International Institute of Information Technology, Hyderabad
End of Semester Examination: Monsoon 2024

SC1.102: CHEMISTRY TOPICS FOR ENGINEERS

Max. Time Allowed: 1.5 Hr | Max. Marks: 60

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Note:
1. Answer all questions. There are SIX questions.
2. Make appropriate assumptions where required.
3. Use of nonprogrammable scientific calculators is allowed.
4. Additional sheet for rough work is NOT allowed.

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Q1. (a) A signal has been reported to occur at 600 Hz downfield from TMS in an NMR spectrometer with a 300-MHz operating frequency. (i) What is the chemical shift of the signal? (ii) What would its chemical shift be in an instrument operating at 100 MHz? [1.5+1.5]

(b) The low-resolution NMR spectrum of 1-nitropropane showed three signals at 1.04 ppm, 2.07 ppm, and 4.37 ppm. Explain the observations. [2]

(c) Explain why (i) the ^{19}F-NMR spectrum of SF_4 consists of two 1:2:1 triplets of equal intensity and (ii) the ^{77}Se-NMR spectrum of SeF_4 consists of a triplet of triplets. (Given: ^{19}F, ^{77}Se, $I = ½$). [4]

(d) Mention one application of NMR spectroscopy in medical field. [1]

Q2. (a) How is the electron paramagnetic resonance (EPR) spectroscopy different from NMR spectroscopy? [4]

(b) What is 'hyperfine splitting' in EPR spectroscopy? [2]

(c) Discuss the hyperfine splitting of methoxymethyl radical, $H_2C(OCH_3)$. Include schematic diagram and comments on the coupled and non-coupled nuclei. [4]

Q3. (a) Describe the difference between a semiconductor and a semimetal. [3]

(b) An oxidation of graphite by heating graphite with a mixture of sulfuric and nitric acids gives intercalation compounds, graphite bisulfates with an approximate formula, $(C_{24})^+HSO_4^-$. Compare the conduction property of graphite bisulfates with that of graphite. Explain. [1.5]

(c) Which of the oxides WO_3, MgO, and CdO are likely to show p- or n-type extrinsic semiconductivity or insulating property? Why? [3]

(d) Describe the working principles of light-emitting diodes (LEDs). [2.5]

Q4. (a) Compare thermotropic and lyotropic liquid-crystals. Give one example (write name and draw structure) of one thermotropic and one lyotropic liquid-crystal molecule. [2,2]

(b) All molecules do not exhibit liquid crystalline property. List the criteria for a molecule to exhibit liquid crystalline property. [2]

(c) Mention two industrial applications of liquid crystals. Mention which liquid crystal phase (nematic/ smectic/cholesteric) is used for the applications you mentioned. [2]

(d) Often ionic substances are solids and a substance that is liquid at room temperature is likely to be a molecular substance. Name an ionic liquid (at room temperature). Suggest possible reasons for this ionic substance to exist in liquid state, not in solid state, at room temperature. [2]

Q5. (a) What are inorganic pigments? Write name and chemical formula of one white, one black, and one coloured inorganic pigment. [1,1.5]

(b) What is meant by high temperature superconductors (HTSs)? [1]

(c) Draw a plot to show the variation of resistance with temperature of a superconductor. [2]

(d) What are 'nanomaterials'? Why do nanomaterials show properties that are substantially different from their bulk counterparts? [1,2]

(e) What are quantum dots? Mention one application of quantum dots. [1.5]

Q6. (a) Name two conducting polymers and draw the structures of the polymers and their corresponding monomers. [3]

(b) Discuss the electrical conduction mechanisms in conducting polymers. [4]

(c) Mention two applications of conducting polymers. [1]

(d) Transition metals have higher melting points and higher hardness, whereas their neighbors like Cu, Ag, Au and Zn are soft and melt at low temperatures. Explain the observations using MO theory. [2]

*****End of Question Paper*****