08. STRUCTURE OF ATOM

Questions and Answers

1. What information does the electronic configuration of an atom provide?

A. The electronic configuration of an atom provides the information about:

(i) distribution of electrons in various atomic orbitals.
(ii) number of electrons present in the atom
(iii) number of valence electrons
(iv) the reactivity of the atom
(v) the block of the atom in periodic table
(vi) properties of the atom
(vii) the bonds formed by the atom

2a. How many maximum number of electrons that can be accommodated in a principal energy shell?

A. The maximum number of electrons that can be accommodated in a principal energy shell is given by $2n^2$, and n is the number of principal energy shell.

Principal energy shell	Maximum number of electrons
K (n=1)	$2(1)^2 = 2(1) = 2$
L (n=2)	$2(2)^2 = 2(4) = 8$
M (n=3)	$2(3)^2 = 2(9) = 18$
N (n=4)	$2(4)^2 = 2(16) = 32$

2b. How many maximum number of electrons that can be accommodated in a sub shell?

A. The maximum number of electrons that can be accommodated in a sub shell is given by $2(2l + 1)$, and l is the angular momentum quantum number of sub shell.

Sub energy shell	l value	Maximum number of electrons
s	0	2
p	1	6
d	2	10
f	3	14

2c. How many maximum number of electrons can be accommodated in an orbital?

A. The maximum number of electrons that can be accommodated in an orbital is 2.

2d. How many sub shells present in a principal energy shell?

A. The number of sub shells present in a principal energy shell is equal to the number of the shell.

Principal energy shell	Number of sub shells	Sub shells
K (n=1)	1	s
L (n=2)	2	s,p
M (n=3)	3	s,p,d
N (n=4)	4	s,p,d,f

2e. How many spin orientations are possible for an electron in an orbital?

A. Two spin orientations are possible for an electron in an orbital. They are +½ and -½.

3. In an atom the number electrons in M-shell is equal to the number of electrons in the K and L shell. Answer the following questions.

a. Which is the outer most shell?
b. How many electrons are there in its outermost shell?
c. What is the atomic number of element?
d. Write the electronic configuration of the element.

A.

Principal Shell	Number of electrons
K (n=1)	2
L (n=2)	8
M (n=3)	10
the number electrons in M-shell is equal to the number of electrons in the K and L shell	

Order of occupation of electrons is :

1s	2s	2p	3s	3p	4s	3d
2	2	6	2	6	2	2

After occupation of 8 electrons in M-shell the electrons enters in N-shell (4s) and next the 9^{th} and 10^{th} electrons of M-shell can be filled.

Electronic configuration is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^2$

(a) N-shell
(b) 2 electrons are in outermost shell.
(c) Atomic number Z=22
(d) Electronic configuration is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^2$

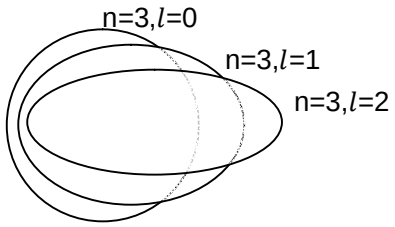
4. Rainbow is an example for continuous spectrum – explain.

A. When sun light dispersed through water droplets a bright colour spectrum is obtained. It is called Rainbow. Rainbow consists of seven colours namely violet, indigo, blue, green, yellow, orange and red (VIBGYOR). The colours spreading continuously and the intensity of each colour is different. So rainbow is an example for continuous spectrum.

NAGA MURTHY- 9441786635
Contact at : nagamurthysir@gmail.com
Visit at : nagamurthy.weebly.com

5. How many elliptical orbits are added by Sommerfeld in third Bohr's orbit? What was the purpose of adding these elliptical orbits?

A. Two elliptical orbits are added by Sommerfeld in Bohr's third orbit. He added two elliptical orbits to explain the micro spectrum that is splitting of spectral lines.



6. What is absorption spectrum?

A. The spectrum obtained when a substance absorbs energy is called absorption spectrum. It contains dark lines on bright background.

7. What is an orbital? How is it different from Bohr's orbit?

A. The path of electron which revolves around the nucleus is called Orbit.

The space around the nucleus where the probability of finding electron is maximum is called Orbital.

	ORBIT	ORBITAL
1.	These are represented by K,L,M,N,O	These are Represented by s,p,d,f,g.
2.	Orbit is two dimentional.	Orbital is three dimentional.
3.	The Max.number of electrons in an orbit is $2n^2$	The Max.number of electrons in an orbital is 2.
4.	Shape is circular.	Shape is spherical or dumbbell shaped or double dumbbell shaped or any other.

8. Explain the significance of three Quantum numbers in predicting the positions of an electron in an atom.

A.There are four quantum numbers.

(i) Principal quantum number
(ii) Azimuthal quantum number
(iii) Magnetic quantum number
(iv) Spin quantum number.

(i) Principal quantum number :

i) It was proposed by Neils bohr.
ii) It is denoted by 'n'.
iii) It gives the size and energy of an orbit.
iv) The values are given as per the number of the orbit.
v) The values are from 1 to n and the values 1,2,3,4,5,… again designated by K,L,M,N,O,… orbits.

(ii) Azimuthal quantum number:

i) It was proposed by Sommer feld.
ii) It is denoted by 'l'.
iii) It gives the shape of the sub shell(orbitals).
iv) The values of l depends on the value of 'n'.
v) The values are from 0 to (n-1) and the values 0,1,2,3,4,… again designated by s,p,d,f,g,…orbitals.

(iii)(a) Magnetic quantum number :

i) It was proposed by Lande.
ii) It is denoted by 'm_l'.
iii) It indicates the orientations of the orbitals in the presence of magnetic field.
iv)The value of 'm' depends on the value of 'l'.
v) 'm_l' can have $(2l+1)$ values and the values are from $-l$ to $+l$.

(iii)(b) Spin quantum number:

i) It was proposed by Uhlenbeck and Goud smit.
ii) It is denoted by 'm_s'.
iii) It indicates the direction of the spin of electrons.
iv)'m_s' has only two values..
v) The values of 'm_s' are $+1/2$ and $-1/2$. Also $+1/2$ represents the clock wise direction and $-1/2$represents the anti clock wise direction.

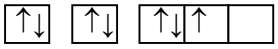
9. What is nl^x method? How it is useful?

A. nl^x method represents the arrangement of electrons in an atom. It is the short hand notation consists of the principal energy level (n-value) and the sub energy level (l-value) and the number of electrons in the sub energy level (x-value)

NAGA MURTHY- 9441786635
Contact at : nagamurthysir@gmail.com
Visit at : nagamurthy.weebly.com

10. Following orbital diagram shows the electron configuration of nitrogen atom. Which rule does not support this?

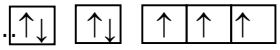
N (Z=7) $1s^2$ $2s^2$ $2p^3$



A. The given data violated the Hund's rule.

Hund's rule: Pairing of electrons in orbitals takes place only when all degenerate orbitals are singly occupied.

In the given data pairing takes place in $2p_x$ orbital with out filling atleast one electron in $2p_z$ orbital.

The correct method is.. 

11. Which rule is violated in the electronic configuration $1s^0\ 2s^2\ 2p^4$?

A. Given electronic configuration is $1s^0\ 2s^2\ 2p^4$. Aufbau's principle is violated in this electronic configuration.

Aufbau's principle: Electron occupies the least energy orbital first. The order of energy of orbital is 1s<2s<2p<3s<3p……..

So electrons are first filled in 1s orbital. The correct electronic configuration is $1s^2\ 2s^2\ 2p^2$.

12. Write the four quantum numbers for the differentiating electron of sodium (Na) atom?

A. Atomic number of sodium (Na) atom is 11.

Electronic configuration is $1s^2\ 2s^2\ 2p^6\ 3s^1$.

The differentiating electron enters in 3s orbital.

The four quantum numbers for the electron are

n	l	m_l	m_s
3	0	0	+ ½

13. What is emission spectrum?

A. The spectrum formed by electro magnetic radiations emitted by a given source which is in excited state is called emission spectrum. It contains bright lines on a dark background.

14. i. An electron in an atom has the following set of four quantum numbers to which orbital it belong to:

n	$\boldsymbol{l}$	$\boldsymbol{m_l}$	$\boldsymbol{m_s}$
2	**0**	**0**	**+ ½**

ii. Write the four quantum numbers for $1s^1$ electron.

A. (i) The given quantum numbers of an electron are

n	l	m_l	m_s
2	0	0	+ ½

n=2 means it is the second principal orbit and l=0 means it is the 's' orbital.

So the electron belongs to 2s orbital.

(ii) The four quantum numbers for $1s^1$ electron are

n	l	m_l	m_s
1	0	0	+ ½

15. Which electronic shell is at a higher energy level K or L?

A. The orbit which is nearer to the nucleus has less energy. K (n=1) is the closest orbit to the nucleus. So Shell L (n=2) is at higher energy level.

17. The wave length of a radio wave is 1.0m. Find its frequency?

A. wave length (λ) = 1.0 m

Speed of light (radio wave) c = 3 x 10^8 m/s

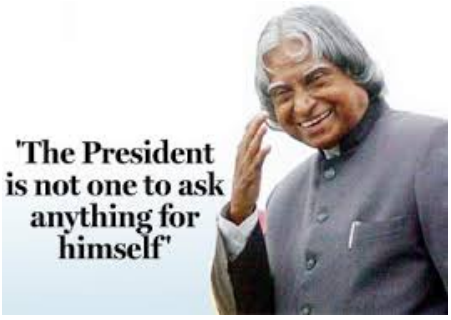
Frequency (ϑ) = ?

Formula : $c = \vartheta\ \lambda$

$$\vartheta = \frac{c}{\lambda} = \frac{3\ X\ 10^8}{1.0} = 3 \times 10^8 \text{ Hz}$$

* ADDITIONAL QUESTIONS *

18. Explain Aufbau's principle.
19. Draw Moelleur's diagram.
20. Write the electronic configurations of the following elements.
    (i) Nitrogen (ii) Magnesium
    (iii) Copper (iv) Chromium
21. Draw the neat diagrams of five d- orbitals.
22. Draw the diagrams of s and p orbitals.
23. Explain Hund's rule of maximum multiplicity with an example.
24. What is a stationary orbit?
25. How many 'm' values are possible for l =3 ?
26. What are the upper and lower limits of 'm' for l =4?
27. How are the three p- orbitals designated?



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