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**ST. JOSEPH’S COLLEGE (AUTONOMOUS), BANGALORE – 27**

**M.Sc. CHEMISTRY- IV SEMESTER**

**SEMESTER EXAMINATION – JANUARY 2020**

**CHDE 0218 – CHEMISTRY OF MATERIALS**

**Time: 2 ½ hours Max. Marks: 70**

*This question paper has* ***two*** *printed pages and* ***three*** *parts*

**PART A**

Answer any **SIX** of the following: 2 x 6 = 12

1. What are ′materials′ in the context of chemistry of materials?
2. List the different modes in atomic force microscopy? Which of these is suitable for studying soft condensed matter?
3. Write the principle of electron energy loss spectroscopy.
4. What are metal organic frame work compounds? Give an example.
5. Explain giant magneto resistance with a suitable example.
6. What are the differences between Weyl and Dirac semimetals?
7. Why do nanoscale ferromagnetic solids exhibit superparamganetism?
8. When do you call a composite a nanocomposite? Give an example.

**PART B**

Answer any **FOUR** of the following: 12 x 4 = 48

9. (a) Discuss the instrumentation, sample preparation and applications of transmission electron microscopy.

(b) How are solid surfaces characterized using X-ray photoelectron spectroscopy? What are the typical information one can get from this characterization? (6 + 6)

10.(a) How are layered solids classified? Give an example for each class.

(b) What are 1:1 and 2:1 clays? Give an example for each.

(c) Explain polytypism in layered solids with suitable examples. (3 + 3 + 6)

11.(a) Give the principle and applications of extended x-ray absorption fine structure.

(b) Write the expression for the thermoelectric power factor, ZT. On the basis of this expression, list the criteria for a solid to be a good thermoelectric material.

(c) How are metal nanoparticles employed in biomedical applications? (5 + 4 + 3)

12.(a) Show, graphically, the variation of the following thermodynamic properties with temperature in superconductors: (i) entropy; (ii) specific heat. Also compare these thermodynamic properties with those of the metal in the normal state.

(b) Discuss, in brief, BCS theory of low temperature superconductivity.

(c) What are conducting polymers? Give two examples. Explain Peierls distortion in conducting polymers. (4 + 4 + 4)

13.(a) Discuss the application of nanomaterials in (i) water splitting; (ii) lithium ion batteries.

(b) Describe the following syntheses with a suitable example for each.

 (i) Solvothermal decomposition to form metal oxide nanoparticles.

 (ii) Solution based synthesis of metal nanoparticles.

 (iii) Solvent-free synthesis of transition metal dichalcogenide nanosheets. (6 + 6)

14.(a) Why are semiconductor nanoparticles called quantum dots? How are they employed in QD-LED television technology?

(b) Write a short note on nanotoxicity.

(c) What are carbon nanotubes (CNT)? How are single walled CNT classified? Give any two applications of CNT. (4 + 3 + 5)

**PART C**

Answer any **TWO** of the following: 5 x 2 = 10

15.(a) CuSO4‧5H2O, on heating, converts to CuSO4‧3H2O at 120 °C, CuSO4‧H2O at 200 °C, and CuSO4 at 270 °C with all the dehydration processes being endothermic. Plot the TG and DSC curves for this process.

(b) The powder X-ray diffraction Bragg reflections for a cubic solid occur at 2θ = 32.56, 39.90, 46.41, 52.27 and 57.71° when recorded using CuKα radiation (λ = 1.5418 Å). Calcualte the unit cell parameter(s) of the solid. (2 + 3)

16.(a) Zeolites are made of tetrahedral silicate building blocks. Identify any three builiding blocks other than silicate that would result in zeolite-like structures.

(b) 4 nm, 6 nm and 10 nm particles of a semiconductor emit red, green and blue light on excitation. Match the particles with the emitted colors. (3 + 2)

17. Design suitable synthesis in the following cases

(i) Au nanoparticles starting from HAuCl4.

(ii) Ag nanoparticles starting from a silver salt without using any chemical reagent.

(iii) ZnO nanoparticles starting from ZnCl2.

(iv) Graphene starting from a dispersion of GO layers.

(v) A heterostructure of MoS2 and WS2.

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