RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. THIRD SEMESTER EXAMINATION, MARCH 2021

SECOND YEAR [BATCH 2019-22]

Date : 12/03/2021 **INDUSTRIAL CHEMISTRY [HONOURS]**

Time : 11 am - 1 pm **Paper : V [CC 5]** Full Marks : 50

Answer **any five** questions: [5 × 10]

1. a) Classify the different kind of engineering materials with examples.

   b) Write the structure-property-application co-relationship of engineering materials for high performance applications

   c) The average degree of polymerization of PVC is 2000. Calculate its average molecular weight in g/mol. [3+5+2]

2. a) What is nanocrystal?

   b) Mention the different chemical & physical method employed to synthesize nanocrystal.

   c) The density of a polymer (PET) sample is 1.407 g/cc and the density of the crystalline phase is 1.515 g/cc and of the amorphous is 1.335 g/cc. Calculate the fractional crystallinity is of the sample. [3+5+2]

3. a) Write a note on composite material.

   b) A unit directional C- fiber epoxy matrix composite contains 60 volume % C-fiber. The density of C-fiber is 1790 Kg/m^3 and that of the epoxy matrix is 1200 Kg/m^3. The tensile modulus of the C-fiber and the epoxy matrix are 340 GPa and 4.5 GPa respectively.

      i) Find out the density of composite in Kg/m^3.

      ii) Calculate the tensile modulus of the composite in GPa

   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] [2+(2.5+2.5)+3]

4. a) Write down the Hall-petch equation.

   b) The yield strength of mild steel with an average grain size of 0.05 mm is 137.9 MPa. The yield stress of the same steel with a grain size of 0.007 mm is 275.8 MPa. What will be the average grain size of the same steel with a yield stress of 206.9 MPa.

   c) Draw different unit cells for seven crystal system. [2+3+5]

5. a) Find out the packing fraction of a FCC and HCP system.

   b) Copper has an atomic radius of 0.127 nm, an FCC crystal structure, and an atomic weight of 63.5 g/mol. Determine the theoretical density. [(3+4)+3]

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

   b) The lattice parameter of α iron is 2.87 Å. If X-rays of wave length 0.71Å are used for X-ray diffraction,

      i) at what 2θ does the first order (220) plane reflections occurs?

      ii) The inter planner spacing d_{210} for Cu which has lattice parameter of 3.61 Å

      [Given: $a = 0.287$ nm , $\lambda = 0.071$ nm and hkl= 220] [4+(3+3)]

7. a) Classify the different nanostructures with examples.

   b) The X-ray diffraction pattern of a well annealed cubic material (lattice parameter, a= 4.2 Å) is taken using Cu-Kα radiation (λ = 1.54 Å)

      i) Find out the Bragg angle for (111) peak .

      ii) If the full width at half maxima (FWHM) of the above peak is 0.4^{o} . Ignoring the instrumental broadening, calculate the crystallite size of the material in Å. [5+(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 an 41.13. Find out the crystal structure of the material.

   b) Write short notes on Schottky defect, Frenkel defect, Edge dislocation and Grain boundaries. [2+(4×2)]

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