

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. SIXTH SEMESTER EXAMINATION, JUNE 2022

THIRD YEAR [BATCH 2019-22]

INDUSTRIAL CHEMISTRY (HONOURS)

Paper : XIV [CC14]

Date : 15/06/2022

Time : 11 am – 1 pm

Full Marks : 50

Group : A

[Answer any two questions]

[2×10]

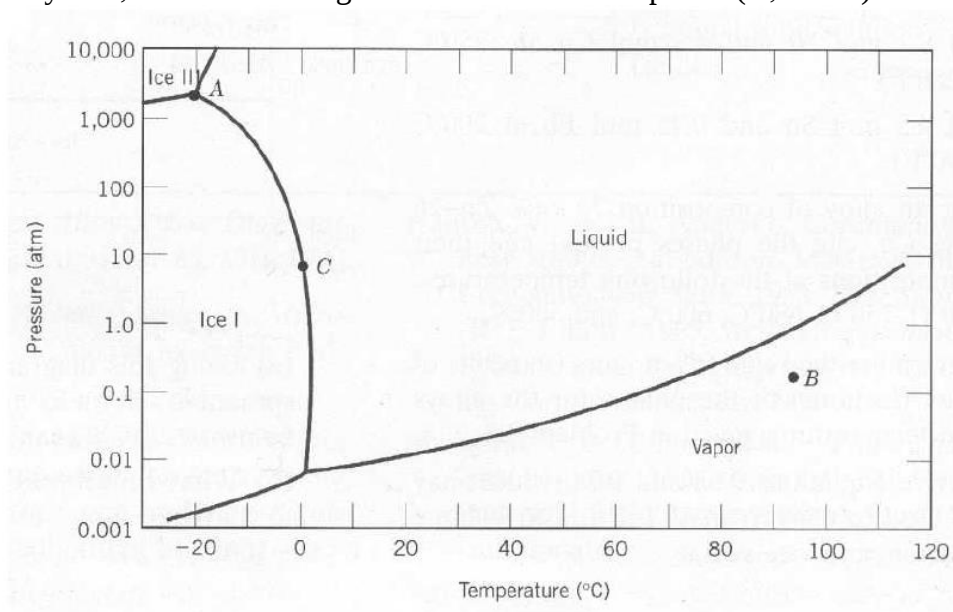
1. a) Using the Larson–Miller (LM parameter 24×10^3) data for the S-590 alloy, predict the time (days) to rupture for a component that is subjected to a stress of 140 MPa at 800 °C.
b) A relatively large plate of a glass is subjected to a tensile stress of 40 MPa. If the specific surface energy and modulus of elasticity for this glass are 0.3 J/m² and 69 GPa, respectively, determine the maximum length (μm) of a surface flaw that is possible without fracture. [5+5]
2. Derive the Vickers Hardness Number ($VHN = 1.8544 P/d^2$). [10]
3. a) A glass plate contains an atomic-scale surface crack. (Take the crack tip radius is equal to the diameter of an O²⁻ ion.) Given that the crack is 1 μm long and the theoretical strength of the defect-free glass is 7.0 GPa, calculate the breaking strength (MPa) of the plate. [Given radius, $r_{O^{2-}} = 0.132$ nm]
b) What are the differences between engineering stress and strain and true stress and strain? [6+4]

Group : B

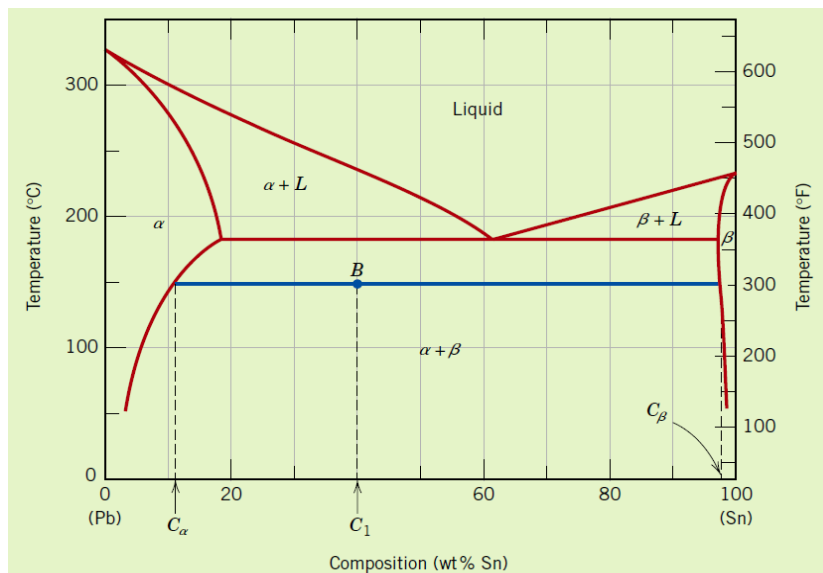
[Answer any three questions]

[3×10]

4. a) In water system, calculate the degree of freedom of each points (A, B & C) [3+(3+4)]



- b) Calculate the relative amount of each phase present in terms of (i) mass fraction and (ii) volume fraction. At 150 °C take the densities of Pb and Sn to be 11.23 and 7.24 g/cm³, respectively.



5. **Common Data for Questions (a) and (b):** A plain 0.45 wt.% carbon steel is cooled slowly from 900°C to just below the eutectoid temperature (723°C) so that the following reaction occurs:
 γ (0.8 wt.% C) $\leftrightarrow$ α (0.02 wt.% C) + Fe_3C (6.67 wt.% C)
- (a): Find the volume % of pearlite for the steel just below 723°C for 0.45 wt.% carbon steel.
- (b): During cooling from 900°C to 723°C, the proeutectoid α forms from γ . Find the volume fraction of proeutectoid α just below 723°C for the steel. [5+5]
6. In a homogeneous nucleation system, derive the critical radius r^* and the activation free energy ΔG^* in terms of latent heat of fusion. [10]
7. a) At atmospheric pressure (pressure arbitrarily chosen), a material of unknown composition shows four phases in equilibrium at 987 K. What is the minimum number of components in the system?
- b) At 900°C, growth rate is a dominant term in the crystallization of a copper alloy. By dropping the system temperature to 400°C, the growth rate drops six orders (10^6) of magnitude and effectively reduces the crystallization rate to zero. Calculate the activation energy (kJ/mol) for self-diffusion in this alloy system. [3+7]
8. a) The fraction recrystallized-time data for the recrystallization at 600°C of previously deformed steel are tabulated here. Assuming that the kinetics of this process obey the Avrami relationship. Determine the fraction recrystallized after a total time of 22.8 min.

Fraction Recrystallized	Time (min)
0.20	13.1
0.70	29.1

- b) Write all necessary equations (only equation) to reach the overall transformation rate for a homogeneous nucleation system. [6+4]

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