RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. THIRD SEMESTER EXAMINATION, MARCH 2022

SECOND YEAR [BATCH 2020-23]

Date : 02/03/2022 **INDUSTRIAL CHEMISTRY (HONOURS)**

Time : 11 am – 1 pm **Paper : V [CC5]** Full Marks : 50

Answer **any five** questions: [5×10]

1. a) Classify the different kind of engineering materials with examples. [3]
   b) Write the structure-property-application co-relationship of engineering materials for high performance applications. [5]
   c) Calculate the degree of polymerization if 6,6-nylon has a molecular weight of 120,000 g/mol. [2]

2. a) What is nanocystal? [3]
   b) Mention the different chemical & physical method employed to synthesize nanocystal. [5]
   c) When a fiber is made of PET, it has crystalline as well as amorphous phases and experiments have revealed that the average density of the overall material is 1.375 g/cc. It is known that the density of the crystalline phase is 1.455 g/cc and that amorphous phase is 1.335 g/cc. Calculate the mass fraction crystallinity (X) in %.

   [Given: $\rho c = 1.455$ g/cc, $\rho s = 1.375$ g/cc, $\rho a = 1.335$ g/cc] [2]

3. a) Write a note on composite material. [2]
   b) A uni directional C- fiber reinforced composite is made up of 30 volume % C-fiber, having a modulus of elasticity 320 Gpa, dispersed in polymer matrix which on hardening has a modulus of elasticity 3.5 Gpa. What will be the modulus of elasticity of the composite in longitudinal and transverse direction of the carbon fiber respectively. [2.5+2.5]
   c) A cemented carbide cutting tool used for machining contains 75 wt% WC, 15 wt% TiC, 5 wt% TaC, and 5 wt% Co. Estimate the density of the composite.

   [Given: The densities of the components of the composite are $\rho WC = 15.77$ g/cc, $\rho TiC = 4.94$ g/cc , $\rho TaC = 14.5$ g/cc , $\rho Co = 8.9$ g/cc] [3]

4. a) Write down the Hall-petch equation. [2]
   b) The lower yield point for an iron that has an average grain diammeter of 1*E-2 mm is 230 MPa. At a grain diameter of 6*E-3 mm, the yield point increases to 275 MPa. At what grain diameter will be the lower yield point 310 Mpa. [3]

σ_y	d (mm)	$d^{-1/2}$ $(mm)^{-1/2}$
230 MPa	$1*E^{-2}$	10.0
275 MPa	$6*E^{-3}$	12.91

   c) Draw different unit cells for seven crystal system. [5]

5. a) Find out the packing fraction of a DLC and HCP system. [3+4]

   b) For potassium chloride (KCl), (a) calculate the packing fraction for the compound.
   Given: rK+ = 0.134 nm and rcl- = 0.182 nm. [3]

6. a) What are the difference between reflection and diffraction? [5]

   b) The density of common salt (Nacl) is 2.14 g/cm3. Calculate the Bragg angle (θB) of diffraction for the (200) reflection using CuKα radiation (λ = 1.542 Aº). The atomic weight of Sodium and chlorine are 23 and 35.5 respectively. [5]

7. a) Classify the different nanostructures with examples. [5]

   b) The first peak in the powder x-ray diffraction pattern of an FCC metal (111) appears at a Bragg angle of 19.2° . The wave length of Cu-Kα radiation is used 0.154 nm

      i) Calculate the lattice parameter of the metal (in nm)?

      ii) The full width of at half maxima (FWHM) of the first peak is 0.35º. Ignoring the microstrain and instrumental broadening, Find out the crystallite size of the sample (in nm). [2.5+2.5]

8. a) The powder X-ray diffraction pattern from a material with cubic structure, the first five lines are at θ values (in degrees) 19.2, 22.3, 32.48, 39.02 and 41.13. Find out the crystal structure of the material. [3]

   b) Derive the mathematical expression of Schottky defect. [7]

——— × ———