electron Fe^{3+} ion, if its magnetic moment is $\sqrt{24}$ BM.
- Find total number of orbitals in which electron density is observed along any of the axis (x or y or z). $s, p_x, p_y, p_z, d_{xy}, d_{xz}, d_{yz}, d_{z^2}, d_{x^2-y^2}$.
- Find the $(n + l)$ value for the last electron entered into Ga. [Atomic no. 31]
- What is the value of $(n + l)$ for the unpaired e^- in an atom of an element which is present in the third period and seventeenth group of the periodic table.
- In multielectronic atom, maximum number of degenerated orbitals present in 3^{rd} shell.
- Calculate maximum number of electrons in ${}_{25}\text{Mn}$ which have $n = 3, m = 0$ and $s = +\frac{1}{2}$.
- Find the total number of orbitals present in 'M' shell of an atom.
- Find the $(n + l)$ value for $4f$ orbital.
- Find the value of $n + l$ for the last electron of ${}_{19}\text{K}$.
- Find the maximum number of electrons in Cr atom which have $m = -1$ and $s = +\frac{1}{2}$ but $n \neq 2$.
- In case of s and p -orbital electrons, each of the $(n - 2)^{th}$ shell electrons shield the n^{th} shell (valence shell) electron by.
- Find the maximum number of electrons having $(n + l + m)$ equal to zero in Cr, if it follows aufbau principle.
- Find the number of electrons having $(n \times l + m) = 3$ for Kr-atom (At. number: $Z = 36$).
- Find the maximum number of e^- having m value ≤ 1 in Cr.

Hints & Solutions

JEE (Advanced) Exercises

Single Correct Answer Type

- (a) According to E.C. Zn^{2+} ion has no unpaired electron so spin only magnetic moment for Zn^{2+} ion is 0.
 $\text{Zn}^{2+} \Rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^0$
- (c) E.C. of B is $1s^2, 2s^2, 2p^1$
in which last electron of $2p$ is shielded by electron of $1s, 2s$
- (a) $m = 0$ to $\pm(\ell + 1)$

$n = 1$	$\ell = 0$	$m = -1, 0, 1$
$n = 2$	$\ell = 1$	$m = -2, -1, 0, 1, 2$
$n = 3$	$\ell = 2$	$m = -3, -2, -1, 0, 1, 2, 3$

Hence s subshell will have 3 orbitals
and p subshell will have 5 orbitals
 d subshell will have 7 orbitals
hence configuration is
 $1s^6 2s^6 2p^8$
- (d) $\text{K}[\text{Ar}] 4s^1$

$n = 4$
$\ell = 0$
$m = 0$
$n \times \ell \times m = 0$

Integer Answer Type

- (9) ${}_{13}\text{Al}$

O	O	-1 0 +1	O	O
$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow$	$\uparrow\downarrow$	\uparrow
1s	2s	2p	3s	3p
$n = 1$	$n = 2$	$n = 2$	$n = 3$	$n = 3$
$\ell = 0$	$\ell = 0$	$\ell = 1$	$\ell = 0$	$\ell = 1$
- (9)

$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow \uparrow \uparrow$
1s	2s	2p	3s	3p
- (0) Electronic configuration of Pd
 $[\text{Kr}], 4d^{10}, 5s^0$
- (4) $\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow$
 Total no. of exchange pair = $\frac{5(5-1)}{2} + \frac{3(3-1)}{2}$
 $= 10 + 3 = 13$
- (5) In 3^{rd} shell $3s, 3p, 3d$ subshells are present and maximum 5 degenerated orbitals are present in d -subshell.

Answers

JEE (Advanced) Exercises

Single Correct Answer Type

1. (a) 2. (c) 3. (b) 4. (d) 5. (d) 6. (c) 7. (d) 8. (c) 9. (a) 10. (c)
11. (c) 12. (b) 13. (d)

Multiple Correct Answers Type

1. (a), (b) 2. (a), (b) 3. (c), (d) 4. (a), (b), (c), (d)
5. (a), (b), (c) 6. (a), (b), (d) 7. (a), (c), (d) 8. (a), (b), (c)

Comprehension Type

- Comprehension-1 1. (b) 2. (d) 3. (c)
Comprehension-2 4. (c) 5. (b) 6. (a)
Comprehension-3 7. (c) 8. (d)
Comprehension-4 9. (d) 10. (b)

Matching Column Type

1. (a) \rightarrow s, t; (b) \rightarrow r, t; (c) \rightarrow q; (d) \rightarrow p, q

Integer Answer Type

1. (9) 2. (9) 3. (0) 4. (4) 5. (7) 6. (2) 7. (6) 8. (5) 9. (4) 10. (5)
11. (3) 12. (9) 13. (7) 14. (4) 15. (2) 16. (1) 17. (0) 18. (6) 19. (022)