Structure of the Atom

CHAPTER 4

EXAM DRILL

ANSWERS

1. Television picture tube.

2. The lowest energy state of an atom is called ground state.

3(i) : Maximum number of electrons in *M*-shell = $2n^2$
$= 2 \times 3^2 = 18$

3(ii) : Potassium (19) : 2, 8, 8, 1

3(iii) : M^{3+} contains electrons = 10
M (neutral) contains electrons = atomic number = 13

3(iv) : Number of electron = atomic number = 2 + 8 + 2 = 12
Thus, element is magnesium.

4(i) : A heavy positively charged body (nucleus) is present at the centre of the atom.

4(ii) : It could not explain stability of the atom.

4(iii) : (b)

4(iv) : (c) Atomic models put forward in the chronological order are Thomson's model, Rutherford's model, Bohr's model.

5. (c) : Element with valency 1 can be both metals or non-metals.

6. (b) : Electrons occupy space around the nucleus.

7. (a)

OR

(b) Atomic number is a whole number.

8. (a) : It is the charge on an electron.

9. (c) : The electrons present in the outermost shell of the atom of an element are called valence electrons.

OR

(a) Energy of the orbit goes on increasing.

10. (a) : It showed that there must be sufficient empty space within the atom.

11. (b) : They have same atomic number, *i.e.*, same number of protons.

OR

(b) Number of electrons in NO_3^- = Electrons in N + 3 × electrons in O + 1
$= 7 + 8 \times 3 + 1 = 32$

12. (b) : The electronic configuration of Cl is 2, 8, 7.
As both have seven electrons in valence shell thus both will have same chemical properties.

13. (b)

14. (c) : The sum of protons and neutrons in the isobar is always same.

15. (a) (i) James Chadwick
(ii) Charge = Zero,
Mass = equal to proton = 1 unit
(iii) In nucleus
(b) Number of neutrons = Mass number – Number of protons
$= 4 - 2 = 2$

OR

(a) Most of the space inside the atom is empty because most of the alpha-particles passed through gold foil without getting deflected.
(b) Very few particles were deflected from their path, indicating that the positive charge of an atom occupies little space.
(c) A very small fraction of alpha-particle were deflected by 180° indicating that all the positive charge and mass of gold atom were concentrated in a very small volume.

16. Electrons are lost or gained from an atom. Electrons are also shared between atoms of two or more elements. Thus, the number of protons during a chemical reaction, *i.e.*, the atomic number of elements, does not change during a chemical reaction.

17. (a) (i) Most of the α-particles passed through gold foil without deflection.
(ii) A small fraction of α-particles got deflected.
(b) (i) Neutrons = Mass number – Atomic number
$= 35 - 17 = 18$
(ii) The electronic configuration will

K	*L*	*M*
2,	8,	7

Thus, number of valence electrons = 7.

18. (a) Hydrogen gas
(b) (i) The atoms of same element havings same atomic number, but different mass numbers are called isotopes
e.g., ${}_1^1H$, ${}_1^2H$, ${}_1^3H$.
(ii) The atoms of different elements with same mass number and different atomic numbers are called isobars.
e.g., : ${}_{20}^{40}Ca$ (atomic number 20) and ${}_{18}^{40}Ar$ (atomic number 18)
Mass number is same (*i.e.*, 40).
(c) (i) Uranium (ii) Cobalt

19. (a) Na contain one electron more than Na^+.
The (+)ve charge indicates that it has lost one electron.
(b) (i) Isotope of iodine is used in the treatment of goitre.
(ii) Isotope of phosphorus is used in the treatment of blood cancer.

(c) Proton

20. (i) The results of experiments carried out by other scientists could not be explained by J.J. Thomson's model of atom.
(ii) The combining capacity of an element is called its valency.
Magnesium has atomic number 12 and electronic configuration is 2, 8, 2.
It can lose 2 electrons to complete octet. Thus, its valency is 2.
Oxygen has atomic number 8 and its electronic configuration is 2, 6.
It can gain 2 electrons to complete octet. Thus, its valency is $8 - 6 = 2$.
(iii) The atomic number is equal to the number of protons.

K	*L*	*M*
2	8	8

S^{2-} has $2 + 8 + 8 = 18$ electrons. Thus, neutral atom will have $(18 - 2) = 16$ electrons.
Thus, atomic number of S^{2-} ion is 16.

OR

(a) Atoms are divisible is supported by the following facts :
(i) Discovery of electrons.
(ii) Discovery of protons.
(b) (i) It has electronic configuration = 2, 8, 8. Its outermost shell has complete octet. Hence, its valency = 0.
(ii) It has electronic configuration = 2, 7.
It can easily gain one electron to complete its outermost octet. Hence, its valency = 1.

21. (a) (i) Only certain special orbits known as discrete orbits of electrons are allowed inside the atom.
(ii) While revolving in discrete orbits the electrons do not radiate energy.
(b) Electronic configuration of Mg atom is 2, 8, 2.

22. (a) Protons are positively charged with 1 unit of mass. Electrons are negatively charged with 1/1836 unit of mass. Neutrons are neutral with one unit mass.
(b) Proton = 1, Electron = 1, Neutron = 1.

23. Isotopes are the atoms of the same element having same atomic number, but different mass numbers.
Three isotopes of hydrogen : $^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$
Isotopes show similar chemical properties because the number of valence electrons in these atoms are same.

OR

(a) The positively charged radiations produced in the discharge tube at low pressure and high voltage are called canal rays. The canal rays have positively charged sub-atomic, particles known as protons(p).
(b) E. Goldstein.

24. Electronic configuration of $X^{2-} = 2, 8$. Since two electrons should be removed from the dinegative ion to form a neutral atom, therefore electronic configuration of $X = 2, 6$.
Atomic number of $X = 2 + 6 = 8$
Thus, X is identified as oxygen.

25. (a) Isotopes of an element have same atomic number and electronic configuration. Since the chemical properties of the elements are related to their electronic configurations. Therefore, the elements with similar configuration will have similar chemical properties. Thus, the isotopes of an element are chemically similar.
(b) The number of protons in the nucleus of an atom is equal to the number of electrons in the extra nuclear portion.
Since each proton and each electron has the same charge, but with opposite magnitude, thus, the atom is electrically neutral.
(c) The atoms of noble gas elements have complete outermost shells. Hence, they are least reactive.
(d) Nucleus of an atom is made up of protons that are positively charged and neutrons that are neutral. The total mass of neutrons and protons make it heavy.
(e) When an atom changes into an ion (cation or anion), the valence shell of the ion has a complete octet or duplet. Therefore, ions are more stable than atoms.

26. The electrons of an atom which take part in chemical reaction are called valence electrons. The atoms combine with each other to achieve the inert gas electronic arrangement or to have eight electrons in the outermost shell. To have 8 electrons in outermost shell is known as octet of electrons. In order to complete the octet and become stable, atoms tend to lose or gain or share electrons. This is the cause of chemical combination.
If an element has 1, 2, or 3 electrons in the outermost shell of its atom, it loses these electrons to achieve the inert gas configuration hence valency of these element is 1, 2 or 3 respectively. If an element has 5, 6, or 7 electrons in the outermost shell, it gains 1, 2, or 3 electrons to achieve inert gas configuration hence valency of these elements is 1, 2 or 3 respectively. In an element with 4 electrons in outermost shell, the octet is completed by sharing 4 electrons with other atom.

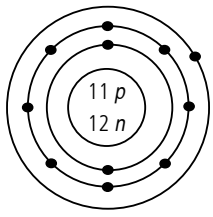
OR

(a) Neutrons were discovered in 1932 by James Chadwick. Neutrons are produced when we bombard a thin foil of beryllium with fast moving α-particles. Neutrons are neutral particles with a mass of 1.675×10^{-27} kg.
(b) The nucleus contains protons and neutrons.

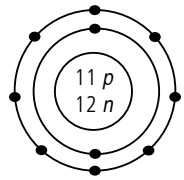
Isotope	Number of protons	Number of neutrons
$^{28}_{14}Si$	14	14
$^{29}_{14}Si$	14	15
$^{30}_{14}Si$	14	16

Since, the mass of natural silicon is very close to the Si-28 isotope, hence Si – 28 isotope will be most abundant in nature.

27. $_{11}Na$ – 2, 8, 1 (11 electrons)
$Na - 1e^- \rightarrow Na^+$ (10 electrons) Electronic configuration 2, 8.



Na atom



Na^+ (sodium ion)

The atomic number of an element is equal to the number of protons in its atom. Since, sodium atom and sodium ion contain the same number of protons, therefore, the atomic number of both is 11.

OR

(a) When an electron gains energy, it jumps from a lower energy level to a higher energy level. The atom then said to be in the excited state. In the excited state, the atom is not stable, it loses or emits energy and jump back to some lower energy level.

(b) *K*-shell is nearest to nucleus.

(c) As *L*-shell is nearer to nucleus than *N*-shell, *N*-shell has higher energy.

(d) The state of the atom with lowest energy is called ground state of an atom.

28. (a) *V*

(b) *U*

(c) *T* and *W*

(d) *S*

(e) *S*

29.

Atom	Atomic symbol	Mass number	Atomic number	Number of		
				Electrons	Protons	Neutrons
Sodium	Na	23	11	11	11	12
Carbon	C	12	6	6	6	6
Oxygen	O	16	8	8	8	8
Potassium	K	39	19	19	19	20
Iron	Fe	56	26	26	26	30
Neon	Ne	20	10	10	10	10

30. (a) The following rules are followed for writing the number of electrons in different energy levels or shells :

(i) The maximum, number of electrons present in a shell is given by the formula $2n^2$ where '*n*' is the orbit number or energy level index 1, 2, 3 ... Hence, the maximum number of electrons in different shells are as follows :

1^{st} orbit or *K*-shell will be $= 2 \times 1^2 = 2$,

2^{nd} orbit or *L*-shell will be $2 \times 2^2 = 8$,

3^{rd} orbit or *M*-shell will be $2 \times 3^2 = 18$,

4^{th} orbit or *N*-shell will be $2 \times 4^2 = 32$ and so on.

(ii) The maximum, number of electrons that can be accommodated in the outermost orbit is 8.

(iii) Electrons are not accommodated in a given shell, unless the inner shells are filled. That is, the shells are filled in a step-wise manner.

(b) The electrons which are present is outermost shell are known as valence electrons like chlorine (2, 8, 7) has 7 valence electrons.

OR

(a) Rutherford's nuclear model of atom.

(b) **Rutherford observed that :**

(i) Most of the α-particles (nearly 99%) passed through the gold foil undeflected.

(ii) Some of the α-particles were deflected by small angles.

(iii) A very few α-particles (1 in 12,000) were either deflected by very large angles or were actually reflected back along their path.

(c) **Rutherford explained his observation as follows :**

(i) Since most of the α-particles passed through the foil undeflected, it indicates that the most of the space in an atom is empty.

(ii) α-Particles being positively charged and having considerable mass, could be deflected only by some heavy, positively charged centre. The small angle of deflection of α-particles indicated the presence of a heavy positive centre in the atom. Rutherford named this positive centre as nucleus.

(iii) α-Particles which make head-on collision with heavy positive centre are deflected through large angles. Since the number of such α-particles is very small, thus the space occupied by the heavy positive centre must be very small.

(d) **The nuclear model of atom had following features :**

(i) There is a positively charged centre in an atom called the nucleus. Nearly all the mass of an atom resides in the nucleus.

(ii) The electrons revolve around the nucleus in circular paths.

(iii) The size of the nucleus is very small as compared to the size of the atom.

(e) **Drawbacks of Rutherford's atomic model :**

(i) It has been found that, if an electrically charged particle revolves around the circular path, then it always radiates out energy. Thus, if an electron moves around the nucleus, it must continuously radiate out energy and hence, gradually move towards nucleus in a spiral path, till it collides with nucleus. However, we know that atom is very stable. Rutherford's model cannot explain this stability.

(ii) Rutherford's model of atom does not say anything about the arrangement of electrons in an atom.

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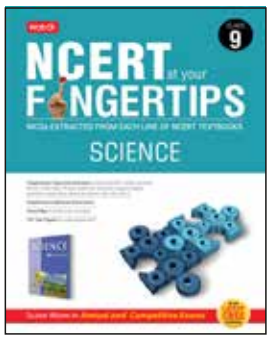

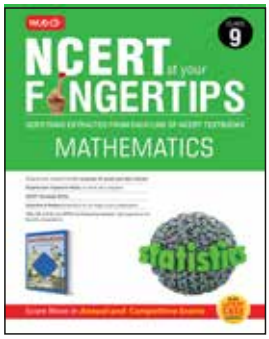

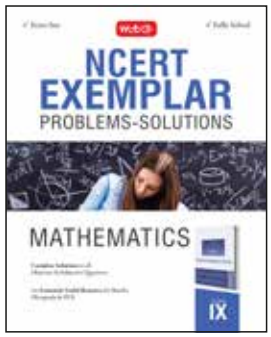

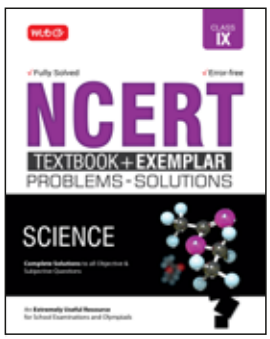

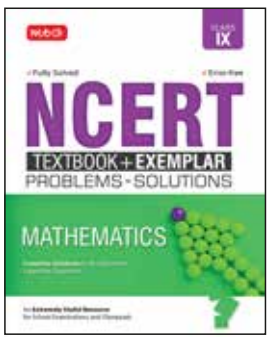

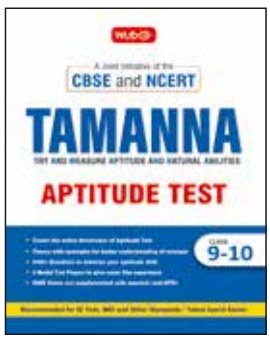

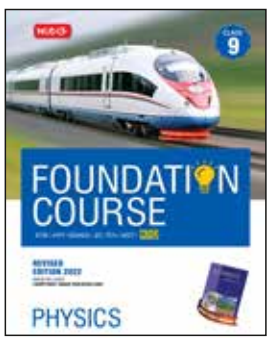

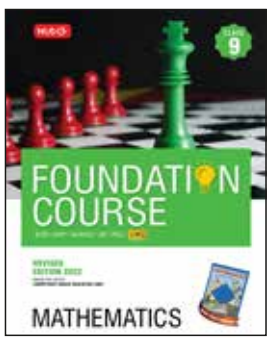

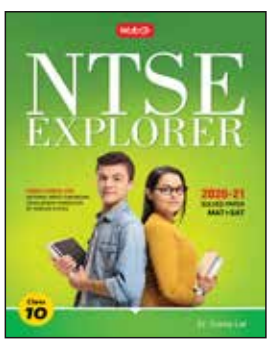

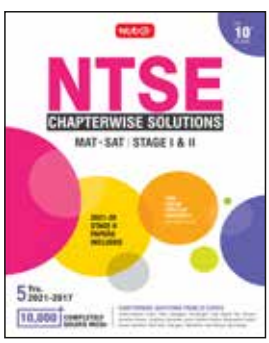

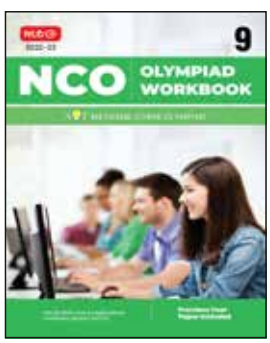

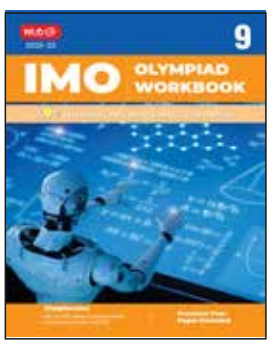

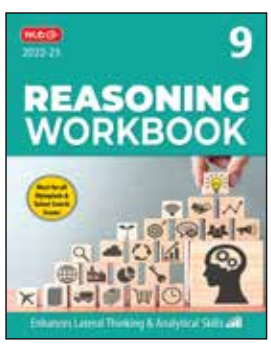

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