Grade IX

Lesson: Structure of Atom

[CHAPTER AT A GLANCE]

ATOMS

Electrons (e)
(Invented by J.J.Thomson)

- Negatively Charged Particles
- Mass approx. $\frac{1}{2000}$ of a proton
- Cathode rays are made up of electrons
- Mass of electron is negligible
- Charge is equal to -1
- These are outside the nucleus

Protons (p^+)
Invented by Goldstein

- Positively Charged Particles
- Mass 2000 times of an electron
- Canal rays consist of positively charged particles
- Charge is equal to +1
- They are inside the nucleus
- Thomson model of an atom
  - Model of Atom similar to Christmas pundding
    - Electrons are in sphere of positive charge like dry fruits in Christmas pudding or like seeds in water melon spread all over
    - Atom is neutral as the number of positively charged is equal to negatively charged particles.

Neutral

- $\because e = p$
  Number of electrons is equal to No of protons

Neutrons (n)
Invented by Chandwick

- Mass nearly equal to protons
- Neutral (no charge)
- They are Inside the nucleus

THE STRUCTURE OF ATOMS

Rutherford Model of Atom

Electrons (e)
1. Most part of an atom is empty
2. Centre of atom is + vely charged called nucleus
3. Centre of atom is heavy where whole mass of atom is concentrated
4. Size of nucleus is $\frac{1}{1,00,000}$ of size of atom.
5. Density of nucleus is very high

Bohr's Model of Atom

Electrons (e)
1. Electrons revolve in certain permitted orbits, K, L, M, N..
2. Electrons do not radiate energy while revolving in these orbits.
3. These orbits are called energy levels.

DISTRIBUTION OF ELECTRONS IN ORBITS

Bohr's Bury Scheme
1. The maximum no. of electrons in an orbit = $2n^2$ where 'n' is orbit number
2. K shell (1st shell) = 2×1^2 = 2 electrons
   L shell (2nd shell) = 2×2^2 = 8 electrons
   M shell (3rd shell) = 2×3^2 = 18 electrons
   N shell (4th shell) = 2×3^2 = 32 electrons
   and so on
3. Last shell(outermost shell) cannot have more than 8 electrons
4. Second last shell (penultimate) cannot have more than 18 electron
5. Shells are filled in stepwise manner.

VALENCY

- It is either equal to valence electrons, i.e. electrons in outermost shell
  Or
  8 – No. of valence electrons
- Valency is equal to number of electrons lost or gained or shared

Atomic Number = Number of Protons = No. of Electrons in Neutral atom

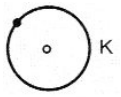
Mass Number = Number of Protons + No. of neutrons

Electronic Configuration : The distribution of electron in various shells is called electronic configuration

ELECTRONIC CONFIGURATION

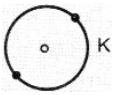
Hydrogen, $^{1}_{1}H$

Electron = 1
Proton = 1
Neutron = 0
K = 1



Helium, $^{4}_{2}He$

Electrons = 2
Protons =2
Neutrons
= 4 – 2 = 2
K = 2



Lithium, $^{7}_{3}H$

Electrons = 3
Protons = 3
Neutrons
= 7 – 3 = 4
K = 2 L = 1

Beryllium, $^{9}_{4}Be$

Electrons = 4
Protons = 4
Neutrons
= 9 – 4 = 5
K = 2 L = 2

Boron, $^{11}_{5}B$

Electrons = 5
Protons = 5
Neutrons
= 11 – 5 = 6
K = 2 L = 3

Carbon $^{12}_{6}C$

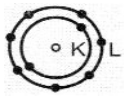
Electrons = 6
Protons = 6
Neutrons
= 12 – 6 = 6
K = 2 L = 4

Nitrogen, $^{14}_{7}N$

Electrons = 7
Proton = 7
Neutrons
= 14 – 7 = 7
K = 2 L = 5

Oxygen, $^{16}_{8}O$

Electrons = 8
Proton = 8
Neutrons
= 16 – 8 = 8
K = 2 L = 6



Fluorine, $^{10}_{9}F$

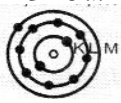
Electrons = 9
Protons = 9
Neutrons
= 19 – 9 = 10
K = 2 L = 7

Neon, $^{20}_{10}Ne$

Electrons = 10
Protons = 10
Neutrons
= 20 – 10 = 10
K = 2 L = 8

Sodium, $^{23}_{11}Na$

Electrons = 11
Protons = 11
Neutrons
= 23 – 11 = 12
K = 2 L = 8 M=1

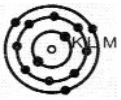


Magnesium $^{24}_{12}Mg$

Electrons = 12
Protons = 12
Neutrons
= 24 – 12 = 12
K = 2 L = 8 M=2

Aluminium, $^{27}_{13}Al$

Electrons = 13
Protons = 13
Neutrons
= 27 – 13 = 14
K = 2 L = 8 M=3



Silicon, $^{28}_{14}Si$

Electrons = 14
Protons = 14
Neutrons
= 28 – 14 = 14
K = 2 L = 8 M=4

Phosphorus, $^{31}_{15}P$

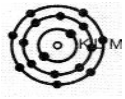
Electrons = 15
Protons = 15
Neutrons
= 31 – 15 = 16
K = 2 L = 8 M=5

Sulphur $^{32}_{16}S$

Electrons = 16
Protons = 16
Neutrons
= 32 – 16 = 16
K = 2 L = 8 M=6

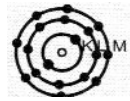
Chlorine, $^{35}_{17}Q$

Electrons = 17
Protons = 17
Neutrons
= 35 – 17 = 18
K = 2 L = 8 M=7



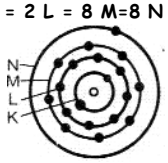
Argon $^{40}_{18}Ar$

Electrons = 18
Protons = 18
Neutrons
= 40 – 18 = 22
K = 2 L = 8 M=8



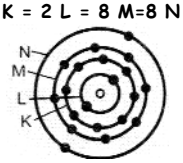
Potassium , $^{39}_{19}K$

Electrons = 19
Protons = 19
Neutrons = 39 – 19 = 20
K = 2 L = 8 M=8 N =1



Calcium , $^{40}_{20}Ca$

Electrons = 20
Protons = 20
Neutrons =40 – 20 = 20
K = 2 L = 8 M=8 N =2



ISOTOPES

$^{1}_{1}H$ e= 1 p= 1 n= 0

$^{2}_{1}H$ e = 1 p = 1 n = 1

$^{3}_{1}He$ e = 1 p = 1 n = 2

Same Atomic number but different Mass number

$^{35}_{17}Cl$ E = 17 p = 17 n = 18

$^{37}_{17}Cl$ e = 17 p =17 n = 20

Same number of electrons and Protons but differ in number of neutrons

ISOBARS

$^{40}_{18}Ar$ e= 18 p = 18 n = 22

$^{40}_{20}Ca$ n= 18 p = 20 n = 20

Same mass number but different Atomic number

ISOTONES

$^{14}_{6}C$ e = 6 p= 6 n= 8

$^{16}_{8}0$ e = 8 p = 8 n = 8

Same number of neutrons

USES OF ISOTOPES

ISOTONES

1. U-235. Nuclear reactor, Atom, Bombs
2. U-238. Age of rocks and earth
3. C-14 . Age of fossils of living organisms
4. Co-60. Cancer treatment
5. P-32. Agricultural research
6. I-131. Treatment of Thyroid
7. Na-24 Detect blood clots
8. $^{2}_{1}H$. Used in heavy water, used in nuclear reactor

Objective Type Questions

I. Multiple choice questions

1. The charge / mass ratio of electron

a) depends upon nature of gas b) depends upon nature of gas

c) remains constant

d) depends upon both nature of gas and nature of electrodes

2. Which of the following statements is / are incorrect for anode rays?

a) They are deflected by electric and magnetic fields.

b) Their charge / mass ratio depends upon the gas in the discharge tube used to produce anode rays.

c) The charge / mass ratio of particles in anode rays is constant.

d) They are produced by ionisation of as in the discharge tube.

3. Rutherford's scattering experiment fails for very small scattering angles because

a) whole nuclear charge of the target atom is not screened by its electrons at all.

b) the impact parameter between the (α - particle source and the nucleus of target is very large as compared to the size of nucleus.

c) the velocity of (α - particles is large.

d) the gold foil is thin.

4. 1 mole of diatomic element X_2 contains 34 and 40 moles of electrons and neutrons respectively . The isotopic formula of the element is

a) $^{74}_{34}X$ b) $^{37}_{34}X$ c) $^{40}_{34}X$ d) $^{74}_{40}X$

5. The conclusion of Rutherford's scattering experiment does not include.

a) $\alpha -$ particles can come within the distance of order of 10^{-14} m of the nucleus.

b) The radius of nucleus is less than 10^{-14} m

c) Scattering follows coulomb's law, i.e. same charges repel each other.

d) The positively charges particles of atom move with very high velocity.

6. The electronic configuration of Rb (37) will be.

a) 2, 8, 18 , 9 b) 2,8, 18, 8, 1 c) 2, 8, 8, 18, 1 d) 2, 8, 18, 1, 8

7. A student weighs 30 kg. Suppose his body is entirely made up of electrons . How many electrons. How many electrons are there in his body?

a) 3.29 x 10^{31} b) 3.29 x 10^{23} c) 3.29 x 10^{30} d) 3.29 x 10^{32}

8. Which of the following is correct ?

Column I	Column II
A. electron	i) Positive charge
B. Proton	ii) No charge
C. Neutron	iii) Negative charge

a) A(iii), B (i) C (ii) b) A (i), B (ii) C (iii)

c) A(iii), B (ii) C (i) d) A(ii), B (i) C (iii)

9. Which of the following is correct?

Column I	Column II
A. electron	i) 1.00867 u
B. Proton	ii) 9.1 x 10^{-31} kg
C. Neutron	iii) 1.00728 u

a) A(ii), B (iii) C (i) b) A (i), B (ii) C (iii)

c) A(iii), B (ii) C (i) d) A(ii), B (i) C (iii)

10. Which of the following are isobars?

a) $^{35}_{17}Cl$, $^{37}_{17}Cl$ b) $^{3}_{1}H$, $^{2}_{1}H$

c) $^{40}_{18}Ar$ $^{40}_{20}Ca$ d) $^{16}_{8}O$, $^{15}_{8}O$

11. Which of the following statement(s) is / are correct?

a) Isotopes differ in number of neutrons but have same number of protons and electrons

b) Isobars differ in number of neutrons but have same number of protons and electrons

c) Isotopes differ in number of electrons, protons and neutrons and differ in chemical properties

d) Isobars differ in number of electrons, protons and neutrons and have some chemical properties

12. Rutherford's α - scattering experiment led to the conclusion that

a) mass and energy are inter – related

b) the mass and the positive charge of an atom are concentrated in the nucleus

c) neutrons are present in the nucleus

d) atoms are electrically neutral

13. Which of the following reactions led to the discovery of the neutron?

a) ${}^{14}_{6}C + {}^{1}_{1}H \longrightarrow {}^{14}_{7}N + {}^{1}_{0}n$

b) ${}^{11}_{5}B + {}^{2}_{1}H \longrightarrow {}^{12}_{6}C + {}^{1}_{0}n$

c) ${}^{9}_{4}B + {}^{4}_{2}He \longrightarrow {}^{12}_{6}C + {}^{1}_{0}n$

d) ${}^{8}_{4}Be + {}^{4}_{2}He \longrightarrow {}^{11}_{6}C + {}^{1}_{0}n$

14. Which of the following pairs have identical values of charge / mass?

a) A proton and a deuterium b) A proton and a neutron

c) A deuterium and an α – particle d) An electron and y-rays

15. Which of the following is true for Thomson's model of atom?

a) Atom consists of neutrons

b) The attraction between clouds of positive charge and the electron balances their mutual repulsion.

c) It can explain the existence of protons

d) It leads to discovery of nucleus.

16. If K, L, M, N, shells of an atom are full. The total number of electrons in that atom are :

a) 60 b) 26 c) 42 d) 36

17)

Atoms	Protons	Neutrons	Electrons
A	17	18	17
B	11	12	10
C	17	20	17
D	1	0	0
E	18	22	18
F	9	10	10

Which of the above are positively charged icons?

a) A and B b) C and D c) B and D d) D and F

18. The electronic configuration of Ca(20) is

a) 2, 8, 10 b) 2, 8, 8, 2 c) 2, 8, 2, 8 d) 2, 2, 8, 8

19. Composition of nucler of two atomic species X and Y are given:

	X	Y
P	6	7
N	8	7

The mass number of X and Y and their relation is

a) 14, 14: Isobars b) 13, 15: Isotopes

c) 14, 14 : Isotopes d) 13, 15 : Isobars

20. Na^+ has 12 neutrons and 10 electrons. Which of the following statement is correct?

a) Na^+ has atomic number equal to 10 and mass number 22

b) Na^+ has atomic number equal to 11 and mass number 23

c) Na^+ has atomic number equal to 10 and mass number 23

d) Na^+ has atomic number equal to 11 and mass number 23

21. Which of the following statement is correct about proton?

a) It is a nucleus of deuterium b) It is an ionised hydrogen atom

c) It is an ionised hydrogen molecule d) α - particles consist of He^+ ions

22. The highest value of e/m of anode rays has been observed when the discharge tube is filled with.

a) N_2 b) O_2 c) He d) H_2

23. When a gold sheet is bombarded by a beam of α – particles, only a few of them got deflected whereas most go straight, undeflected. This is because.

a) the force of attraction exerted on α – particles by electrons is insufficient

b) the volume of nucleus is smaller than that of atom

c) the force of repulsion acting on fast moving α – particles is very small.

d) the neutrons have no effect on α – particles

24. Which of the following statements does not belong to Bohr's model?

a) Energy of the electrons in the orbit is quantised, i.e. they have fixed energies.

b) The electron in the orbit nearest to the nucleus is n lowest energy state and farthest away from nucleus is n highest energy state.

c) The Electrons radiate energy during revolution due to force of attraction between nucleus and electrons.

25. Which of the following statements is incorrect?

a) Co-60 is used in treatment of cancer.

b) I-132 is used in thyroid scan and treatment of goiter:

c) C- 14 is used to determine the age of old samples of living organisms.

d) $^{2}_{1}H$ is used to determine the age of old samples of water and wine.

26. How many electrons, protons and neutrons will be present in x^-, if atomic number of x is 9 and mass number is 19 ?

a) E = 9, P = 9, N = 10 b) E = 10, P = 9, N = 10

c) E = 10, P = 10, N = 10 d) E = 9, P = 10, N = 10

27)

Elements	A	B	C	D	E
Mass Number	1	7	14	40	40
Atomic Number	1	3	7	18	20

The element which can lose two electrons easily is

a) B b) C c) D d) E

28. Which of the following do not have same number of valence electrons?

H, He, Li, Be, B, C, N, O, F, Ne, Na, Mg, Al, Si, P, S, Cl, Ar, K, Ca

a) H, Li, Na, K b) He, Mg, Be, Ca c) B, Al, N, P d) O, S

29. An element has 3 valence electrons in its outermost 3rd shell, the name of element is

a) B b) Al c) Ga d) In

30. Which of the following does not have 8 valence electrons?

a) Ar b) Ne c) Kr d) He

31. Which of the following correctly represent the electronic distribution in the Mg atom?

a) 3, 8, 1 b) 2, 8, 2 c) 1, 8 ,3 d) 8,2,2

32. Rutherford's alpha (α) particles scattering experiment resulted into discovery of

a) Electron b) Proton

c) Nucleus in the atom e) Atomic mass

33. The number of electrons in an element X is 15 and the number of neutrons is 16. Which of the following is the correct representation of the element?

a) ${}^{31}_{15}X$ b) ${}^{31}_{16}X$ c) ${}^{16}_{15}X$ d) ${}^{15}_{16}X$

34. Dalton's atomic theory successfully explained

i) Law of conservation of mass ii) Law of constant composition

iii) Law of radioactivity iv) Law of multiple proportion

a) i, ii, and iii b) i, iii, iv c) ii, iii and iv d) i, ii and iv

35. Which of the following statements about Rutherford's model of atom are correct

i) Considered the nucleus as positively charged

ii) Established that the ∝- particles are four times as heavy as a hydrogen atom

iii) Can be compared to solar system

iv) Was in agreement with Thomson's model

a) i and iii b) ii and iii c) I and iv v) only i

36. Which of the following are true for an element?

i) Atomic number = number of Protons + number of electrons

ii) Mass number = number of Protons + number of neutrons

iii) Atomic mass = number of Protons + number of neutrons

iv) Atomic number = number of Proton + number of electrons

a) i and ii b) i and iii c) ii and iii d) ii and iv

37. In the Thomson's model of atom, which of the following statements are correct?

i) the mass of the atom is assumed to be uniformly distributed over the atom

ii) the positive charge is assumed to be uniformly distributed over the atom

iii) the electrons are uniformly distributed in the positively charged sphere

iv) the electrons attract each other to stabilise the atom

a) i, ii and iii b) i and iii c) I and iv d) I, iii and iv

38. Rutherford's $\propto$ - particle scattering experiment showed that

i) electrons have negative charge

ii) the mass and positive charge of the atom is concentrated in the nuclease

iii) neutron exists in the nucleus

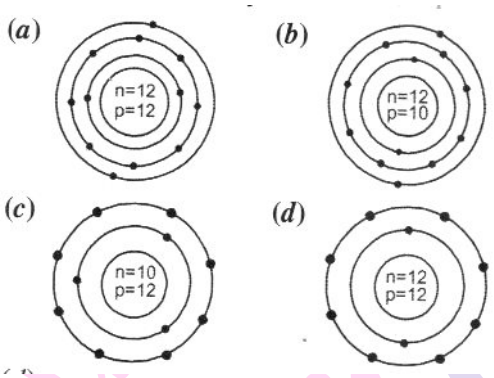
iv) most of the space in atom is empty

i) i and iii b) ii and iv c) i and iv d) iii and iv

39. The iron of an element has 3 positive charges. Mass number of the atom is 27 and the number of neutrons is 14. What is the number of electrons in the ion?

a) 13 b) 10 c) 14 d) 16

40. Identify the Mg^{2+} ion from the figure where, n and p represent the number of neutrons and protons respectively.



1. c	2. c	3. b	4. b	5. d	6. b	7. a	8. a	9. a	10.c
11. a	12. b	13. c	14. c	15. b	16. d	17. c	18. b	19. a	20. b
21. b	22. d	23. b	24. d	25. d	26. b	27. d	28. c	29.b	30.d
31. b	32. d	33. a	34. d	35. a	36. d	37. a	38. b	39. b	40. d

41. Match the Column I with Column II

Colum I	Column II
1. Co - 60	a. To detect blood clots
2. C – 14	b. Thyroid scan
3. 1-132	c. Radiocarbon dating for dead organisms
4. Na – 24	d. Treatment of cancer

1. D	2. C	3. B	4. A

I. Fill in the blanks

42. The total number of protons and neutrons present in one atom of an element is known as its _____.

43. The maximum no. of electrons which can be accommodate in the L shell of an tom is _____.

42. mass number	43. 8

I. True or false

44. The density of nucleus is low

45. The size of atoms is smaller than that of nucleus

44. False	45. False

Direction (Q.46 – to Q.48) : In the following Questions the Assertion and Reason have been put forward. Read the statements carefully and choose the correct alternative from the following.

a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.

b) The Assertion and the Reason are correct but the reason is not the correct explanation of the Assertion

c) Assertion is true but the Reason is false

d) The statement of the Assertion is false but the Reason is true.

46. Assertion : Cathode rays consist of negatively charged particles, these are attracted towards anode (+ve) terminal.

Reason : Anode rays (canal rays) consist of positively charged particles and these are attracted towards cathode (-)

b) The Assertion and the Reason are correct but the reason is not the correct explanation of the Assertion

47. Assertion : Charge on 1 electron is $1.602 \times 10^{-19} C$.

Reason : Mass of 1 electron is 1.602×10^{-19} kg.

c) Assertion is true but the Reason is false

48. Assertion : Helium has 2 valence electrons and its valency is 0.

Reason : Helium is most abundant element in universe

c) Assertion is true but the Reason is false

49. Who discovered the electron?

J.J. Thomson discovered electron

50. What are canal rays?

Canal rays (Anode fays) consist of positively charged particles.

51. The fundamental particles of an atom are _____ and _____.

Electrons, protons

52. What is the charge on an electron?

-1.602 x 10^{-19} kg

53. What is the mass of an electron?

9.1 x 10^{-31} kg

54. What is the charge on cathode rays?

Negative

55. What is the charge on canal rays?

Positive

56. In which of the rays e/m ratio is constant?

Cathode rays

57. What is the charge on a proton?

+ 1.602 x 10^{-19} C

58. What is the mass of a proton?

It is nearly equal to that of hydrogen atom.

59. Most of the mass of an atom is concentrated in a small region called _____.

Nucleus

60. Nucleus of an atom was discovered by _____.

Rutherford

61. Who discovered nucleus and by which experiment?

Rutherford by $\propto$ - rays scattering experiment

62. What is a proton? Who discovered it?

Proton is positively charged particle present in nucleus. It was discovered by Goldstein

63. What are $\propto$ - rays ?

$\propto$ - rays consist of positively charged particles that is helium nuclei.

64. Which metal was bombarded with $\propto$ - rays in Rutherford's experiment

Gold

65. What was the drawback of Rutherford's model of the atom?

It could not explain the stability of atom.

66. What are the charge and mass of a neutron?

Neutron does not have any charge. Its mass is 1.675 x 10^{-27} kg

67. What are the maximum number of electrons that can be accommodated in outer most shell of an atom?

The maximum number of electrons which can be present in outermost shell is 8.

68. Atomic number of an element is 12. What is its valency?

Its valency is equal to 2 because its electronic configuration is 2,8,2. It can lost 2 electrons to become stable like noble gases.

69. The atomic- number of neon is 10. Write its electronic configuration.

2, 8

70. Atomic number of an element is 16. What is its valency?

Its valency is 2 because its electronic configuration is 2, 8 , . It can gain 2 electrons to become stable.

71. What happens to an element 'Z' if its atom gains three electrons?

It acquires three negative charge, i.e. Z^{3-} ion is formed

72. Helium atom has 2 electrons in its valence shell but its valency is not 2. Explain

Its valency is zero because its first shell is the outermost shell which is complete. It cannot lose or gain or share electrons.

73. According to Bhor and Bury scheme what is the maximum number of electrons in M-shell = 2 x 3^2 = 2 x 9 = 18

74. In the notation of nitrogen $=^{14}_{7}N$ what do the numbers 14 and denote?

The number 14 represents mass number and 7 represents atomic number.

75. If Mg^{2+} has 12 protons and 12 neutrons what is its atomic number and mass number?

Atomic number = p = 12

Mass number = n + p = 12 + 12 = 24

76. What is the difference between Na and Na^{+} in terms of number of electrons?

Na atom has 11 electrons whereas Na^{+} ion has 10 electrons

77. Which sub-atomic particles of an atom are responsible for atomic mass?

Neutrons and protons are responsible for atomic mass.

78. What is the atomic number of the element X, which has 2 shells, K and L having 2 and 6 electrons respectively?

Atomic number = 2 + 6 = 8

79. An Atom of an element is represented as $^{19}_{9}X$. How many electrons and neutrons are present in this atom?

Number of electrons = 9 = Number of protons = Atomic number

∴ Neutron = Mass number – Atomic number = 19 – 9 = 10

80. Write the mass number of neon and argon from the data given below :

Elements	No.of protons	No. of neutrons
Neon	10	10
Argon	18	22

Mass number of Neon = p + n = 10 + 10 = 20

Mass number of Argon = p + n = 18 + 22 = 40.

81. Write the representation of a Nitrogen atom with mass number 14 and atomic number 7.

$^{14}_{7}N$

82. The mass number of an atom is 32 If its atomic number is 16, then the atom has _____electrons

16.

83. Why are the shells in which electrons revolve called energy levels?

It is because each shell is associated with fixed amount of energy, therefore, they are called energy levels.

84. An atom of an element has two electrons in the outermost M shell. State

a) Electronic configuration b) Valency of this element

85. Find the electron distribution for the element that has atomic number 20 and write its valency

Electronic configuration is 2,8,8,2and valency is equal to 2.

86. An atom of element has two electrons in the K shell, four electrons in L shell what is the atomic number of the element. Identify the element.

Atomic number of element is 2 + 4 = 6. It is carbon

87. What are the numbers of protons, neutrons and electrons present in $^{59}_{27}Co$, $^{59}_{27}Co$ $^{108}_{47}Ag$,?

$^{59}_{27}Co$, has e = 27, p = 27, n = 59 - 27 = 32

$^{108}_{47}Ag$ has e = 47, p = 47, n = 108 - 47 =61

I. Short answer questions

88. State the observations in ∝-particle scattering experiment which led Rutherford to make the following conclusions:

a) Most of the space in an atom is empty

b) Whole mass of an atom is concentrated in its centre.

c) Centre is positively charged

a) Most of the rays passed through thin gold foil undeviated.

b) Very few rays bounced back to the same path

c) Some rays deflected through larger angles.

89. a) State the limitation of J.J. Thomson's model of an atom.

b) Define valency by taking the examples of magnesium (At.No.= 12)and oxygen (At. No= 8)

c) S^{2-} has completely filled K,L andM shells. Find its atomic number

a) Although Thomson's model explained that atoms are electrically neutral, the results of experiments carried out by other scientists could not be explained by this model.

b) Valency is defined as number of electrons lost or gained to become stable.

Mg(12) has electronic configuration 2,8,2. It can lost two electrons to become stable therefore, its valency is equal to 2

O (8) has electronic configuration 2,6. It can gain 2 electrons to become stable like neon, therefore, its valency is equal to 2.

c) S^{2-} has electronic configuration 2, 8, 8. Its atomic number is equal to 16 because it has 16 protons. Atomic number is equal to the number of electrons

90. a What was Thomson's model of an atom?

b. Write any two observations of Rutherford's model of atom

a) Thomson's model of an atom

i) Atom consists of positive charge uniformly distributed

ii) Electrons are embedded in positively charged sphere like seeds in watermelon.

iii) Atom is neutral

iv) Mass of atom is also uniformly distributed.

b) i) Most of $\propto$- rays passed through gold foil undeviated

ii) Some $\propto$ -rays deviated through larger angles

91. What were the conclusions of Rutherford's $\propto$ - particle scattering experiment.

i) The centre of atom is positively charge and whole mass of atom is concentrated in the centre

ii) Most of part of atom is hollow

iii) The size of nucleus is $\frac{1}{100,000}$ of the size of atom.

iv) The density of nucleus is very high.

92. Give reasons

a) Mass number of on atom excludes the mass of an electron

b)Nucleus of an atom is charged

c) Alpha particle scattering experiment was possible by using gold foil only and not by foil of any other metal.

a) It is because mass of electron is negligible.

b) Nucleus of an atom consists of positively charged protons and neutrons which do not have charge.

c) It is because gold metal is highly malleable and very thin foil of gold foil was taken

93. The number of electrons, protons and neutrons of 5 elements are given below:

Element	A	B	C	D	E
Electrons	4	18	17	11	17
Protons	6	18	17	9	17
Neutrons	6	22	20	10	18

a) Which of them is a cation?

b) Which of them is an anion?

c) Which is an atom of an inert gas?

a) 'A ' is a cation as it has proton more than electron

b) 'D' is an anion as it has electrons more tan protons

c) 'B' is an inert gas as it has 8 electrons in outermost shell (2,8,8)

94. a) Explain Bohr and Bury rules for distribution of electrons into different shells.

b) Draw the electronic structure of element X with atomic number 17 and element Y with atomic number 16?

a) Bohr and Bury Scheme for Distribution of Electrons in Different Energy Levels:

i) The maximum number of electrons in an energy level is equal to $2n^2$ where 'n' is the energy level.

1st energy level can have $2n^2 = 2 \times 1^2 = 2$ electrons.

2nd energy level can have $2 \times 2^2 = 8$ electrons

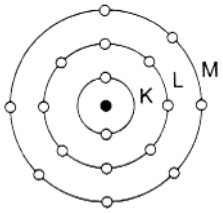
3^{rd} energy level can have $2 \times 3^2 = 18$ electrons

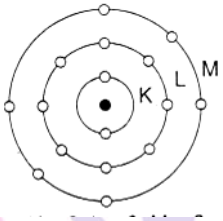
ii) The last energy level (Outermost energy level) cannot have more than 8 electrons

iii) The last but one shell (Penultimate shell) cannot have more than 18 electrons

iv) The last but second shell (anti-penultimate shell) cannot have more than 32 electrons.

b) X (17) = 2, 8 ,7 Y (16) = 2, 8, 6





K =2, L = 8, M =7 K =2, L = 8, M =6

95. An atom of an element has 7 electrons in its L shell

a) What is its atomic number ?

b) State its valency

c) Identify the element

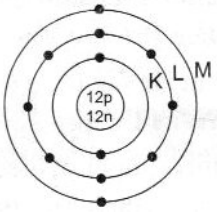
a) Its atomic number is equal to 2 + 7 = 9

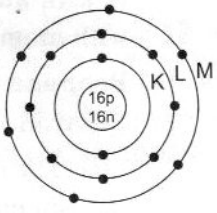
b) Its valency is equal to one as it can gain 1 electron to become stable

c) The element is fluorine.

96. With the help of schematic representation of atomic structure of magnesium and sulphur, explain how are electrons distributed in different orbits.

Magnesium Sulphur





K =2, L = 8, M =7 K =2, L = 8, M =6

97. In the following table, the mass number and the atomic number of certain elements are given:

Elements	Mass No	Atomic
A	2	1
B	3	1
C	3	2`
D	6	3
E	9	4
F	11	9
G	19	9
H	23	11

a) How many neutrons are present in "F"

b) Which atoms are isotopes of the same element?

c) Which atom will form singly positively charged ion?

d) Which is atom of an inert gas?

e) Which will form singly negatively charged ion?

f) Which of these has 11 electrons ?

a) Number of neutrons in "F" is equal to 11 -5 = 6

b) A and B are isotopes of the same element

c) 'D' and 'H' can form singly +ve ions

d) Element 'C' is inert gas

e) 'G' will form singly negatively charged ion

f) 'H' has 11 electrons.

98. Fill in the blanks :

Element	Atomic Number	P	E	N	Mass Number
Na^{+}	11	11	-	12	23
Ca^{2+}	20	20	18	--	40
Oxygen	8	8	-	8	16

Element	Atomic Number	P	E	N	Mass Number
Na^+	11	11	10	12	23
Ca^{2+}	20	20	18	20	40
Oxygen	8	8	8	8	16

99. The description of atomic particles of two elements X and Y is given below :

	X	Y
Protons	**8**	**8**
Neutrons	**8**	**8**
Electrons	**8**	**8**

a) What is the atomic number of Y?

b) What is the mass number of X?

c) What is the relation between X and Y?

d) Which element / Elements do they represent?

e) Write the electronic configuration of X

f) Write the cation /anion formed by the element

a) 'Y' ahs atomic number 8, i.e. equal to number of protons

b) 'X' has mass number 16 (n + p = 8 + 8 = 16)

c) 'X' and 'Y' are isotopes as these differ in neutrons

d) They represent isotopes of oxygen, $^{16}_{8}O$ and $^{17}_{8}O$

e) X has electronic configuration

K	L
2	6

f) The anion formed by element is X^{2-} or O^{2-}

100) Which of the following are isotopes and which are isobars?

Argon, Protium, Calcium, Deuterium Explain, why the isotopes have similar chemical properties but they differ in physical properties?

$^{1}_{1}H$ (Protium) and $^{2}_{1}H$ (Deuterium) are isotopes $^{40}_{18}Ar$ and Ca are isobars.

Isotopes have similarly in chemical properties as these have the same atomic number i.e. the same number of valence electrons but differ in physical properties due to difference in mass number.

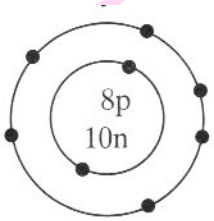
101. What are isotopes? Write 3 isotopes of hydrogen. Why do isotopes show similar chemical properties?

Isotopes are the atoms of the same element having different mass number but same atomic number.

$^{1}_{1}H$, $^{2}_{1}H$, $^{2}_{1}H$ are isotopes of hydrogen

Isotopes have similar chemical properties because they have the same atomic number, therefore, same number of valence electrons hence similar chemical properties.

102. What information do you get from the figure given below about the atomic number, mass number and valency of atom X?



Atomic number is equal to 8. Mass number is equal to 18.

'X' has electronic configuration 2, 6

It has valency equal to 2 as it can gain 2 electron easily to become stable.

103. Composition of the nuclei of two atomic species 'X' and 'Y' are given below.

	X	Y
Protons	8	8
Neutrons	8	10

a) Write the mass number of x and Y respectively

b) Write the electronic configuration of the element 'x'

c) 'x' and 'Y' have the same number of valence electrons due to the same atomic number, therefore, they have the same chemical properties. They are isotopes.

104. a) Calculate the average atomic mass of chlorine if it exists commonly in two isotopes.

$^{35}_{17}CL$ (75%) and $^{37}_{17}CL$ (25%)

b) Write the main drawback of Rutherford's model of an atom.

Ans. (a) Average atomic mass

= 35 x $\frac{75}{100} + 37 \times \frac{25}{100}$

$\Rightarrow = \frac{2625}{100} + \frac{925}{100} = \frac{3550}{100} = 35.5u$

(b) Drawbacks of Rutherford's Model of an Atom: Any charged particle when accelerated is expected to radiate energy. To remain in a circular orbit, the electron would need to undergo acceleration. Therefore, it would ratiate energy.

The loss of energy would lead to shrinking of the orbit in size. in short time, it would hit the nucleus. Therefore, an atom cannot be expected to bestable.

105. a). Chlorine occurs in nature in two isotopic forms with masses 35u and 37u in the ratio of 3:1 Calculate the average atomic mass of chlorine atom on the basis of this data.

b) Give any three uses of isotopes.

Ans. (a) Average atomic mass = $\frac{35 \times 3 + 37 \times 1}{4}$

= $\frac{105+37}{4} = \frac{142}{4} = 35.5u$

(b) (i) U-235 is used for the production of electricity with the help of nuclear reatctors.

(ii). U-238 is used to determine the age of very old rocks and even the age of the earth.

(iii) $^{14}_{6}C$ is used to determine the age of old samples of living organisms.

(iv) Cobalt – 60 is used in the treatment of cancer [any three]

106. Elements from A to F have in them the distribution of electrons, neutrons and protons as follows

Atoms/ ions	Number of Electrons	Number of Neutrons	NUMBER OF Protons
A	4	4	3
B	10	12	11
C	17	18	17
D	17	20	17
E	18	22	18
F	19	21	19

Making use of these data, find

(a) a pair of ions

(b) an atom of a noble gas

(c) a pair of isobars

(d) a pair of isotopes

Ans. a) A and B are ions

b) E is a noble gas

c) E and F are isobars

d) C and D are isotopes

107. Define mass number and atomic number, How are these represented around the symbol of an element? The mass number and atomic number of an isotope of uranium (U) are 235 and 92 respectively. Calculate the number of protons and neutrons in the nucleus of the atom.

Ans. Mass number is defined as the sum of the number of protons and neutrons. Atomic number is equal to the number of protons. It can be represented by this method : Let us take the example of uranium.

$^{235}_{92}U$ $\longrightarrow$ Here 235 is the mass number of uranium and 92 is the atomic number of uranium.

It contains 92 protons and 235 – 92 = 143 neutrons.

108. a) How many neutrons are present in C-14 isotope of carbon?

b) How many protons does He^{2+} ion possess?

c) How many electrons can be filled in the third orbit of an atom at a maximum?

Ans a) Number of neutrons = Mass number – Atomic number = 14 – 6 = 8

b) He^{2+} has 2 protons

$\therefore Number\ of\ protons = Atomic\ number.$

c) The maximum number of electrons that can be filled in 3rd orbit = 2 x 3^2 = 2 x 9 = 18 electrons.

I. Long answer questions

109. How were cathode rays produced using a discharge tube? Give four properties of cathode rays. Why does e/m ratio of negatively charged particles remain constant for all gases? Draw a neat and labelled diagram of a cathode ray tube.

Ans: When high voltage of 10000 v is passed through discharge tube at very low pressure. Cathode rays are produced.

Properties of cathode rays:

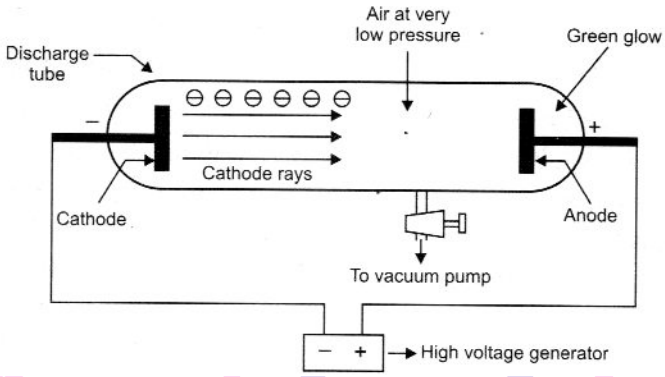
a) They consist of negatively charged particles.

b) The e/m ratio of particles of cathode rays is found to be the same

c) Cathode rays are deviated towards +ve terminal in electric field.

d) The deviation towards +ve terminal is more in electric field.

It is because electrons are present in all the atoms.i.e. they are fundamental particles of all atoms. Therefore, e/m ratio of negatively charged particles remains constant.



Production of cathode rays

110. How were anode rays produced? Explain with the help of a neat and labelled diagram. Give four properties of anode rays. Why does e/m ratio of positively charged ions present in anode rays depend upon the nature of the gas?

Ans. Anode rays or canal rays are produced by using perforated cathode in discharge tube at very low pressure and high voltage of the order of 10000 volts.

Properties of anode (canal) rays:

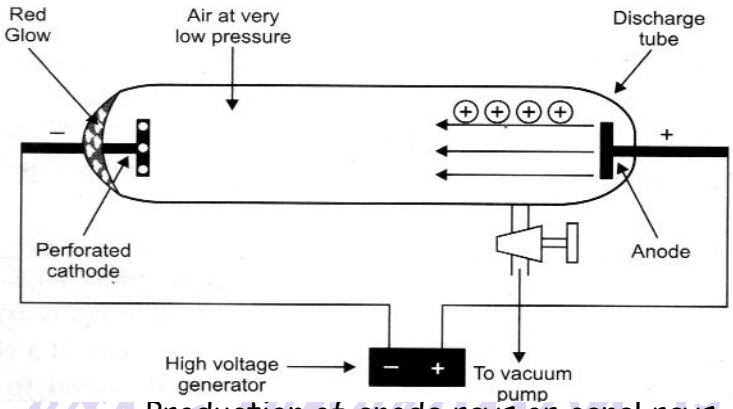
a) They consist of positively charged particles.

b) The e/m ratio of positively charged particles is not found to be the same for every gas.

c) Anode rays are deviated towards -ve terminal in electric field.

d) The deviation towards -ve terminal is more in electric field.

It is because canal rays are formed by ionisation gas. Mass and charge on positively charged ions will depend upon nature of gas, therefore, e/m ratio depends upon nature of gas.



Production of anode rays or canal rays

111. Read the following passage and with your own knowledge answer the following questions:

In order to overcome the objections raised against Rutherford's model of the atom,

Neil Bohr put forward the following postulates about the model of an atom.

(i) Only certain special orbits known as discrete orbits of electrons are allowed inside the atom.

(ii) while revolving in discrete orbits the electons do not radiate enerty.

Write the following statements in your answer book after completing them

a) Atom are made up of _____, _____and _____ b) …… amended Rutherford's shortcomings.

c) Electrons do not radiate energy while revolving in _____ orbits

d) Discrete orbits are also known as _____

e) The K shell can accommodate _____ electrons whereas L can accommodate _____ electrons. _____

f) Atomic mass of an element is the sum of number of _____ and _____ [CBSE2014]

Ans: a) electrons, protons, and neutrons

b) Bohr

c) same

d) energy levels

e) 2, 8

f) neutrons, protons.

112. a) what are the postulates of Bohr's model of an atoms?

b) Show diagrammatically the electrons distributions in Sodium, Lithium and Aluminium atoms [CBSE 2011]

Ans. a) Bohrmade a bold new suggestion that particle at atomic level would behave differently from macroscopic [bigger] objects.

According to Bohr's theory

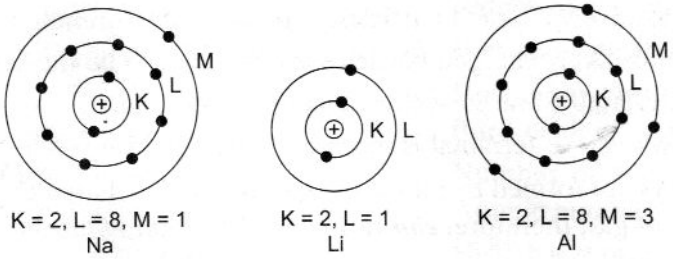
(i) Electrons revolve in certain orbits having well defined energy.

(ii) Electrons do not emit radiation at long as they remain in the same orbit.

(iii) Simply of energy excites the electron to higher energy level

(iv) Emission of energy takes place when it jumps from higher energy level to lower energy level.

b)



113. a) Explain why did Rutherford select a gold foil in his alpha scattering experiments?

b) What observations in a scattering experiment led Rutherford to make the following observations:

i) Most of the space in an atom is empty

ii) Nucleus is positively charged

c) Mention any two drawbacks of Rutherford's model. [CBSE 2011]

Ans. a) It is because very thin foil of gold can be made

b) (i) Most of the rays passed undeviated.

(ii) Some of the rays were deflected by large angles.

c). Drabacks of Rutherford's Model of an Atom.

Any charged particle when accelerated is expected to radiate energy. To remain in a circular orbit, the electron would need to undergo acceleration. Therefore it would radiate energy. The loss of energy would lead to shrinking of the orbit in size. In short time, it *would hit the nucleus. Therefore, an atom cannot be expected to be stable.*

114. a) State the three observations made by Rutherford on his $\propto$ -particle scattering experiment.

b) Write the Electronic Configuration of an element whose mass number is 31 and atomic number is 15. What is its valency?

a) Rutherford's experiment established the presence of atomic nucleus.

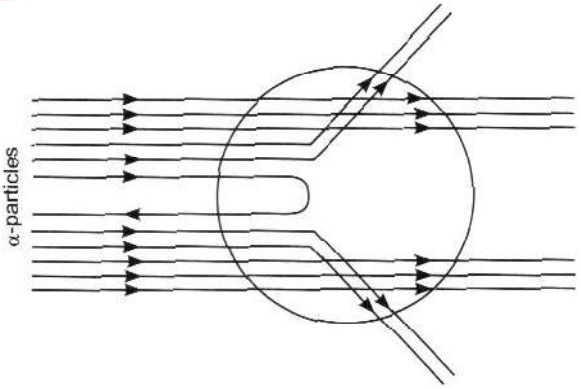
Rutherford's experiment (Discovery of Nucleus) : Rutherford bombarded on a gold foil with a stream of $\propto$ -particles, which are positively charged helium nuclei. He made the following observations:

i) Most of the $\propto$ -rays (99%) passed through gold foil undeviated from their path.

Conclusion : Most of the space around atoms is hollow or empty.

ii) Some of the rays were deviated through larger angles showing that centre of the atom is positively charged.

iii) Very few rays were deflected back from their path which shows hat there is positively charged heavy centre which occupies very small space which is called nucleus. The whole mass of atom is concentrated at this centre.
Some more conclusions were made on the basis of these observations.



Scattering of ∝ - particles by gold foil

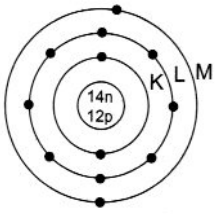
iv) The volume of the nucleus is $\frac{1}{1,00,000}$ of thetotal volume of the atom, where the electrons revolve around the nucleus.

v) The density of nucleus is very high (any three)

b) Electronic configuration = 2,8,5 and valency = 3 because it can gain 3 electrons to become stable.

115. a) An element has an atomic number 12 and an atomic mass no.26. Draw a diagram showing the distribution of electrons in the orbits and the nuclear composition of the neutral atom of the element. What is the valency of the element and why?

b) If this element X combines with another element Y whose electronic configuration is 2,8,7 what will be the formula of the compound thus formed? State how did you arrive at this formula



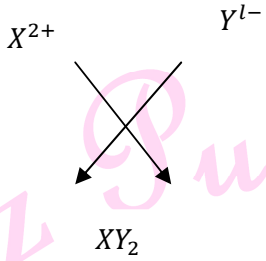
P + n = 26

12 + n = 26

N = 26 – 12 = 14

Its valency is equal to 2 as it can lose 2 electrons to become stable. Its nucleus has 12 protons and 14 neutrons.

b) Formula of the compound XY_2 It is bivalent. Y has electronic configuration 2, 8, 7 Therefore valency = 1, i.e. it is monovalent.



116. a) Define valency what conclusions can be drawn about the reactivity of an atom from its valency?

b) Why does an atom of \argon have zero valency? Explain using the electronic configuration of Argon.

a) Valency is defined as the number of electrons lost or gained or shared to attain the nearest noble gas (stable) configuration. If valency is equal to 1 or 2 the element is highly reactive. If valency is equal to zero it is not reactive. If valency equal to 3 or 4 it is less reactive.

b) Argon has its octet complete (2,8, 8) therefore it cannot gain or lost or share electrons. So its valency is equal to zero.

117. a) The average atomic mass of a sample of an element X is 16.2 u. What are the percentage of isotope $^{16}_{8}X$ and $^{18}_{8}X$ in the sample

b) On the basis of Thomson's model of an atom explain how the atom is neutral as a whole.

a) Percentage of wiill be 'x' therefore, percentage of $^{16}_{8}X$ will be 100 – x

16.2 = $\frac{18 \times x + 16\,(100-x)}{100}$

1620 = 18x + 1600 - 16x

2x = 20; $x = \frac{20}{2}$ = 10%

∴ % of will be 10%

% of $^{16}_{8}X$will be 100 – 10 = 90%

b) Positively charged of particles and negative charged particles sre equal therefore an atom is neutral on the basis of Thomson model

NCERT

I. Short answer questions

1. Is it possible for the atom of an element ro have one electron, one proton and no neutron? If so, name the element

Yes the element is hydrogen

2. Write any two observations which support the fact that atoms are divisible.

a) Discovery of electrons b) Discovery of protons c) Discovery of neutrons

(any two) The existence of these particles show that atoms are divisible.

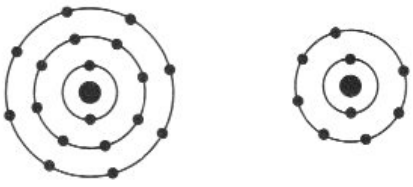
3. Will $^{35}_{17}cl$ have different valencies? Justify your answer.

No. They will have the same valencies because their atomic numbers are same, electronic configuration is same and they have the same number of valence electrons.

4. Why did Rutherford select a gold foil in his $\propto$-ray scattering experiment?

It is because gold is highly malleable and thus a very thin foil of gold can be obtained.

5. Find out the valency of the atoms represented by the figure (a) and (b)



(a) (b)

a) has valency equal to zero as its octet is complete, i.e. it has 8 electrons in its valence shell

b) has valency equal to 1 as it has 7 valences electrons. It can gain or share 1 electron to become stable.

6. One electron is present in the outermost shell of the atom of an element X. What would be the nature and value of charge on the ion formed if this electron is removed from the outermost shell?

It will acquire positive charge and value will be equal to +1

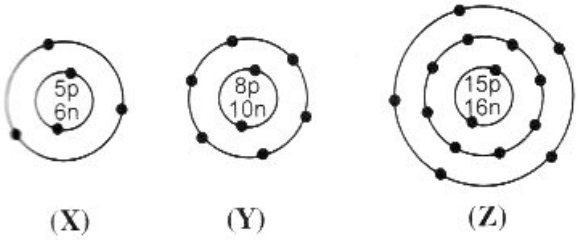
7. Write down the electron distribution of chlorine atom. How many electrons are there in the shell? (Atomic number of chlorine is 17)

Cl (17) ⟹ k =2 l = 8 m = 7. The L shell has eight electrons

8. In the atom of an element X, 6 electrons are present in the outermost shell. If it acquired noble gas configuration by accepting requisite number of electrons, then what would be the charge on the ion so formed"?

It will acquire negative charge and value will be equal to -2 because it will gain 2 electrons

9. What information do you get from the figure about the atomic number, amss number and valency of atoms X,Y and Z? Give your answer in a tabular form.



Element	Atomic number	Mass number	Valency
X	5	11	3
Y	8	18	2
Z	15	31	3

10. In response to a question, a student stated that in an atom, the number of protons is greater than number of neutrons, which in turn is greater than the number of electrons. Do you agree with the statement? Justify your answer.

No it is not possible. Number of protons cannot be greater than number of electrons in case of neutral atoms. These should be equal. Number of protons also cannot be greater than neutrons except in the case of Hydrogen.

11. Calculate the number of neutrons present in the nucleus of an element X which is represented as $^{31}_{15}X$.

Element is $^{31}_{15}X$

No.of Netureons = Mass number – Atomic number = 31 -15 = 16

12. Match the names of the Scientist given in column A with their contributions towards the understanding of the atomic structures as given in Column B.

Column A	Column B
a) Ernest Rutherford	i) Indivisibility of atoms
b) J.J. Thomson	ii) Stationary orbits
c) Dalton	iii) Concept of nucleus
d) Neils Bohr	iv) Discovery of electrons
e) James Chadwick	v) Atomic number
f) E. Goldstein	vi) Neutron
g) Mosley	vii) Canal rays

a) iii	b) iv	c) i	d) ii	e) vi	f) vii	g) v

13. The atomic number of calcium and argon are 20 and 18 respectively but the mass number of both these elements is 40. What is the name given to such a pair of elements?

They are isobars.

14. Complete the table on the basis of information available in the symbols given below:

a) $^{35}_{17}CL$ **b)** $^{12}_{6}CL$ **c)** $^{81}_{35}Br$

Element	n_p	n_n

Element	n_p	n_n
a) $^{35}_{17}CL$	17	18
b) $^{12}_{6}CL$	6	6
c) $^{81}_{35}Br$	35	46

15. Helium atom has 2 electrons in its valence shell but its valency is not 2. Explain

Helium atom is zero valent because its first shell is the outermost shell which is full and therefore it is stable. It cannot gain or lose or share electrons

16. Fill in the blanks in the following statements :

a) Ruterford's $\propto$ - particle scattering experiment led to the discovery of the _____.

b) Isotopes have the same_____ but different _____.

c) Neon and chlorine have atomic numbers 10 and 17 respectively. Their valencies will be _____ and _____ respectively.

d) The electronic configuration of silicon is _____ and that of sulphur is _____.

a) Atomic nucleus

b) atomic number, mass number

c) 0, 1

d) Silicon -2, 8, 4 ; Sulphur -2, 8 6

17. An element x has a mass number 4 and atomic number 2. Write the valency of this element

Its atomic number is 2, it has 2 electrons in 1st shell. Its valency is zero as i has sable electronic configuration.

I. Long answer questions

18. Why do Helium, Neon and Argon have zero valency?

Helium has 2 electrons in its valence shell whereas Neon and Argon have 8 electrons in their valency shells. They have maximum possible number of electrons in their valence shells, so they have no tendency to gain or lose or share electrons to form bonds. Therefore they are zero valent.

19. The ratio of the radii of hydrogen atom and its nucleus is 10^5 : 1 Assuming the atom and its nucleus to be spherical., (a) What will be the ratio of their sizes? b) If atom is represented by planet earth 'R_e' = 6.4 x 10^6 m, estimate the size of the nucleus.

a) Volume of sphere = $\frac{4}{3}\pi r^3$

Volume of atom = $\frac{4}{3}\pi R^3$

[Where 'R' is radius of atom]

Volume of nucleus = $\frac{4}{3}\pi r^3$

[Where 'r' is radius of nucleus]

Radius of atom (R) = 10^5 x radius of nucleus (r)

∴ Volume of atom = $\frac{4}{3}\pi\,(10^5 r)^2$

$= \frac{4}{3}\pi \times 10^{15} r^3$

Ratio of the volume of atom to that of nucleus = $\frac{\frac{4}{3}\pi \times 10^{15} r^3}{\frac{4}{3}\pi r^3} = 10^{15}$

b) If the atom is represented by the planet earth('R_e' = 6.4 x 10^6 m) then the radius of the nucleus would be

$r_n = \frac{R_e}{10^6}$;

$r_n = \frac{6.4 \times 10^6 \ m}{10^6}$ = 6.4 x 10m = 64 m

20. Enlist the conclusions drawn by Rutherford from his $\propto$ -ray scattering experiment

a) Most part of atom is hollow as most of $\propto$ -rays went undeviated through the gold foil.

b) Very few $\propto$ -rays (1%) deviated from their path, so very small portion on the centre of atom is positively charged called nucleus.

c) A very small number of $\propto$ -rays came back in the same path showing hat size of nucleus is very small and heavy.

21. In what way is the Rutherford's atomic model different from that of Thomson's atomic model?

According to Rutherford, atom consists of positively charged centre called nucleus. Electrons revolve around the nucleus in fixed path called orbits. The nucleus is very small as compared to atom. The density of nucleus is very high as its size is small and whole mass of atom is concentrated into the nucleus.

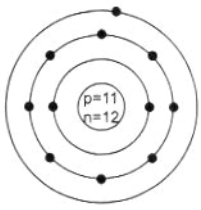
According to Thomson, the electrons are embedded in a positively charged sphere like seeds of watermelon and the mass of atom was assumed to be uniformly distributed.

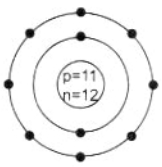
22. Show diagrammatically the electron distributions in a sodium atom and a sodium ion and also give their atomic number.

Na (11) =2 , 8, 1

Na^+ (11) = 2,8

e^- = 11 -1 = 10





K = 2 L = 8, M =1 K =2 , L = 8

Atomic number = 11 Atomic number = 11

Atomic number remains the same as it is equal to number of protons.

23. In the Gold foil experiment of Geiger and Marsden, that paved the way for Rutherford's model of an atom, ~ 1.00% of the $\propto$ - particles were found to deflect at angles $> 50^0$ If one mole of $\propto$ - particles were bombarded on the gold foil, compute the number of $\propto$ - particles that would deflect at angles less than 50^0.

No. of $\propto$ - particles deviated at angle $> 50^0$ = 1%

No. of $\propto$ - particles deflected at less than 50^0 = 100 -1 = 99%

No. of $\propto$ - particles bombarded = 6.022 x 10^{23}

= $\frac{596.178}{100}$ x 10^{23} = 5.96 x 10^{23}