

Atomic Physics

Tutorial 2: L-S coupling, J-J coupling; Spectroscopic notation of atomic states, Zeeman Effect

Q1:

The term symbol for atomic states are quoted as 3P_2 and $^2D_{5/2}$. What are the values of L , S and J ?

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Discuss the fine structure of sodium D line. Draw D_1 and D_2 lines due to the transitions between 2P and 2S levels.

25

2013

Q2:

A sample of a certain element is placed in a magnetic field of flux density 0.3 tesla. How far apart is the Zeeman component of a spectral line of wavelength 4500 Å ? Given : $e/m = 1.76 \times 10^{11}$ c/kg, $c = 3.0 \times 10^8$ ms⁻¹.

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2014

Q3:

Obtain an expression for the normal Zeeman shift. Illustrate the Zeeman splitting of spectral lines of H atom and the allowed transitions for the $l = 1$ and $l = 2$ states.

2014

Q4:

What is Zeeman effect ? How can it be understood on the basis of quantum mechanics ?

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2015

Q5:

Obtain Zeeman splitting for sodium D-lines.

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2015

Q6:

Find the magnetic moment of an atom in $3P_2$ state, assuming that LS coupling holds for this case.

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2015

Q7:

Compute the allowed spectral terms for two non-equivalent p-electrons on the basis of Pauli's exclusion principle.

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2016

Q8:

Explain in detail L-S coupling and j-j coupling schemes.

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2016

Q9:

Describe the importance of *L-S* and *J-J* coupling in atomic spectroscopy. What are experimental evidences of their existence?

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2018

Q10:

What is Zeeman effect? Discuss the factors on which Larmor frequency is dependent.

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2018

Q11:

Describe normal and anomalous Zeeman effect. Explain how it lifts the degeneracy in hydrogen atom.

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2019

Q12:

Determine the normal Zeeman splitting of the cadmium red line of 6438 Å, when the atoms are placed in a magnetic field of 0.009 T.

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2020

Q13:

What is Zeeman effect? Explain Zeeman effect on the basis of classical electron theory.

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2020

Q14:

Find the minimum magnetic field needed for the Zeeman effect to be observed in a spectral line of 400 nm wavelength when a spectrometer whose resolution is 0.010 nm is used. Write the answer in the nearest high integer. 10

2021

Q15:

Calculate the Larmor precessional frequency for a magnetic induction field of 0.5 T. Hence calculate the splitting in wave numbers of a spectral line due to normal Zeeman effect for the same field. 10

2021

Q16:

The quantum numbers of two electrons in a two valence electron atom are;

$$n_1=8 \quad l_1=4 \quad s_1=\frac{1}{2}$$

$$n_2=7 \quad l_2=2 \quad s_2=\frac{1}{2}$$

(i) Assuming L - S coupling, find the possible value of L and hence of J .

(ii) Assuming j - j coupling, find the possible values of J . 7+8

2021

Q17:

Describe normal and anomalous Zeeman effect. Explain how it lifts the degeneracy in hydrogen atom. 20

2021

Q18:

Show that the Landé g -factor for pure orbital angular momentum and pure spin angular momentum are 1 and 2 respectively. Further, evaluate the g -factor for the state 3P_1 . 10

2022

Q19:

- (i) Show that for a given principal quantum number n , there are n^2 possible states of the atom.
- (ii) An atomic state is denoted by ${}^4D_{5/2}$. Find the values of L , S and J . For this state, what should be the minimum number of electrons involved? Suggest a possible electronic configuration.

7+8=15

2022

Q20:

If an atom is placed in a magnetic field of strength 0.1 weber/m^2 , then calculate the rate of precession and torque on an electron with $l = 3$ in the atom.

Given that the magnetic moment of the electron makes an angle of 30° with the magnetic field.

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2023

Q21:

What is Lande's g factor? Evaluate the Lande's g factor for the 3P_1 level in the $2p3s$ configuration of the ${}^6\text{C}$ atom. Also calculate the splitting of the level when the atom is placed in an external magnetic field of 0.1 tesla .

5+5+5=15

2023

Q232.

Differentiate between L-S coupling and J-J coupling.

What are the possible orientations of $\vec{J}$ for the $J = \frac{3}{2}$ and $J = \frac{1}{2}$ states that correspond to $l = 1$?

5+10=15

2024

Q23.

The quantum numbers of two electrons in a two-valence electron atom are

$$n_1 = 6, \quad l_1 = 3, \quad s_1 = \frac{1}{2}$$

$$n_2 = 5, \quad l_2 = 1, \quad s_2 = \frac{1}{2}$$

Assuming L-S coupling, find the possible values of L and J .

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2025

Q24.

Draw the normal Zeeman pattern for ${}^1F_3 - {}^1D_2$ transition.

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2025