

Physical Experiment Ⅱ

Prelab Report

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| Lab Title: | The Franck-Hertz Experiment |
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**Answers to Questions** (20 points)

(1)The first excitation potential of an atom is the minimum energy required to excite an atom from its ground state (the lowest, most stable energy state) to its first excited state (the nearest higher-energy, unstable state).

This energy value is typically measured in electron volts (eV). In the Franck-Hertz experiment, when the kinetic energy of an accelerating electron is exactly equal to the atom's first excitation potential, an inelastic collision is most likely to occur. The electron transfers its energy to the atom, causing it to become excited, while the electron itself loses this amount of energy. It is by observing this phenomenon that we measure the first excitation potential.

(2)Bohr's theory of the hydrogen atom has three basic assumptions:

1.Orbital Postulate: Electrons move in specific circular orbits around the nucleus.

2.Stationary State Postulate: An electron can only exist in these specific, discrete stable orbits. While in these orbits, the atom does not radiate energy.

3.Transition Postulate: An atom radiates or absorbs energy (in the form of a photon) only when an electron "jumps" from one energy level to another. The photon's energy is equal to the energy difference between the two levels (Ei − Ef =hν).

The core of this theory is the "quantization" of atomic energy levels. James Franck and Gustav Hertz provided experimental proof for his theory through their experiment, which was the first to directly observe the quantized nature of energy absorption by atoms.

(3)The Franck-Hertz effect was considered important enough for a Nobel Prize because of its landmark significance:

It was the first experiment in history to provide direct proof of the existence of discrete, quantized energy levels within atoms. Before this discovery, Bohr's atomic theory was a compelling model but lacked direct experimental validation. The Franck-Hertz experiment, with its clear data showing a periodic rise and fall in current, demonstrated unequivocally that atoms can only absorb energy in specific, discrete amounts ("quanta") rather than in a continuous manner.

This discovery provided the most powerful and direct experimental support for Bohr's hypothesis of quantized energy levels. It served as a crucial verification in the early development of quantum mechanics and fundamentally advanced our understanding of the microscopic structure of atoms.