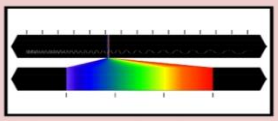
Chapter 6



Structure of Atom

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Textual Questions

1. What information does the electronic configuration of an atom provide? (AS1)

Ans: The electronic configuration of an atom gives information of
i) Valency of that element.
ii) Reactivity of an element.
iii) Metalic nature of the element.
iv) Which period does the element belong to
v) Which group does the element belong to
vii) The position of an electron in the space of atom.

2. a. How many maximum number of electrons that can be accommodated in a principal energy shell?
b. How many maximum number of electrons that can be accommodated in a sub shell?
c. How many maximum number of electrons can be accommodated in an orbital?
d. How many sub shells present in a principal energy shell?
e. How many spin orientations are possible for an electron in an orbital?

Ans: a) $2n^2$
b) $2(2l+1)$
c) 2
d) n
e) 2

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. (AS1)
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.

Ans: a) N-shell
b) 2
c) 22
d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$

4. Rainbow is an example for continuous spectrum – explain.(AS1)

Ans: i) Rainbow is a natural spectrum.
ii) It consists of different colours with different wavelengths
iii) This spectrum has no sharp boundaries in between colours
iv) That's way rainbow is continuous spectrum

5. How many elliptical orbits are added by Sommerfeld in third Bohr's orbit? What was the purpose of adding these elliptical orbits?(AS1)

Ans: Sommerfeld added two elliptical orbits to Bohr's third orbit.
Purpose: Sommerfeld successfully explain the fine spectrum of hydrogen atom

6. What is absorption spectrum?

Ans: The spectrum obtained when the substance absorbs energy is called absorption spectrum. Its contains dark lines on bright background.

7. What is an orbital? How is it different from Bohr's orbit?(AS1)

Ans: The space around the nucleus where the probability of finding the electron is maximum is called orbital.
i) Orbits are circular shapes,but orbitals have definite shapes
ii) The maximum number of electrons can be accommodated in orbit is $2n^2$, but orbital can

be accommodate only 2 electrons.

iii) Bohr's orbit has a definite boundary, but orbital have no boundary.

8. Explain the significance of three Quantum numbers in predicting the positions of an electron in an atom.(AS1)

Ans: 1. Principal Quantum Number (n)

i) The principal quantum number gives the size and energy of the main shell and it is denoted by n.

ii) 'n' has positive integer values of 1, 2, 3,...

iii) As 'n' increases, size and energy of the shell increases.

iv) The shells are denoted by the letters K,L,M,N,...

Shell	K	L	M	N
n	1	2	3	4

2. The angular - momentum quantum number (*l*)

i) The angular momentum quantum gives the shape of sub-shells and it is denoted by *l*

ii) '*l*' has integer values from 0 to n-1 for each value of 'n'.

iii) The sub-shell are designated by the letters s,p,d,f...

l	0	1	2	3
Name of the sub-shell	s	p	d	f

3. The magnetic quantum number (m_l)

i) It gives the information about the orientation of orbitals in the presence of magnetic field.

ii) The magnetic quantum number (m_l) has integer values between -l and l, including zero.

iii)For given *l* value, m_l has $(2l+1)$values

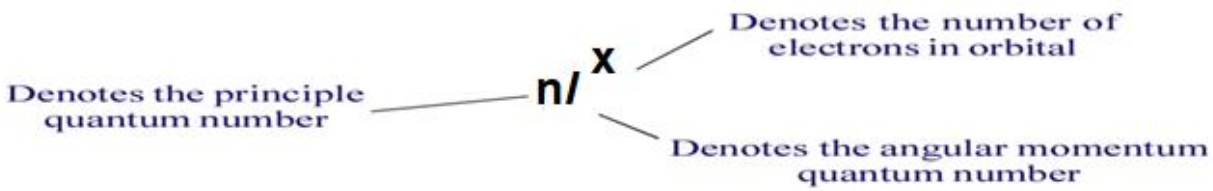
iv) s-orbital is spherical in shape, p-orbital is dumbell-shaped and d-orbital are double dumbell-shaped

Sub shells	Number of orbitals $(2l+1)$	Maximum number of electrons
s (l=0)	1	2
p (l=1)	3	6
d (l=2)	5	10
f (l=3)	7	14

9. What is nl^x method? How it is useful? (AS1)

Ans: The shorthand notation of electronic configuration is nl^x.

This gives the information as follows

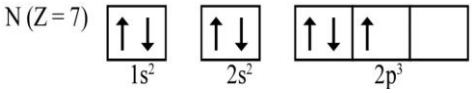


Useful of nl^x method:

i. To write the electronic configuration of an atom.

ii. To find the position of electrons around the nucleus in an atom.

10. Following orbital diagram shows the electron configuration of nitrogen atom. Which rule does not support this? (AS1)



Ans: Hund's rule

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

Ans: AufbauPrinciple

12. Write the four quantum numbers for the differentiating electron of sodium (Na) atom? (AS1)

Ans:

n	l	m_l	m_s
3	0	0	+ ½

13. Why there are exemptions in writing the electronic configurations of Chromium and Copper ?

Ans: Elements which have completely filled or half-filled 3d-orbital have more stability. So an electron from the 4s orbital is excited and rises to a 3d orbital. Hence electronic configuration of Chromium and Copper are exempted.

14. What is emisssion spectrum?

Ans: The spectrum of radiation emitted by a substance from its excited state is an emission spectrum. Its contains bright lines on dark background.

15. i. An electron in an atom has the following set of four quantum numbers to which orbital it belong to: (AS2)

n	l	m_l	m_s
2	0	0	+ ½

ii. Write the four quantum numbers for $1s^1$ electron. (AS1)

Ans: i) 2s

ii) n=1, l=0, m_l=0, m_s= + ½

16. Which electronic shell is at a higher energy level K or L? (AS2)

Ans: L

17. Collect the information regarding wave lengths and corresponding frequencies of three primary colours red, blue and green. (AS4)

Ans:

Primary colour	**Wavelength(nm)**	**Frequency(Hz)**
Red	700	4.29×10^{14}
Blue	470	6.38×10^{14}
Green	530	5.66×10^{14}

18. The wave length of a radio wave is 1.0m. Find its frequency. (AS7)

Ans: Given λ=1 m c=3×10^8 m/s ν=?

We know that $c = \nu \lambda$

$\nu = c/\lambda = 3 \times 10^8 / 1 = 3 \times 10^8$ Hz

Fill in the blanks

1. If n = 1 then angular momentum quantum number (l) = ...

Ans: 0

2. If a sub-shell is denoted as 2p then its magnetic quantum number values are ....., ..., ...

Ans: -1, 0, +1

3. Maximum number of electrons that an M-shell contain is/are .....

Ans: 18

4. For 'n', the minimum value is ..... and the maximum value is .....

Ans: 1, ∞

5. For 'l', the minimum value is .....and the maximum value is .....

Ans: 0, (n-1)

6. For 'm_l ' the minimum value is ..... and the maximum value is .....

Ans: $-l$, $+l$

7. The value of 'm_s ' for an electron spinning in clock-wise direction is ..... and for anti-clockwise direction is .....

Ans: +1/2, -1/2

Multiple Choice Questions

1. An emission spectrum consists of bright spectral lines on a dark back ground. Which one of the following does not correspond to the bright spectral lines? [ ]

a) Frequency of emitted radiation b) Wave length of emitted radiation

c) Energy of emitted radiations d) Velocity of light

Ans: d

2. The maximum number of electrons that can be accommodated in the L – shell of an atom is: [ ]

a) 2 b) 4 c) 8 d) 16

Ans: c

3. If l = 1 for an atom then the number of orbitals in its sub-shell is [ ]

a) 1 b) 2 c) 3 d) 0

Ans: c

4. The quantum number which explains about size and energy of the orbit or shell is: [ ]

a) n b) l c) m_l d) m_s

Ans: a

Additional Questions

½ Mark Questions

1. An emission spectrum consists of bright spectral lines on the dark background. Which one of the following does not correspond to the bright spectral lines?

A) Frequency of emitted radiation B) Wavelength of emitted radiation

C) Energy of emitted radiations D) Velocity of light

Ans: B) Wavelength of emitted radiation

2. The maximum no. of electrons that can be accommodated in the L–shell of an atom is?

Ans: Eight(8) electrons.

3. If l = 1 for an atom then the number of orbitals in its sub-shell is _____

Ans: Two(2).

4. What is the shape of s –orbital?

Ans: Spherical.

5. What is the shape of p –orbital?

Ans: Dumbell.

6. What is the shape of d –orbital?

Ans: Double dumbbell.

7. What is the shape of f –orbital?

Ans: Double dumbbell.

8. Quantum theory was proposed by?

Ans: Erwin Schrodinger.

9. Splitting of spectral lines in an electric field is known as?

Ans: Stark Effect.

10. The number of electrons in a shell is limited to?

Ans: $2n^2$.

11. Splitting of spectral lines in the magnetic field is known as?

Ans: Zeeman Effect.

12. Write the Planck's constant value?

Ans: 6.626×10^{-34} JS.

13. Bohr's model explains all the line spectra observed in the case of _____atom.

Ans: Hydrogen.

14. Bohr's model failed to account for the splitting off?

Ans: Atomic spectra.

15. Match the following.

1. Value of n	[ ]	A) o to (n - 1)
2. Value of l	[ ]	B) +1/2, -1/2
3. Value of m_l	[ ]	C) Non- zero integers
4. Value of m_s	[ ]	D) –l to + 1
5. d- orbital	[ ]	E) l = 1
		F) l = 2

A) B, C, D, E, A B) A, B, C, D, E C) E, D, C, B, A D) C, A, D, B, F

Ans: D) C, A, D, B, F

16. Match the following.

1. Continuous spectrum [ ] A) Gaseous atoms

2. Line spectrum [ ] B) 589nm – 589.6nm
3. Band spectrum [ ] C) Rainbow
4. Absorption spectrum [ ] D) Molecules
5. Wavelength range of Na vapour[ ] E) Absorption energy.

A) B, D, A, E, C B) C, A, D, E, B C) E, D, C, B, A D) C, A, D, B, F

Ans: B) C, A, D, E, B

17. Match the following.

1. Quantum theory [ ] A) Moeller
2. Stationary orbits [ ] B) Max plank
3. Relative energies of orbits [ ] C) Erwin Schrödinger
4. Quantum model of an atom [ ] D) Niel's Bohr
5. No two electrons have same set of four Quantum numbers [ ] E) Wolfgang Pauli

A) B, D, A, E, C B) C, A, D, E, B C) B, D, A, C, E D) C, A, E, B, D

Ans: C) B, D, A, C, E

18. Match the following.

1. Size and shape of main shell [ ] A) l
2. sub- shells [ ] B) m_s
3. Orientation of orbitals [ ] C) n
4. Direction of spin [ ] D) electronic configuration
5. Distribution of electrons [ ] E) m_l

A) B, D, A, E, C B) C, A, D, E, B C) B, D, A, C, E D) C, A, E, B, D

Ans: D) C, A, E, B, D

19. Match the following.

1. Chromium [ ] A) [Ar] $4s^2$ $3d^{10}$
2. Carbon [ ] B) [Ar] $4s^1$ $3d^{10}$
3. Copper [ ] C) [He] $2s^2$ $2P^2$
4. Zinc [ ] D) [He] $2s^2$ $2P^3$
5. Nitrogen [ ] E) [Ar] $4s^1$ $3d^5$
F) [NE] $3s^1$

A) E, C, B, A, D B) C, A, D, E, B C) B, D, A, C, E D) C, A, D, B, F

Ans: A) E, C, B, A, D

20. Name of the atom which has a electronic configuration is $1s^2 2s^2 2p^6 3s^2 3p^6$?

Ans: Argon(Ar).

21. Match the following.

Orbital		No. of electrons
1. s. orbital	[ ]	A) 6
2. p orbital	[ ]	B) 2
3. d orbital	[ ]	C) 14
4. f orbital	[ ]	D) $2n^2$
5. For 'n' orbit	[ ]	E) 10

A) B, D, A, E, C B) B, A, E, C, D C) B, D, A, C, E D) C, A, D, B, F

Ans: B) B, A, E, C, D

22. Aufbau principle is violated in?

A) $1s^2$ $2s^2$ $2p^6$ B) $1s^2$ $2s^2$ $2p^6$ $3s^1$ C) $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^1$

Ans: C) $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^1$

23. X: Atomic spectral lines arise because of emition /absorption of certain frequency of light energy.
Y: The lines in atomic spectra can be used to identify unknown atoms.

A) Both X and Y are true. B) X is true and Y is wrong. C) Both X and Y are Wrong.

Ans: A) Both X and Y are true.

24. Who proposed the elliptical orbits?

Ans: Sommerfeld.

25. Observe the following table.

n	l	m_l	m_s
3	3	0	+1/2

This table indicated the orbital_____

A)3f orbital. B) 3p orbital C) 3s orbital D) 3d orbital

Ans: A)3f orbital.

26. The wave length of radio wave is 1m. Its frequency is_____

Ans: 3×10^8 Hz.

27. Principle quantum number: Orbit: : Magnetic quantum number:_____
    A) Spin B) Orbitals C)Elliptical orbits D)Angular momentum

Ans: B

28. Arrange the orbital in ascending order of their energies
    4s, 3p, 4p, 3d

Ans: 3p, 4s, 3d, 4p

29. What happens when electron jumps from exited state to ground state?

Ans: Radiation of energy is emitted

30. In the given data which shell has least energy

K	L	M
(n=1)	(n=2)	(n=3)

Ans: K

31. If l=2 for an atom then the number of orbitals in its sub-shell is
    a) 2 b) 3 c) 4 d) 5

Ans: d

32. If l = 3 what are the value of m_l ?

Ans: -3,-2,-1,0,1,2,3

33. Which principle gives the information that maximum number of electrons filled in an orbital is 2?

Ans: Pauli's exclusion principle

1 Mark Questions

1. How do you appreciate the use of **nl^x** method to understand the arrangement of electrons in an atom ?

Ans: It helps us to determine the four quantum values of a particular electron.

2. What are the magnetic quantum number values for 3*P* orbital?

Ans: -1, 0, 1

3. Write the value of plank's constant.

Ans: 6.626×10^{-34} Js

4. Complete the following table based on quantum numbers

n	l	Sub shell	No. of degenerated orbitals
1	0	s	
2	1		3
3	2	d	

Ans:

n	l	Sub shell	No. of degenerated orbitals
1	0	s	0
2	1	p	3
3	2	d	5

5. If ***l*=4** then what is the minimum and maximum values of m_l

Ans: 0, 3

6. Define Electromagnetic spectrum?

Ans: The wide variety range of wavelengths is known as the electromagnetic spectrum.

7. Define visible spectrum ?

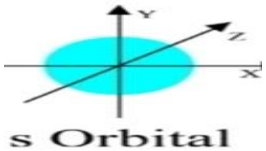
Ans: The range of wavelengths covering red colour to violet colour is called the visible spectrum.

8. Out of 3d and 4s, which has more (n+l) value ? Explain

Ans: (n+l) value of 3d= 3+2=5
(n+l) value of 4s= 4+0=4
3d has more (n+l) value than 4s.

9. Draw the shape of s-orbital

Ans:



s Orbital

10. Write the symbol of the outermost shell of Magnesium(Z=12) atom. How many electrons are present in the outermost shell of Magnesium?

Ans: Symbol of the outermost shell of Magnesium= M
No.of electrons in outermost shell of Magnesium=2

11. Write four quantum number values for valance electron of potassium.

Ans: n=4, l=0, m_l=0, m_s=+1/2

12. What is the name given to orbitals of equal energy?

Ans: Degenerate orbitals

13. Which of the following orbitals are possible 1p,2s,2p and 3f ?

Ans: 2s,2p

14. What is Plank's equation?

Ans: E = hν

2 Marks Questions

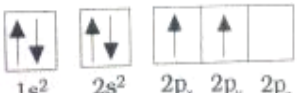
1. For a better understanding about the electronic configuration of an atom, teacher wrote a short hand notation **nl^x** on black board. Looking at this notation. What be the probable questions that generate in the student's mind? What would be those questions ? (OR) Your friend is unable to understand **nl^x** . What questions will you ask him to understand **nl^x** method

Ans: 1) What is nl^x method?
2) What are uses of nl^x method?
3) What are the symbols of n,l and x ?
(write any two relevant questions)

2. Explain Hund's rule (or) Explain the principle which describes the arrangement of electrons in degenerate orbitals.

Ans: Hund's rule: Electron pairing in orbitals starts only when all available empty orbitals of the same energy are singly occupied(OR) Electron pairing takes place only after all the available degenerate orbitals are occupied by one electron each

Explination: The E.C of carbon atom(Z=6) is $1s^2\ 2s^2\ 2p^2$
The first four electrons go into 1s and 2s orbitals
The next two electrons go into $2p_x$ and$2p_y$ orbitals
But, they do not pair in $2p_x$ orbital



3. The differenciate electron in an atom has following set of quantum numbers are given, then answer the given questions

n	***l***	**m_l**	**m_s**
3	**0**	**0**	**+1/2**

a) Which orbital this electron belongs b) Write the name of the element

Ans: i) 3s ii) Sodium

4. The electronic configuration of an element is **$1s^2 2s^2 2p^6$.** Fill the following quantum numbers for 8th electron?

Quantum Numbers	**n**	***l***	**m_l**	**m_s**
Values				

Ans:

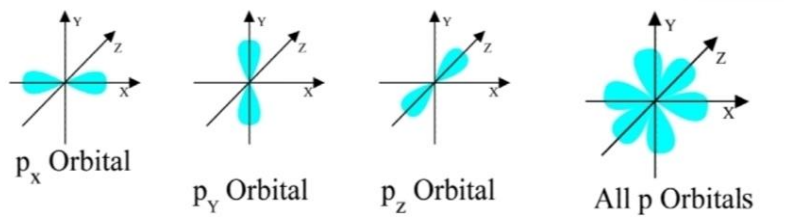
Quantum Numbers	**n**	***l***	**m_l**	**m_s**
Values	3	0	0	+1/2

5. Answer the following questions
i) Write the electronic configuration of chromium
ii) Write the electronic configuration of copper

Ans: i) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ i) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$

6. Draw the shape of p-orbitals

Ans:



7. The electron enters into 4s orbital after filling 3p orbital but not into 3d. Explain the reason.

Ans:

Orbital	4s	3d
(n+ℓ) value	(4+0)=4	(3+2)=5

According Aufbau principle electron enters least (n+ℓ) value orbital. So electron enter into 4s instead of 3d after 3p

4 Marks Questions

1. Complete the following table with suitable answers

Name of the Element	Electronic Configuration	Azimutal quantum number of Differentiating electron	Principal quantum number of Differentiating electron
Mg		**0**	
Chlorine	**$1s^2 2s^2 2p^6 3s^2 3p^5$**		
	$1s^2 2s^2 2p^3$	**1**	**2**
Carbon			

Ans:

Name of the Element	Electronic Configuration	Azimutal quantum number of Differentiating electron	Principal quantum number of Differentiating electron
Mg	**$1s^2 2s^2 2p^6 3s^2$**	**0**	**3**
Chlorine	**$1s^2 2s^2 2p^6 3s^2 3p^5$**	**1**	**3**
Nitrogen	**$1s^2 2s^2 2p^3$**	**1**	**2**
Carbon	**$1s^2 2s^2 2p^2$**	**1**	**2**

2. Write postulates and limitations of Bohr's model of hydrogen atom.

Ans: **Main Postulates:**

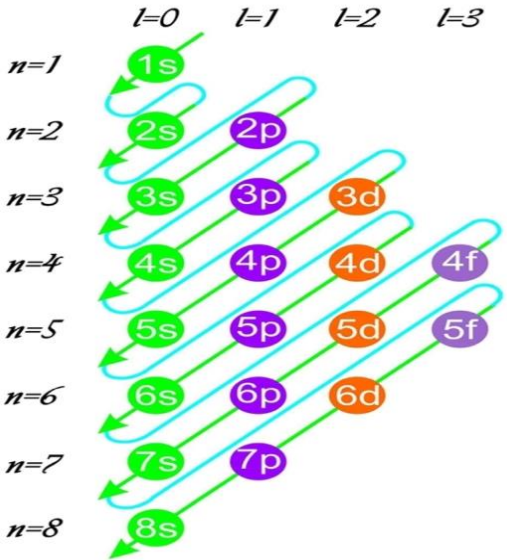
1. Niels Bohr proposed that electrons in an atom occupy 'stationary orbitals(states) of fixed energy at different distances from the nucleus.
2. When an electron jumps from a lower energy(ground state) to higher energy states(excited state) it absorbs energy or emits energy when such a jump occurs from a higher energy state to a lower energy state.
3. The energies of an electron in an atom can have only certain values E1, E2, E3 ……; that is, the energy is quantized. The states corresponding to these energies are called stationary states and the possible values of the energy are called energy levels.

Limitations:

i) Bohr's model failed to account for splitting of line spectra of hydrogen atom into finer lines.
ii) Bohr's model could not explain the Zeeman and stark effects.

3. Draw a diagram to show that the filling order of atomic orbitals and their ascending order of energies ? (OR) Draw Moeller's chart showing the increasing order of energy levels of various orbitals

Ans:



1s < 2s < 2p < 3s < 3p < 4s < 3d < 4p< .....

4. State and explain with one example of Aufbau principle?

Ans: The lowest-energy orbitals are filled first.

Two general rules help us to predict electronic configurations.

1. Electrons are assigned to orbitals in order of increasing value of $(n+l)$.
2. For sub-shells with the same value of $(n+l)$, electrons are assigned first to the sub-shell with lower 'n'.

Ex: In Scandium(Z=21), first twenty electrons can be accommodated in 1s,2s,2p,3s,3p and 4s orbitals.The last electron can enter into either 3d or 4p orbital

Orbital	$(n+l)$ value
3d	3+2=5
4p	4+1=5

Both orbitals have $(n+l)$ value. But 3d orbital is least "n" value. So last electron enter into 3d orbital.

5. Explain Pauli's exclusion principle with suitable example.

Ans: According to Pauli Exclusion Principle no two electrons of the same atom can have all four quantum numbers the same.

Ex: The electronic configuration of Helium(Z=2) is $1s^2$

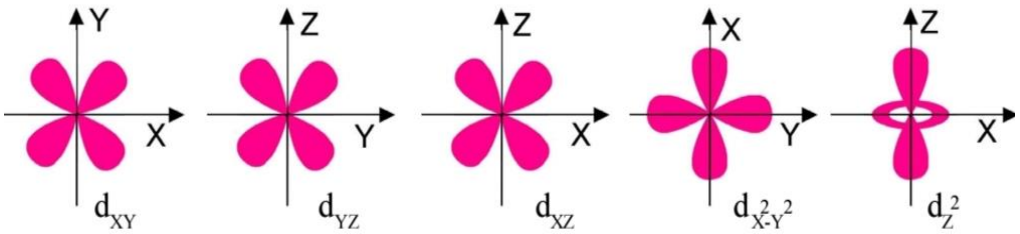
↑↓

Electron	n	l	m_l	m_s
1^{st}	1	0	0	+1/2
2^{nd}	1	0	0	-1/2

We observe that three quantum numbers are equal but fourth one is different

6. Draw the shapes of d- orbitals and write their names.

Ans:



7. Complete the following table

S.No	Electron entering orbital	Principle quantum number	Angular momentum quantum number	Magnetic quantum number	Spin quantum number
1	$3s^1$	3	0		
2		2	1		+1/2 or -1/2
3	$4f^1$			-3 or -2 or -1 or 0 or 1 or 2 or 3	+1/2 or -1/2
4	$5s^1$	5			+1/2 or -1/2

Ans:

S.No	Electron entering orbital	Principle quantum number	Angular momentum quantum number	Magnetic quantum number	Spin quantum number
1	$3s^1$	3	0	0	+1/2 or -1/2
2	$2p^1$	2	1	-1	+1/2 or -1/2
3	$4f^1$	4	3	-3 or -2 or -1 or 0 or 1 or 2 or 3	+1/2 or -1/2
4	$5s^1$	5	0	0	+1/2 or -1/2

8. Atomic number of element is 17. Answer the following questions

i) Write the name of the element

ii) Write the electronic configuration

iii) How many electrons are present in M-shell

iv) Write the nearest noble gas element

Ans: i) Chlorine

ii) $1s^2 2s^2 2p^6 3s^2 3p^5$

iii) 7

iv) Argon

9. The electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^1$

Answer the following questions

a) What is the atomic number of element ?

b) Write the four quntum numbers $3p^1$?

c) What is shape of $2s^2$?

d) How many shells are present in this element ?

Ans: a) 13

b) n=3, l=1, m_l=-1 or 0 or 1, m_s=+1/2 or -1/2

c) spherical

d) 3