Chapter 5: Inside the atom

Question: 1. Fill in the blanks:

(1) Electron, proton, neutron are the types of **subatomic particles** in an atom.
(2) An electron carries a **negative** charge.
(3) The electron shell **K** is nearest to the nucleus.
(4) The electronic configuration of magnesium is 2, 8, 2. From this it is understood that the valence shell of Magnesium is **M**
(5) The valency of hydrogen is 'one' as per the molecular formula H_2O. Therefore valency of 'Fe' turns out to be **3** as per the formula Fe_2O_3.
(6) An atom is electrically **neutral**.
(7) Except hydrogen, the nuclei of all atoms contain **neutrons**.
(8) $^{12}_{6}C$, $^{13}_{6}$**C**, and $^{14}_{6}C$ are isotopes of carbon.
(9) An atom has 11 protons and **12** neutrons and hence its atomic mass number is 23.
(10) The element **Helium** has two electrons in the K shell, but it is a noble gas.
(11) Isotopes of the element have the same **chemical** properties
(12) Electrons must absorb **energy** to transit between orbits.

Question: 2. Rewrite the following statements selecting the correct options:
(1) The symbol A is used to denote the **atomic mass number**
(a) atomic number (b) atomic radius
(c) atomic mass number (d) atomic mass
(2) The existence of isotopes is due to the presence of different number of **neutrons**
(a) electrons (b) protons
(c) neutrons (d) positrons
(3) In the nucleus of a sodium atom (Na), there are **12** neutrons
(a) 11 (b) 12
(c) 10 (d) 9
(4) Isotopes of an element have the same number of **electrons**.
(a) neutrons (b) nucleons
(c) electrons (d) atoms
(5) The great Indian philosopher proposed that matter is made up of invisible tiny particles.
(a) Aryabhatta (b) Kanad
(c) Bhaskaracharya (d) Chanakya
(6) The maximum capacity of the M shell is **18** electrons.
(a) 2 (b) 8
(c) 18 (d) 32
(7) The mass of the electron is **1800** times less than that of a hydrogen atom.
(a) 1800 (b) 8100
(c) 1550 (d) 1600
(8) The L shell is the valence shell in **oxygen.**
(a) hydrogen (b) chlorine
(c) oxygen (d) sodium

Question: 3. State whether the following statements are True or False:
(1) An atom as a whole is electrically neutral. **True**
(2) The mass of an atom is distributed evenly within it. **False**

(3) The electron has the same mass as that of the proton. **False**
(4) The electron in the K shell has maximum energy. False
(5) Isotopes have same atomic number but different atomic mass number. **True**
(6) Matter is composed of molecules and molecules are made of atoms. **True**
(7) In India, total 22 nuclear reactors in eight places are functioning. **True**

Question: 4. Consider the relation between the items in the first pair and write the correlation for second pair:
(1) K:2 :: M:**18**
(2) Carbon:2, 3:: Fluorine:**2,7**
(3) Nitrogen: Valency three:: Fluorine: **Valency one**
(4) Atomic radius: pm:: Atomic mass: **um**
(5) NaH: Valency of Na: 1:: MgCl2: Valency of Mg: **2**

Question: 5. Match the columns:

[1] Column I	**Answers**	**Column II**
(1) Proton	Positively charged	**(a) Negatively charged**
(2) Electron	Negatively charged	**(b) Neutral**
(3) Neutron	Neutral	**(c) Positively charged**

[2] Column I	**Answer**	**Column II**
(1) Thomson	Electron	**(a) Well defined orbits**
(2) Rutherford	Scattering experiment	**(b) Neutron**
(3) Chadwick	Neutron	**(c) Scattering experiment**
(4) Bohr	Well defined orbits	**(d) Electron**

Question: 6. Distinguish between the following:

(1) Proton and Neutron:

Proton	**Neutron**
1. Protons carry a positive charge of +1.	1. Neutrons have no charge
2. In an atom number of proton is equal to number of electron	2. In an atom number of neutron is not always equal to number of electron
3. Protons were discovered by Ernest Rutherford	3. Neutrons were discovered by James Chadwick

(2) Atomic number and Atomic mass number :

Atomic number	**Atomic Mass Number**
1. The atomic number is the number of protons in the nucleus of an atom	1. The atomic mass number is the total number of protons and neutrons in an atom's nucleus.
2. The atomic number is represented by the symbol Z.	2. The atomic mass number is represented by the symbol A.
3. All the isotopes of an element have the same atomic number	3. Different isotopes of the same element have different mass numbers

Question. 7. Answer the following questions in one sentence each i

(1) Name the particles which are present in the nucleus of an atom.

Answer: The nucleus of an atom contains protons and neutrons.

(2) State the relation between the number of protons, the number of neutrons and the atomic mass number (A) of an element

Answer: The atomic mass number (A) is the sum of the number of protons and the number of neutrons in the nucleus.

(3) Carbon contains 6 protons and 6 neutrons. State Its atomic number and atomic mass number.

Answer: The atomic number of carbon is 6, and its atomic mass number is 12.

(4) State one use of isotopes of cobalt.

Answer: Isotopes of cobalt, such as cobalt-60, are used in cancer treatment through radiotherapy.

(5) Write the electronic configuration of chlorine.

Answer: The electronic configuration of chlorine is 2,8,7.

(6) State the number of electrons in the K shell of helium.

Answer: The K shell of helium contains 2 electrons.

(7) From the symbol "O", state the electronic configuration of oxygen and the atomic mass number of isotope oxygen.

Answer: The electronic configuration of oxygen is 2, 6, and the atomic mass number of the isotope oxygen is 16.

(8) How many electrons could there be in the outermost orbit of an element whose valency is 3?

Answer: An element with a valency of 3 could have 5 electrons in its outermost orbit.

(9) Which element is used as fuel in atomic reactors?

Answer: Uranium is used as fuel in atomic reactors.

(10) What are the symbols used for the shells which accommodate the electrons in various atoms? (Use your brain power! Textbook page 34)

Answer: The shells are represented by the symbols K, L, M, N.

(11) What is the symbol and ordinal number of the innermost shell? (Use your brain power! Textbook page 34)

Answer: The symbol of the innermost shell is K, and its ordinal number is 1.

(12) Write symbol of electron distribution in shell of fluorine atom? (Use your brain power! Textbook page 34)

Answer: The electron distribution in the shell of a fluorine atom is 2,7.

(13) Which is the outermost shell of fluorine atom? (Use your brain power! Textbook page 34)

Answer: The outermost shell of a fluorine atom is the L shell.

(14) Which is the outermost shell of sodium atom? (Use your brain power! Textbook page 34)

Answer: The outermost shell of a sodium atom is the M shell.

(15) Which is the outermost shell of hydrogen atom? (Use your brain power! Textbook page 34)
Answer: The outermost shell of a hydrogen atom is the K shell.

Question: 8. Answer the following questions:

(1) Explain Dalton's atomic theory.
OR
Write the postulates of Dalton's atomic theory.
Answer: British scientist John Dalton put forth in 1803 A.D. his celebrated ‘Atomic Theory’. According to this theory matter is made of atoms and atoms are indivisible and indestructible. All atom of an element are alike while different element have different atom with different mass.
(2) Describe Thomson's atomic model.
Answer: Thomson's atomic model, also known as the "plum pudding model," proposed that an atom consists of a positively charged sphere with negatively charged electrons embedded within it, resembling a pudding with plums scattered inside. This model explained the electrical neutrality of atoms, as the positive and negative charges balanced each other.
(3) How will you think about atomic mass distribution according to Thomson's model? Whether this distribution is uniform or non-uniform as per Dalton's atomic theory? (Use your brain power! Textbook page 29)
Answer: In Thomson's model, the atomic mass is uniformly distributed, while Dalton's theory suggests no internal structure for mass distribution.
(4) If the striker flicked by you misses the coin that you aimed at, where would the striker go? (Can you tell? Textbook page 29)
Answer: The striker will continue moving in the same direction it was flicked if it misses the coin.
(5) If the striker hits the coin, in which direction would it go? Straight forward to a side or in the reverse direction? (Can you tell? Textbook page 29)
Answer: The coin will move straight forward in the direction the striker was traveling.
(6) What were the observations of the experiment of scattering of alpha particles?
OR
Explain Rutherford's scattering experiment.
Answer: Observations:

- Most alpha particles passed straight through the gold foil.
- A small number were deflected at small angles, and very few bounced back.

Conclusion: Rutherford concluded that atoms have a small, dense, positively charged nucleus, with most of the atom being empty space.
(7) Explain Rutherford's atomic model.
Answer:
1. There is a positively charged nucleus at centre of an atom.
2. Almost the entire mass of the atom is concentrated in the nucleus.
3. Negatively charged particles called electrons revolve around the nucleus.
4. The total negative charged on all the electron is equal to the positive charge on the nucleus. As the opposite charges are balanced the atom is electrically neutral.
5. There is an empty space between the revolving electron and the atomic nucleus.

(8) Which discovery did point out that an atom has internal structure? (Use your brain power! Textbook page 30)
Answer: The discovery of electrons by J.J. Thomson and the subsequent scattering experiment by Rutherford showed that an atom has internal structure, with a nucleus and orbiting electrons.

(9) What is the difference between the solid atom in Dalton's atomic theory and Thomson's atomic model? (Use your brain power! Textbook page 30)

Answer: Dalton's atomic theory described atoms as solid, indivisible spheres, whereas Thomson's model proposed that atoms contain internal structure, consisting of negatively charged electrons embedded in a positively charged "pudding" (plum pudding model).

(10) Explain the difference between the distribution of positive charge in Thomson's atomic model and Rutherford's atomic model. (Use your brain power! Textbook page 30)

Answer: In Thomson's atomic model, the positive charge is spread uniformly throughout the atom, while in Rutherford's model, the positive charge is concentrated in a small, dense nucleus at the center of the atom.

(11) What is the point difference between the place of electron in the atomic models of Thomson and Rutherford? (Use your brain power! Textbook page 30)

Answer: In Thomson's model, electrons are embedded within a positively charged sphere, while in Rutherford's model, electrons orbit around the nucleus in mostly empty space.

(12) What is the thing which is present in Rutherford's atomic model and not present in Dalton's and Thomson's atomic models? (Use your brain power! Textbook page 30)

Answer:

Dalton's atomic model	**Rutherford's atomic model**
Dalton's atomic theory does not tell anything about the structure of the atom. There is no mention of electron in Dalton's atomic theory,	Rutherford's atomic model tells about the structure of the atom, i.e. the electron revolving around the nucleus.

Thomson's Atomic model	**Rutherford's atomic model**
The electrons are embedded in a gel of positive charge. Here the electrons are stationary and there is no concept of nucleus.	In Rutherford's atomic model, the electrons are not stationary, they revolve around the nucleus which is positively charged.

(12) What is the difference in the atomic models of Thomson and Rutherford?

Answer:

Thomson atomic models	**Rutherford atomic models**
1. Plum pudding model (electrons in a positive "pudding")	1. Nuclear model (dense nucleus surrounded by electrons)
2. Positive charge is uniformly distributed throughout the atom	2. Positive charge concentrated in the nucleus
3. Electrons are embedded in a positively charged "soup"	3. Electrons orbit the nucleus in defined paths
4. Based on experiments with cathode rays	4. Based on gold foil scattering experiment

(14) Explain Niels Bohr's atomic model. OR

Write the postulates of Bohr's atomic model.

Answer: Postulates of Bohr's Atomic Model:

1. Electrons revolve around the nucleus in fixed circular orbits with quantized energy levels.
2. Each orbit corresponds to a specific energy level, and electrons can move between these levels by absorbing or emitting energy.
3. Electrons in these orbits do not radiate energy; therefore, they remain stable in their paths unless they change energy levels.

(15) What is meant by subatomic particle? Give brief information of three subatomic particles with reference to electrical charge, mass and location.
Answer: A subatomic particle is a particle smaller than an atom and is a fundamental building block of matter.
Three Subatomic Particles:

- Proton
    - Electrical Charge: Positive (+1)
    - Mass: Approximately 1 atomic mass unit (amu) or 1.67 x 10^-27 kg
    - Location: Found in the nucleus of the atom.
- Neutron
    - Electrical Charge: Neutral (0)
    - Mass: Approximately 1 atomic mass unit (amu) or 1.68 x 10^-27 kg
    - Location: Also located in the nucleus of the atom.
- Electron
    - Electrical Charge: Negative (-1)
    - Mass: Approximately 1/1836 of an amu or 9.11 x 10^-31 kg (much lighter than protons and neutrons)
    - Location: Orbiting the nucleus in electron shells or energy levels.

(16) Define the terms: (1) Atom (2) Atomic number (3) Atomic mass number.

Answer: (1) Atom: An atom is the smallest unit of an element that retains its chemical properties, consisting of a nucleus (containing protons and neutrons) and electrons that orbit around the nucleus.
(2) Atomic number: The atomic number is the number of protons present in the nucleus of an atom, and it determines the element's identity and its position in the periodic table.
(3) Atomic mass number: The atomic mass number is the total number of protons and neutrons in the nucleus of an atom, representing the mass of the atom.

(17) How many types of subatomic particles are found in atom? (Use your brain power! Textbook page 32)
Answer: There are three types of subatomic particles found in an atom: protons, neutrons, and electrons.
(18) Which subatomic particles are electrically charged? (Use your brain power! Textbook page 32)
Answer: The subatomic particles that are electrically charged are protons (positively charged) and electrons (negatively charged).
(19) Which subatomic particles are present in the nucleus? (Use your brain power! Textbook page 32)
Answer: The subatomic particles present in the nucleus are protons and neutrons.
(20) Where are electrons revolving around the nucleus placed? (Use your brain power! Textbook page 32)
Answer: Electrons revolve around the nucleus and are placed in electron shells or energy levels.
(21) What is meant by atomic mass number? Explain how the atomic number and mass number of carbon are 6 and 12 respectively.
Answer:
Atomic mass number is the total number of protons and neutrons in the nucleus of an atom.
For carbon:
Atomic number (Z) = 6 (number of protons).
Mass number (A) = 6 protons + 6 neutrons = 12.

(22) The symbol used for oxygen is 'O'. There are 8 protons and 8 neutrons in its nucleus. From this determine the atomic number (Z) and mass number (A) of oxygen and arrange these in a conventional symbol. (Use your brain power! Textbook page 32)
Answer: For oxygen:
Protons = 8, Neutrons = 8.
Atomic number (Z) = 8 (number of protons).
Mass number (A) = 8 protons + 8 neutrons = 16.
The conventional symbol for oxygen is

(23) Atomic number of carbon is 6. How many electrons are there in a carbon atom? (Use your brain power! Textbook page 32)
Answer: The atomic number of carbon is 6, which means it has 6 electrons in a neutral carbon atom.
(24) A sodium atom contains 11 electrons. What is the atomic number of sodium? (Use your brain power! Textbook page 32)
Answer: A sodium atom contains **11 electrons**, which means its atomic number (Z) is **11**.
(25) The atomic number and mass number of magnesium are 12 and 24 respectively. How will you show this by the convention symbol? (Use your brain power! Textbook page 32)
Answer: The atomic number of magnesium (Z) is 12, and the mass number (A) is 24.
The conventional symbol for magnesium is $^{22}_{12}Mg$
(26) The atomic number and mass number of calcium are 20 and 40 respectively. Deduce the number of neutron present in the calcium nucleus. (Use your brain power! Textbook page 32)
Answer:
The atomic number of calcium (Z) is 20, and the mass number (A) is 40.
The number of neutrons = Mass number - Atomic number = 40 - 20 = **20 neutrons**.
(27) Deduce from the datum provided.
Answer: Skip this question
(28) Write a note on distribution of electrons in orbits.
OR What is the maximum number of electrons that can be accommodated in each of the orbits (shells) K. L, M, N,..., etc.?
Answer: Electrons are arranged in orbits (shells) around the nucleus according to the following rule:
- Maximum number of electrons in a shell = $2n^2$, where 'n' is the shell number.

- For example:
  - K-shell (n=1) can hold **2 electrons**.
  - L-shell (n=2) can hold **8 electrons**.
  - M-shell (n=3) can hold **18 electrons**.
  - N-shell (n=4) can hold **32 electrons**.

(29) There is a similarity in atomic structure and solar system. The planets revolve around the sun due to the gravitational force. Which force might be acting in the atomic structure? (Can you tell? Textbook page 33)
Answer: Similar to how gravitational force keeps planets in orbit around the sun, **electrostatic force** (the attraction between positively charged protons and negatively charged electrons) holds electrons in orbit around the nucleus in an atom.
(30) Positively charged proton are together in the nucleus. What might be, one of the function of the neutrons in the nucleus? (Can you tell? Textbook page 33)
Answer: Neutrons help **reduce the repulsive force** between the positively charged protons by adding a stabilizing force within the nucleus. They prevent the nucleus from breaking apart by providing nuclear stability.
(31) Use the following molecular formulae to determine the valencies of H, Cl, O, S, N, C, Br, I, Na. Molecular formulae - H2, HCl, H_2O, H2S, NH3, CH4, HBr, HI, NaH. (Can you recall? Textbook page 34)

Answer: By analyzing the molecular formulae, the valencies of elements are as follows:

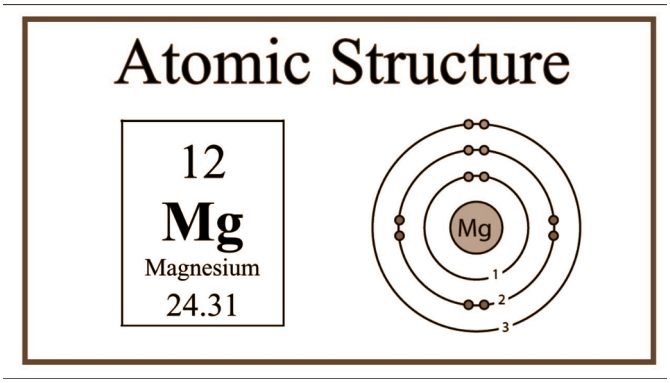
- Hydrogen (H): In H_2, hydrogen has a valency of 1 (H-H bond, each hydrogen has 1 bond).
- Chlorine (Cl) : In HCl, chlorine has a valency of 1 (one bond with hydrogen).
- Oxygen (O): In H_2O, oxygen has a valency of 2 (two bonds with hydrogen).
- Sulfur (S): In H_2S, sulfur has a valency of 2 (two bonds with hydrogen).
- Nitrogen (N): In NH_3, nitrogen has a valency of 3 (three bonds with hydrogen).
- Carbon (C): In CH_4, carbon has a valency of 4 (four bonds with hydrogen).
- Bromine (Br): In HBr, bromine has a valency of 1 (one bond with hydrogen).
- Iodine (I): In HI, iodine has a valency of 1 (one bond with hydrogen).
- Sodium (Na): In NaH, sodium has a valency of 1 (one bond with hydrogen).

(32) Draw suitable diagrams to show the electronic configuration of the atoms of the following elements Hydrogen, helium, carbon, neon, sodium, chlorine.

Answer: Homework

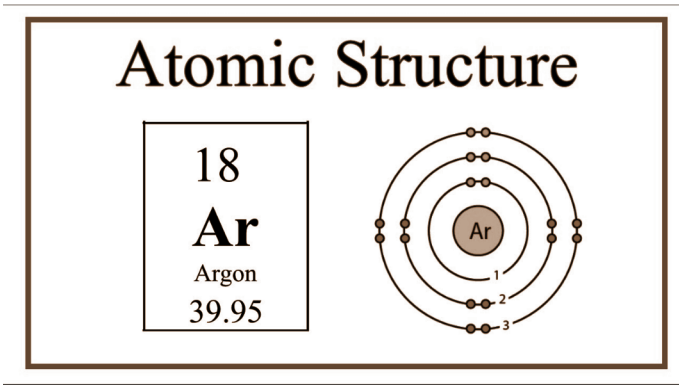
(33) Diagrammatic sketch of electronic configuration of magnesium (Atomic number 12).

Answer:



(34) Diagrammatic sketch of electronic configuration of argon (Atomic number 18).

Answer:



(35) What is meant by valency of an element? What is the relationship between the number of valence electron and valency?

Answer:

Valency: Valency is the ability of an element's atom to combine with other atoms. It is determined by the number of electrons an atom needs to gain, lose, or share to complete its outermost shell (achieve a stable configuration).

Relationship:

If the number of valence electrons (electrons in the outermost shell) is 1, 2, or 3, the element's valency is equal to the number of these electrons (as the atom can lose them to become stable).

(36) What is meant by the atomic number (Z) of an element? (Use your brain power! Textbook page 36)

Answer: The atomic number (Z) of an element is the number of protons present in the nucleus of an atom. It uniquely identifies the element and determines its position in the periodic table. In a neutral atom, the atomic number is also equal to the number of electrons.

(37) The number of electrons of some elements is given here. By using it write the electronic configuration, number of valence electron and valency of the respective elements.

Answer: Homework

38) Atomic mumbers (Z) of some elements are given here. Write down the number of electron present in the outermost shell of each of them. (Use your brain power! Textbook page 36)

Answer: Homework

(39) Why are the atomic numbers and atomic mass numbers always in whole numbers?
(Use your brain power! Textbook page 36)

Answer: Atomic numbers and atomic mass numbers are always whole numbers because:

1. Atomic Number (Z): The atomic number represents the number of protons in the nucleus of an atom. Since protons are discrete particles, you cannot have a fraction of a proton. Therefore, atomic numbers are whole numbers.
2. Atomic Mass Number (A): The atomic mass number is the total number of protons and neutrons in the nucleus. Both protons and neutrons are whole particles, so their sum must also be a whole number.

Thus, both atomic numbers and atomic mass numbers are expressed as whole numbers in the periodic table.

(40) Sulphur contains 16 protons and 16 neutrons. What would be its atomic number and mass number? (Use your brain power! Textbook page 36)

Answer:

Atomic Number (Z): The atomic number of sulfur is 16 (equal to the number of protons).
Mass Number (A): The mass number of sulfur is the sum of protons and neutrons, which is 16+16=32. Therefore, the mass number is 32.

(41) Define: Isotopes.

Answer: Isotopes are atoms of the same element that have the same number of protons (same atomic number) but different numbers of neutrons, resulting in different mass numbers. For example, carbon-12 and carbon-14 are isotopes of carbon.

(42) Define: Moderator.

Answer: A **moderator** is a material used in nuclear reactors to slow down fast neutrons produced during fission reactions. Slowing down the neutrons increases the likelihood of them causing further fission in fissile materials. Common moderators include water, heavy water, and graphite.

Question: 9. Give scientific reasons:

(1) All the mass of an atom is concentrated in the nucleus.

Answer: The nucleus contains protons and neutrons, which have significantly larger masses compared to electrons. Since electrons have negligible mass, the majority of an atom's mass is concentrated in the nucleus.

(2) Atom is electrically neutral.

Answer: An atom is electrically neutral because it contains an equal number of protons (positively charged) and electrons (negatively charged). The positive and negative charges balance each other out, resulting in no overall charge.

(3) Atomic mass number is a whole number.

Answer: The atomic mass number is the sum of protons and neutrons in the nucleus. Since both protons and neutrons are whole particles, their sum must also be a whole number, making the atomic mass number a whole number.

(4) Atoms are stable though negatively charged electron are revolving within it.

Answer: Atoms are stable because the negatively charged electrons are attracted to the positively charged nucleus by electrostatic forces. This attraction keeps the electrons in their orbits, preventing them from spiraling into the nucleus and allowing the atom to maintain a stable structure.

(5) In Rutherford's experiment, some alpha particles colliding with the thin gold foil are turned back.
Answer: In Rutherford's experiment, the deflection of some alpha particles indicated that a small, dense, positively charged nucleus exists within the atom. This nucleus repels the positively charged alpha particles, causing them to be turned back instead of passing through, which demonstrated that most of the atom is empty space.
(6) Two electrons in helium atom are placed in only one shell while three electrons in lithium atom occupy two shells.
Answer: Helium, with two electrons, has a full outer shell (the first shell can hold a maximum of two electrons), resulting in a stable configuration. In contrast, lithium has three electrons: two in the first shell and one in the second shell. The additional electron in the second shell causes lithium to be less stable compared to helium, which leads to different chemical properties.

Question. 10: Complete the following
Do it yourself