

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION)

CLASS: IMSc  
& MSc  
BRANCH: Chemistry

SEMESTER : IMSc  
VIII & MSc II  
SESSION : SP/22

SUBJECT: CH411 Equilibrium, Non-equilibrium & Statistical Thermodynamics

TIME: 2Hours

FULL MARKS: 50

**INSTRUCTIONS:**

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
  2. Attempt all questions.
  3. The missing data, if any, may be assumed suitably.
  4. Before attempting the question paper, be sure that you have got the correct question paper.
  5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
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- Q.1(a) Write down the different statements of 1<sup>st</sup> law of thermodynamics mathematical as well as energy conservation form. Consider an ideal gas that occupies 1.00 dm<sup>3</sup> at a pressure of 2.00 bar. If the gas is compressed isothermally at a constant external pressure,  $p_{ext}$ , so that the final volume is 0.500 dm<sup>3</sup>, what is the smallest value  $p_{ext}$  can have? Calculate the work involved using this value of  $p_{ext}$ . Solve the problem with proper reasons wherever required. [5]
- Q.1(b) Using the combined form of the 1<sup>st</sup> law and 2<sup>nd</sup> law of thermodynamics and appropriate maxwell relations, derive the two thermodynamics equations of state from [5]
- (1)  $dU=TdS-PdV$
- (2)  $Dh=TdS+VdP$
- Q.2(a) Define free energy. How does the free energy vary with temperature? [5]
- Q.2(b) What is the chemical potential? How does it vary with temperature. Show it graphically also. [5]
- Q.3(a) A class of 7 students is given a quiz worth upto 10 points. The individual scores are 7,9,9, 4,2, 10 & 8. What is the average score on the quiz by probability method? [5]
- Q.3(b) Explain Ensemble, Canonical, Grand Canonical and microcanonical ensembles, microstate, and macrostate. [5]
- Q.4(a) Derive rotational partition function  $q_{rot}$  in terms of moment of Inertia, thermal energy,  $KT$  and  $h$ . [5]
- Q.4(b) Write notes on (i) Dipole - dipole interactions (ii) Induced dipole- induced dipole interactions. [5]
- Q.5(a) What are the various transport processes. Write their phenomenological equations. [5]
- Q.5(b) Describe in detail Onsager reciprocal relation for analyzing couple irreversible flow. [5]

:::::04/05/2022 E:::::