Atomic Physics

Tutorial 1: Stern-Gerlach experiment, electron spin, fine structure of hydrogen atom

Q1:

the electron within a distance r_0 of the proton in the ground state. 10

(d) How are electrons distributed in the various sub-shells for $n = 3$? Give the quantum numbers for the electrons in the second shell. 10

(e) What do you understand by [illegible]

2013

Q2.

Show that the velocity of electron in the first orbit of hydrogen atom is $\left(\frac{1}{137}\right)C$ where C is the velocity of light. (Given electronic charge = $1{\cdot}602\times10^{-19}C$ Planck Constant $6{\cdot}63\times10^{-34}$ J.s, permittivity = $8{\cdot}85\times10^{-12}\ C^2N^{-1}m^{-2}$) 15

2013

Q3:

If K, L and M energy levels of platinum are approximately 78, 12 and 3 keV, respectively, below the vacuum level, calculate the wavelengths of K_α and K_β lines. 10

2015

Q4:

Find the energy, momentum and wavelength of a photon emitted by a hydrogen atom making a direct transition from an excited state with n = 10 to the ground state. Also find the recoil speed of the hydrogen atom in this process. *10*

2016

Q5:

Describe Stern-Gerlach experiment. Discuss how it has explained space quantization and electron spin. Find the value of angle between the spin angular momentum $\vec{S}$ and its z-component of an electron moving along the external magnetic field $\vec{B}$. *10+10+10=30*

2016

Q6:

The series limit wavelength of Balmer series in hydrogen spectrum is experimentally found to be 3646 Å. Find the wavelength of the first line of this series. *10*

2016

Q7:

Calculate the radius of electron orbit for Li^{++} in ground state. 10

2018

Q8:

Prove that Bohr hydrogen atom approaches classical conditions, when n becomes very large and small quantum jumps are involved. 10

2020

Q9:

A blue lamp emits light of mean wavelength of 4500 Å. The rating of the lamp is 150 W and its 8% of the energy appears as light. How many photons are emitted per second by the lamp? 10

2020

Q10:

Explain how the magnetic moments of atoms, the space quantization of angular momentum and the spin of electron are measured using Stern-Gerlach experiment. 15

2020

Q11:

Calculate the frequency of the electron in the first Bohr orbit of hydrogen atom. 15

2020

Q12:

In the Stern-Gerlach experiment using Ag atoms, the oven temperature is 1000 K, $l \approx 25$ cm and $\frac{\partial B_z}{\partial z} \simeq 10^{+3}$ Tesla/m. Calculate the separation of the two components. *10*

2020

Q13:

Explain spin-orbit coupling. Discuss the splitting of spectral lines of H-atom due to spin-orbit coupling. 15

2021

Q14:

(i) Why does Stern-Gerlach experiment enjoy so much importance in atomic physics ?

(ii) Draw the schematic diagram of this experiment and comment on the shapes of the magnet pole pieces.

(iii) Why was the atomic beam of silver used in this experiment ? 20

2022

Q15.

A beam of hydrogen atoms emitted from an oven at 400 k is sent through a Stern-Gerlach experiment having magnet of length 1 m and a gradient field of 10 tesla/m. Calculate the transverse deflection of an atom at the point where the beam leaves the magnet. 10

2023

Q16:

What is vector atom model ? How the principal features of vector atom model were explained by Stern-Gerlach experiment ? 5+10=15

2023

Q17.

How is Rydberg constant related to emission wavelength of hydrogen spectrum ? *10*

2024

Q18.

Find out the difference in frequencies of Lyman-alpha line in hydrogen and deuterium atoms. 15

2025

Q19.

The Stern-Gerlach experiment is a landmark experiment in quantum mechanics. Discuss about the most important findings of this experiment. 15

2025