

Atomic Structure JEE Main PYQ – 3

Total Time: 25 Minute

Total Marks: 40

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Atomic Structure

1. Arrange the following orbitals in decreasing order of energy (+4, -1)

A. $n = 3, l = 0, m = 0$

[31-Jan-2023 Shift2]

B. $n = 4, l = 0, m = 0$

C. $n = 3, l = 1, m = 0$

D. $n = 3, l = 2, m = 1$

The correct option for the order is :

a. $D > B > C > A$

b. $B > D > C > A$

c. $A > C > B > D$

d. $D > B > A > C$

2. Maximum number of electrons that can be accommodated in shell with $n = 4$ (+4, -1)
are:

[30-Jan-2023 Shift2]

a. 72

b. 16

c. 32

d. 50

3. The wave function (Ψ) of $2s$ is given by $\Psi_{2n} = \frac{1}{2\sqrt{2\pi}} \left(\frac{1}{a_0}\right)^{1/2} \left(2 - \frac{r}{a_0}\right) e^{-\frac{r}{2a_0}}$ At $r = r_0$, (+4, -1)
radial node is formed Thus, r_0 in terms of a_0

[30-Jan-2023 Shift2]

a. $r_0 = \frac{a_0}{2}$

b. $r_0 = 2a_0$

c. $r_0 = 4a_0$

d. $r_0 = a_0$

4. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R : (+4, -1)

[30-Jan-2023 Shift2]

Assertion (A) : Acetal / Ketal is stable in basic medium.

Reason (R) : The high leaving tendency of alkoxide ion gives the stability to acetal ketal in basic medium

In the light of the above statements, choose the correct answer from the options given below

- a. Both A and R are true but R is NOT the correct explanation of A
- b. A is false but R is true
- c. A is true but R is false
- d. Both A and R are true and R is the correct explanation of A

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6. If the radius of ground state hydrogen is 51 pm, find out the radius of 5th orbit of Li^{2+} ions. (closest integer) (+4, -1)
-

7. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R). (+4, -1)

Statement-1: According to Bohr's Model, angular momentum is Quantized for stationary orbits.

Statement-2: Bohr's Model doesn't follow Heisenberg's Uncertainty Principle. In the light of the above statements, write the detailed answer:

- [26 Aug 2021 Shift 1]
- a. Both Statement - 1 and statement - 2 are true
 - b. Statement - 1 is true and statement - 2 is false
 - c. Statement - 1 is false and statement - 2 is true
 - d. Both Statement - 1 and statement - 2 are false

8. Which of the following sets of quantum numbers is not allowed? (+4, -1)

- [25-Jul-2022-Shift-1]
- a. $n = 3, l = 2, m_l = 0, s = +\frac{1}{2}$
 - b. $n = 3, l = 2, m_l = -2, s = +\frac{1}{2}$
 - c. $n = 3, l = 3, m_l = -3, s = -\frac{1}{2}$
 - d. $n = 3, l = 0, m_l = 0, s = -\frac{1}{2}$

9. The d-electronic configuration of $[CoCl_4]^{2-}$ in tetrahedral crystal field is $e^m t_2^n$. Sum of "m" and "number of unpaired electrons" is (+4, -1)

10. The IUPAC nomenclature of an element with electronic configuration (+4, -1)

$[Rn]5f^{14}6d^17s^2$ is:

[26-Jul-2022-Shift-1]

- a. Unnilbium
- b. Unnilunium
- c. Unnilquadium
- d. Unniltrium

Answers

1. Answer: a

Explanation:

(A) $n = 3; l = 0; m = 0$; $3s$ orbital

(B) $n = 4; l = 0; m = 0$; $4s$ orbital

(C) $n = 3; l = 1; m = 0$; $3p$ orbital

(D) $n = 3; l = 2; m = 0$; $3d$ orbital

As per Hund's rule energy is given by $(n + l)$ value. If value of $(n + l)$ remains same then energy is given by n only.

So, the correct option is (A).

Concepts:

1. Structure of Atom:

Atomic Structure:

The atomic structure of an element refers to the constitution of its nucleus and the arrangement of the electrons around it. Primarily, the atomic structure of matter is made up of [protons](#), electrons and neutrons.

Dalton's Atomic Theory

Dalton proposed that every matter is composed of atoms that are indivisible and indestructible.

The following are the postulates of his theory:

- Every matter is made up of atoms.
- Atoms are indivisible.
- Specific elements have only one type of atoms in them.
- Each atom has its own constant mass that varies from element to element.
- [Atoms](#) undergo rearrangement during a chemical reaction.
- Atoms can neither be created nor be destroyed but can be transformed from one form to another.

Cons of Dalton's Atomic Theory

- The theory was unable to explain the existence of **isotopes**.
- Nothing about the structure of atom was appropriately explained.
- Later, the scientists discovered particles inside the atom that proved, the atoms are divisible.

Subatomic Particles

1. Protons - are positively charged subatomic particles.
2. Electron - are negatively charged subatomic particles.
3. Neutrons - are electrically neutral particles and carry no charge

Atomic Structure of Isotopes

Several atomic structures of an element can exist, which differ in the total number of nucleons. These variants of elements having a different nucleon number (also known as the mass number) are called isotopes of the element. Therefore, the isotopes of an element have the same number of protons but differ in the number of neutrons. For example, there exist three known naturally occurring isotopes of hydrogen, namely, protium, deuterium, and tritium.

2. Answer: c

Explanation:

The correct answer is (C) : 32

The number of electrons in the orbitals of sub-shell of $n=4$ are

4s	2
4p	6
4d	10
4f	14
(Total)	32

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3. Answer: b

Explanation:

The correct answer is (B) : $r_0 = 2a_0$

At node $\Psi_{2s} = 0$

$$\therefore 2 - \frac{r_0}{a_0} = 0$$

$$\therefore r_0 = 2a_0$$

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4. Answer: c

Explanation:

For Assertion :Acetal and ketals are basically ethers hence they must be stable in basic medium but should break down in acidic medium.

Hence assertion is correct.

For reason: Alkoxide ion (RO^-) is not considered a good leaving group hence reason must be false.

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6. Answer: 425 - 425

Explanation:

The answer is 425

$$r_H = 51pm$$

$$(r_H^{2+})_5 = (r_H)_1 \times \frac{n^2}{Z} = 51 \times \frac{5^2}{3} = 425pm$$

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7. Answer: a

Explanation:

The correct answer is (A). Both Statement - 1 and statement - 2 are true

According to the Bohr model, the angular momentum is quantised and equal to $\frac{nh}{2\pi}$

Heisenberg's uncertainty principle explains the orbital concept, which is based on the probability of finding the electron.

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8. Answer: c

Explanation:

The correct option is (C): $n = 3, l = 3, m_l = -3, s = -\frac{1}{2}$

Concepts:

1. Quantum Mechanical Model of the Atom:

Quantum Mechanics:

[Quantum mechanics](#) is an evolving and much-advanced field of science that aims at understanding the properties of matter and objects in relation to their corresponding atomic and sub-atomic nature. It further illustrates the characteristics of the atoms, protons, electrons, and neutrons specifically and in the context of each other. It aims at studying [electromagnetic radiation](#) as well. This is a sub-part of the wider theory of quantum physics.

Read Also: [Quantum Mechanical Model of Atom](#)

Quantum Mechanical Models:

Presently, the scientific world has only two acceptable and working models of quantum mechanics. Such as,

- The first model for the understanding and application of quantum mechanics that is acceptable currently is the Bohr Model.

The basis of this model of the Bohr is seen in terms of mathematics which is used for understanding the complex structures.

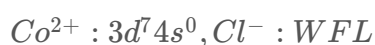
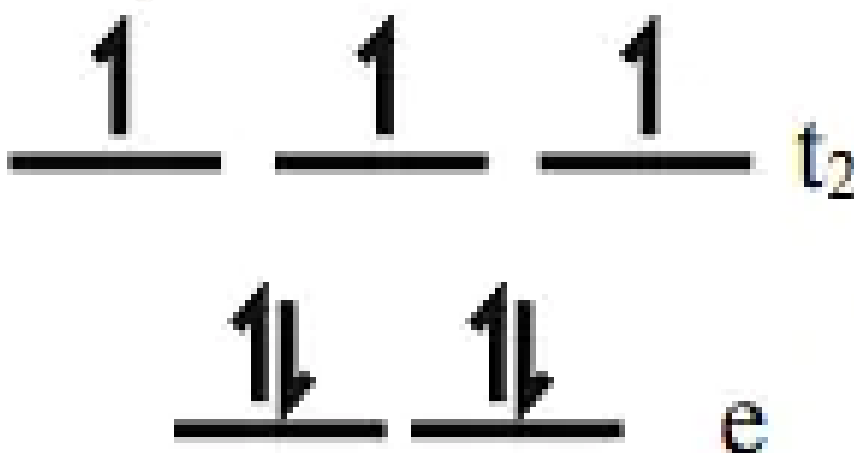
- Another acceptable model is the Quantum Mechanics Model which has its basis in quantum theory.

This quantum theory ultimately defines the exact properties of matter over a period of time. It usually works on the uncertainty principle.

9. Answer: 7 - 7

Explanation:

The correct answer is 7.



Number of unpaired electrons = 3

So, answer = 7

Concepts:

1. Subshell Electronic Configuration:

[Electron Configuration](#) is referred to as the distribution of [electrons](#) in an atom's orbitals. An electron in an atom is defined by a set of four quantum numbers (n), the most important of which defines the main energy level known as a shell. The filling of electrons into different subshells, also known as orbitals (s, p, d, f) in an atom. The position of an element in the periodic table is determined by the quantum numbers of the last orbital filled.

Subshells:

- The azimuthal quantum number (denoted by 'l') determines the subshells into which electrons are distributed.
- The value of this quantum number is determined by the value of the principal quantum number, n . As a result, when n equals 4, four different subshells are possible.
- When $n = 4$, The s, p, d, and f subshells correspond to $l=0$, $l=1$, $l=2$, and $l=3$ values, respectively.
- The formula $2*(2l + 1)$ gives the maximum number of electrons that a subshell can accommodate.
- As a result, the s, p, d, and f subshells can each hold a maximum of 2, 6, 10, and 14 electrons.

10. Answer: d

Explanation:

The correct option is (D).

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