

## Chapter 2 — Atomic Structure

## 2. Questions for Short Answers

**1. Why is it said that almost all the mass of an atom is concentrated in its nucleus?**

Ans: An atom is made of electrons, protons and neutrons. Protons and neutrons are the heavy particles and both of them are present in the nucleus, where they are held together by a strong nuclear force. The mass of the electron is very small in comparison — a proton is 1836 times heavier than an electron. Therefore, although the nucleus is less than one hundred-thousandth of the size of the atom, it contains more than 99.9% of the mass of the atom.

**2. Why are elements different from one another?**

Ans: The atoms of all the elements contain the same electrons, protons and neutrons, but an atom of one element differs from an atom of another element because it contains a different number of these fundamental particles. The number of protons (the atomic number) is fixed and unique for each element. The difference in the properties of the elements is due to this difference in the properties of their constituent atoms.

**3. How many neutrons are present in  $^{210}_{83}\text{Bi}$ ?**

Ans: Mass number  $A = 210$ , atomic number  $Z = 83$ . Number of neutrons  $N = A - Z = 210 - 83 = 127$ . So, a bismuth-210 atom contains 127 neutrons (with 83 protons and 83 electrons).

**4. Why is tritium ( $^3\text{H}$ ) a radioactive element?**

Ans: Tritium has one proton and two neutrons in its nucleus. This nucleus is unstable, so it carries excess energy which it throws out in the form of radiation. An isotope whose nucleus emits radiation in this way is called a radioactive isotope, and tritium is therefore radioactive. The other two isotopes of hydrogen, protium and deuterium, are stable and do not emit any radiation.

**5. How can an atom absorb and evolve energy?**

Ans: An atom absorbs and gives out energy through its electrons. Each shell (energy level) has a fixed value of energy, and this energy increases as the distance of the shell from the nucleus increases. When an electron absorbs energy it jumps from a lower shell to a higher shell, which is farther from the nucleus. When the electron returns from the higher shell to the lower one, it evolves (gives out) exactly the same amount of energy.

### 3. Constructed Response Questions

#### 1. Why does the energy of electron increase as we move from first shell to second shell?

Ans: The first shell (K shell) is nearest to the nucleus, so the electron present in it is held by the strongest attraction of the nucleus and its energy is minimum; this is called the ground state. The second shell lies at a greater distance from the nucleus, where the attraction of the nucleus is weaker, and the orbits that are further away possess successively greater energy. Hence an electron in the second shell has more energy than an electron in the first shell.

#### 2. Why is it needed to lower the pressure of the gas inside the discharge tube?

Ans: The pressure of the gas is lowered so that the gas particles become far apart from one another. At ordinary pressure the gas molecules are too many and too close, they collide with the rays again and again, and the rays cannot travel across the tube. When the pressure is made very low and a very high voltage is applied, the gas conducts electricity and the cathode rays can travel freely from the cathode to the anode, so their properties can be observed and studied.

#### 3. What is the classical concept of an electron? How has this concept changed with time?

Ans: According to the classical concept, given by Bohr's atomic model, the electron is a particle which revolves around the nucleus in definite circular paths called orbits or shells. As long as the electron revolves in a particular orbit its energy remains fixed, and it is not allowed to occupy any space in between the orbits. With time this concept has changed. According to the modern approach, electrons are like charged clouds whose location around the nucleus cannot be predicted with one hundred percent certainty; all we can say is that there is a certain probability of finding the electron at a certain probable distance from the nucleus.

#### 4. Why are the nuclei of the radioactive elements unstable?

Ans: The nuclei of radioactive elements carry excess energy, which makes them unstable. In order to become stable they emit this excess energy in the form of radiation. In doing so a radioactive element is transformed into another chemical element; this process is called radioactive decay. The new element may itself be stable or it may again be radioactive and emit further radiation.

#### 5. During discharge tube experiments, how did the scientists conclude that the same type of electrons and protons are present in all the elements?

Ans: In the discharge tube the same kind of negatively charged rays (cathode rays) were produced no matter which gas was taken in the tube. Thomson passed them through electric and magnetic fields and found the same mass-to-charge ratio for them every time. Since the particles were identical whatever the gas, the scientists concluded that electrons are the subatomic particles of all the elements. Similarly, Rutherford's experiments in 1917 proved that the hydrogen nucleus, that is the proton, is present in other nuclei as well, so protons too are common to all the elements.