Total No. of printed pages = 4

63/2 (SEM-1) CHM 104

2021

(held in 2022)

CHEMISTRY

(Theory Paper)

Paper Code : CHM-104

(Spectroscopy – I)

Full Marks – 80

Time – Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions :

   (a) State Frank-Condon principle and briefly explain the three typical situations of intensity distribution in absorption band. 2+3=5

   (b) Why we find broad bands in electronic spectra of metal complexes ? 2

   (c) Discuss selection rules in d-d transitions with relaxation. 3

[Turn over

(d) Write down the mechanism of Laser action. 5

Or

Write down the mechanism of Phosphorescence. 5

(e) How many charge transfer spectra are found in metal complexes ? How can you identify charge transfer bands ? Why the colour of $KMnO_4$ is purple ? 2+2+1=5

2. Answer the following questions :

(a) Which one is microwave active ? 1

(i) O_2 (ii) H_2

(iii) Br_2 (iv) HCl

(b) Write the selection rule for Roto-vibrational spectra. 2

(c) Mention few importance of rotational spectroscopy. 2

(d) How rotational spectroscopy may be used to calculate temperature of a surface ? 5

(e) What kind of shifting of lines in the spectrum do you observe for a particular molecule centrifugal distortion and isotopic substitution ? Explain with examples. 10

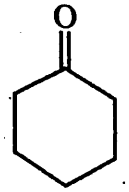
3. How do you calculate bond length in rotational spectroscopy ? Does CO_2 show pure rotational spectrum ? Explain briefly. 1+1+3=5

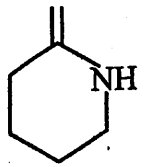
4. Answer the following questions :

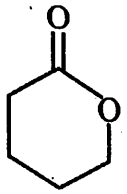
(a) Discuss the different mode of vibrations of IR spectroscopy. What is Hooke's law ? Explain its significance in IR spectroscopy. 2+3=5

(b) Explain the effect of ring strain on carbonyl stretching frequency with examples. 5

(c) Why ketones absorb at a lower frequency than aldehydes ? Arrange the following structures in order of their increasing C = O stretching frequency and explain why. 2+3=5

(i) 

(ii) 

(iii) 

downfield compared to those of acetylene. At what range (δ value) the benzene protons can be expected to appear in ^1H NMR spectrum ? 1+4=5

(b) Explain the factors that affect the chemical shift in NMR spectrum. 5

(c) What are chemically equivalent and non-equivalent protons ? What are shielding and deshielding in NMR spectroscopy ? Explain with examples. 2+3=5

(d) For an octahedral copper complex that shows z-in tetrahedral distortion, $g_\perp > g_\parallel$. Explain briefly why. What will happen to the order of g values if the complex shows z-out tetragonal distortion ? 2+3=5

(e) How many g values do you expect for a complex in frozen state that shows an axial spectrum ? Sketch the spectrum in both absorptive and first order derivative mode. Sketch both the absorptive and first order derivative mode of the ESR spectrum is recorded in solution state. 2+1+2=5

5. Answer any *four* of the following questions : 5×4=20

(a) Explain why benzene protons appear at a downfield compared to those of acetylene. At what range (δ value) the benzene protons can be expected to appear in ^1H NMR spectrum ? 1+4=5

(b) Explain the factors that affect the chemical shift in NMR spectrum. 5

(c) What are chemically equivalent and non-equivalent protons ? What are shielding and deshielding in NMR spectroscopy ? Explain with examples. 2+3=5

(d) For an octahedral copper complex that shows z-in tetrahedral distortion, $g_\perp > g_\parallel$. Explain briefly why. What will happen to the order of g values if the complex shows z-out tetragonal distortion ? 2+3=5

(e) How many g values do you expect for a complex in frozen state that shows an axial spectrum ? Sketch the spectrum in both absorptive and first order derivative mode. Sketch both the absorptive and first order derivative mode of the ESR spectrum is recorded in solution state. 2+1+2=5