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

CLASS: B.TECH **SEMESTER: III**
BRANCH: CHEMICAL/CHEMICAL (P&P) **SESSION : MO/2019**

SUBJECT : CL201 THERMODYNAMICS

TIME: 2:00 HOURS **FULL MARKS: 25**

INSTRUCTIONS:
1. The total marks of the questions are 25.
2. Candidates may attempt for all 25 marks.
3. Before attempting the question paper, be sure that you have got the correct question paper.
4. The missing data, if any, may be assumed suitably.

Q1 A horizontal piston/cylinder arrangement is placed in a constant-temperature bath. The piston slides in the cylinder with negligible friction, and an external force holds it in place against an initial gas pressure of 14 bar. The initial gas volume is 0.03 m^3. The external force on the piston is reduced gradually, and the gas expands isothermally as its volume doubles. If the volume of the gas is related to its pressure so that the product *PV* is constant, what is the work done by the gas in moving the external force? How much work would be done if the external force were suddenly reduced to half its initial value instead of being gradually reduced? [5]

Q2 (a) With the help of virial equation of state, derive [2]

$$B' = \frac{B}{RT}$$

Q2 (b) Calculate the work of mechanically, reversible, isothermal compression of 1 mol of methyl chloride from 1 bar to 55 bar at 373 K based on the following form of the virial equation: [3]

$$Z = 1 + B'P$$

B (virial coefficient) for Methyl chloride at 373 K = -242.5 cm^3mol^{-1}.

Q3 (a) A heat engine receives reversibly 420 kJ/cycle of heat from a source at 327 °C and rejects heat reversibly to sink at 27 °C. There are no other heat transfers. For each of the three hypothetical amounts of heat rejected, in (a), (b), and (c) below, compute the cyclic integral of dQ/T. From these results show which case is irreversible, reversible and impossible: (a) 210 kJ/cycle rejected, (b) 105 kJ/cycle rejected, (c) 315 kJ/cycle rejected. [2]

Q3 (b) An insulated tank (V = 1.6628 L) is divided into two equal parts by a thin partition. On the left is an ideal gas at 100 kPa and 500 K; on the right is a vacuum. The partition ruptures with a loud bang. (a) What is the final temperature in the tank? (b) what is the ΔS_{univ} for the process? [3]

Q4 One mole of an ideal gas, C_P = (7/2) R and C_V = (5/2) R, is compressed adiabatically in a piston/cylinder device from 2 bar and 25 °C to 7 bar. The process is irreversible and required 35% more work than a reversible, adiabatic compression from the same initial state to the same final pressure. What is the entropy change of the gas? [5]

Q5 Derive expression for residual properties: G^R/RT and H^R/RT using the truncated form of virial equation of state: Z = 1 + BP/RT, where R = Universal gas constant and B = second virial co-efficient. [5]

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