CHAPTER NO. 20 (ATOMIC SPECTRA)

Question 20.1:- Bohr's theory of hydrogen is based on several assumptions. Do any of these assumptions contradict classical physics?

Answer:- First postulate of Bohr's theory of hydrogen disagrees with the classical physics.

BOHR'S FIRST POSTULATE	CLASSICAL VIEW
An electron, bound to the nucleus in an atom, can move around the nucleus in certain circular orbits without radiating.	According to the classical physics, an accelerated electron should radiate energy in the form of EM waves due to its circular motion around nucleus. Its energy should decrease gradually and eventually it should fall into nucleus.

Question 20.2:- What is meant by line spectrum? Explain, how line spectrum can be used for the identification of elements?

Answer:- A spectrum which consists of isolated sharp parallel lines, in which each line corresponds to a definite frequency and wavelength, is called line spectrum.

Each element has its own characteristic lines of definite wavelengths. Thus, an element can be easily identified by observing its spectrum.

Question 20.3:- Can the electron in the ground state of hydrogen absorb a photon of energy 13.6 eV and greater than 13.6 eV?

Answer:- It can absorb a photon of energy 13.6 eV and greater than 13.6 eV. The ionization energy of the electron in the ground state of hydrogen atom is 13.6 eV and by absorbing a photon having energy greater than 13.6 eV, hydrogen atom will be ionized and the surplus energy of photon is taken away by free electron as its kinetic energy.

Question 20.4:- How can the spectrum of hydrogen contain so many lines when hydrogen contains one electron?

Answer:- Each line in a line spectrum indicates a particular transition between two allowed energy levels of hydrogen atom. When hydrogen atom is excited, it means electron in its first shell jumps to some higher energy level. The electron comes back to ground level by several jumps (atomic transitions). As the result, photons of different wavelengths are emitted. That's why the spectrum of hydrogen contains so many lines.

Question 20.5:- Is energy conserved when an atom emits photon of light?

Answer:- Yes, the energy is conserved when an atom emits a photon of light. The energy emitted during de-excitation is exactly equal to the energy absorbed by the atom during excitation. Thus, the energy is conserved in this process, i.e., total energy remains constant.

Question 20.6:- Explain why a glowing gas gives only certain wavelengths of light and why that gas is capable of absorbing the same wavelengths? Give a reason why it is transparent to other wavelengths?

Answer:- Electrons in an atom have fixed energy levels. When electron jumps from higher energy level to lower energy level during de-excitation, photons of particular wavelengths are emitted. On the other hand, when white light is passed through gas, it absorbs only those photons which have the energy equal to the difference of any two energy levels in atom of the gas. All other photons pass through the gas un-absorbed. In other words, gas is transparent for those photons.

A glowing gas only emits those wavelengths which lie in its emission spectrum and absorbs only those wavelengths which lie in its absorption spectrum.

Question 20.7:- What do we mean when we say that the atom is excited?

Answer:- If a certain amount of energy is supplied to the electrons of an atom by an external source, it will be raised up to one of the higher allowed states by absorption of energy. Then the atom is said to be in excited state.

Question 20.8:- Can X-rays be reflected, refracted, diffracted and polarized just like any other waves? Explain.

Answer:- Yes, X-rays can be reflected, refracted, diffracted and polarized as they are electromagnetic waves of higher frequency and shorter wavelength. Therefore, the X-rays possess all the properties as do light waves but the conditions for reflection, refraction, diffraction and polarization of light waves are different.

Question 20.9:- What are the advantages of lasers over ordinary light?

Answer:- The laser light over ordinary light has following advantages:

i. Laser light is monochromatic, while ordinary light has number of wavelengths.
ii. Laser light is coherent, while ordinary light has no phase coherence.

iii. Laser light moves in the same direction, while ordinary light spreads in all possible directions.
iv. Laser light is much more intense than the ordinary light.
v. Laser light is used in telecommunication along with fiber optics.
vi. It is potential source for inducing fusion reactions.
vii. It is used to generate three dimensional images of objects in a process called holography.

Question 20.10:- Explain why the laser action could not occur without population inversion between atomic levels?

Answer:- When a material is in thermal equilibrium, most of the atoms are in ground state. The material is exposed to some external source of energy and atoms move to excited state by absorbing fixed amount of energy. The atoms then fall to meta-stable state (an excited state of relatively longer lifetime). In this way, more than half of atoms reside in the meta-stable state. This is called population inversion.

At this stage, when external source of photon is used for lasing action, the probability of stimulated emission is greater than the probability of stimulated absorption and laser action takes place. Without population inversion, laser action could not occur.