

Molecular Physics

Tutorial 2: Importance of neutral hydrogen atom, molecular hydrogen and molecular hydrogen ion in astronomy; Fluorescence and Phosphorescence; Elementary theory and applications of NMR and EPR; Elementary ideas about Lamb shift and its significance.

Q1:

What do you understand by H-one (HI) interstellar clouds and their importance to understand the universe. 10

2013

Q2

- (a) With proper selection rules, construct the energy level diagram and allowed transitions for ESR spectrum of hydrogen atom. 10
- (b) Why are Raman scattering experiments important? 30

2013

Q3:

Explain how the nuclear spin I depends on the mass number A and atomic number Z of atoms. 10

2014

Q4:

- (i) Obtain an expression for the resonance condition in NMR. 10
- (ii) Explain the relaxation processes in NMR spectroscopy. 10

2014

Q5:

What is Lamb shift? What is its significance in determining the fine structure of H_{α} Balmer line in hydrogen atom? 10

2016

Q6:

State Franck-Condon principle. Define Franck-Condon factors. Using schematic diagram, explain the decay of excited states leading to the phenomena of fluorescence and phosphorescence. 20

2017

Q7:

Explain the principle of Nuclear Magnetic Resonance (NMR) with the help of an energy level diagram. Give examples of nuclei which exhibit NMR. What major inferences can be drawn from an NMR spectra ?

20

2017

Q8:

In an NMR experiment, hydrogen atoms are subjected to a magnetic field of 5.0 T. Determine the difference in energy (kJ/mol) between two spin states of the nuclei of hydrogen atom and the frequency of radiation required for NMR.

15

2017

Q9:

Discuss the fine structure of hydrogen spectrum. How is it of importance in the astronomical observations?

15

2018

Q10:

What is nuclear precession? How is it used in the principle of working of an NMR?

10

2018

Q11:

Discuss the theory of rotational and vibrational spectra of diatomic molecules. What is the difference between fluorescence and phosphorescence?

20

2018

Q12:

What is Lamb shift? Discuss its significance in determining the fine structure of H_{α} Balmer line in hydrogen atom.

15

2019

Q13:

Write the principle of nuclear magnetic resonance (NMR). Explain the design and working of NMR, and write its important applications.

20

2020

Q14:

Calculate the magnetic field strength required to observe the NMR spectrum of protons in benzene at 120 MHz. [Given the value of nuclear g -factor g_N for protons is 5.585] 10

2022

Q15:

What is nuclear magnetic resonance? Explain its working principle and use in magnetic resonance imaging systems. 5+5+10=20

2023

Q16.

Explain how the hydrogen spectrum is used for imaging the universe. 10

2024

Q17.

What is Lamb shift in the fine structure of hydrogen spectrum? Discuss its theory based upon second quantization. 8+7=15

2024

Q18.

Describe Electron Paramagnetic Resonance. Highlight its differences with NMR and discuss its applications. 5+10=15

2024

Q19.

Distinguish between fluorescence and phosphorescence. Explain the mechanisms responsible for these phenomena. Discuss the applications of fluorescence and phosphorescence in the fields such as biochemistry, material science, etc. 15

2025