BPHE-106/PHE-06

ASSIGNMENT BOOKLET
Bachelor's Degree Programme (B.Sc.)

THERMODYNAMICS AND STATISTICAL MECHANICS

Valid from January 1, 2021 to December 31, 2021

It is compulsory to submit the Assignment before filling up the Term-End Examination Form.

Please Note

- **You can take electives (56 or 64 credits) from a minimum of TWO and a maximum of FOUR science disciplines, viz. Physics, Chemistry, Life Sciences and Mathematics.**
- **You can opt for elective courses worth a MINIMUM OF 8 CREDITS and a MAXIMUM OF 48 CREDITS from any of these four disciplines.**
- **At least 25% of the total credits that you register for in the elective courses from Life Sciences, Chemistry and Physics disciplines must be from the laboratory courses. For example, if you opt for a total of 64 credits of electives in these 3 disciplines, at least 16 credits out of those 64 credits should be from lab courses.**
- **You cannot appear in the Term-End Examination of any course without registering for the course. Otherwise, your result will not be declared and the responsibility will be yours.**

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068

2021

Dear Student

We hope you are familiar with the system of evaluation to be followed for the Bachelor's Degree Programme. At this stage you may probably like to re-read the section on assignments for Elective Courses in the Programme Guide that we sent you after your enrolment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation, which consists of **one tutor-marked assignment (TMA)** for this 4-credit course. **Submit your assignment response at your Study Centre.**

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully:

1) On top of the first page of your TMA answer sheet, please write the details exactly in the following format:

ENROLMENT NO. : ……

NAME : ……

ADDRESS : ……

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COURSE CODE : ……..

COURSE TITLE : ……..…….

ASSIGNMENT NO. : ……..…

STUDY CENTRE : ……..……. DATE : ….……

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAYS.

2) Use only foolscap size good quality writing paper (but not of very thin variety) for writing your answers.

3) Leave 4 cm margin on the left, top and bottom of your answer sheet.

4) Your answers should be precise and in your own words.

5) While solving problems, clearly indicate the question number along with the part being answered. Write units at each step of your calculations as done in your study material. Marks will be deducted for not adhering to this practice. Take care of significant digits in your work. Recheck your work before submitting it.

6) **This assignment will remain valid from January 1, 2021 to December 31, 2021**. However, you are advised to submit it within **12 weeks** of receiving this booklet to accomplish its purpose as a teaching-tool.

We strongly feel that you should retain a copy of your assignment response to avoid any unforeseen situation and append, if possible, a photocopy of this booklet with your response.

We wish you good luck.

Tutor Marked Assignment
THERMODYNAMICS AND STATISTICAL MECHANICS

Course Code: BPHE-106/PHE-06
Assignment Code: BPHE-106/PHE-06/TMA/2021
Max. Marks: 100

Note: Attempt all questions. Symbols have their usual meanings. The marks for each question are indicated against it.

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1. a) Calculate the probability that the speed of a chlorine molecule will lie between 200 m s^{-1} and 220 m s^{-1} at 300 K. Given that mass of chlorine molecule = 70u, $k_B = 1.38 \times 10^{-23}$ JK^{-1} and $N_A = 6.02 \times 10^{26}$ $kmol^{-1}$. (5)

   b) Calculate the temperature at which the root mean square velocity of a chlorine molecule will be equal to its escape velocity from the earth's gravitational field. Given that the radius of earth is 6400 km. (5)

   c) For a given gas the coefficient of viscosity is 1.9×10^{-5} N s m^{-2} and the diffusion coefficient is 1.2×10^{-5} $m^2 s^{-1}$. Calculate the density and mean free path at average molecular velocity of 380 m s^{-1}. (5)

   d) Define degree of freedom of a molecule. Write its general formula. Calculate the degree of freedom for a single atom. (5)

   e) Write van der Waal's equation of state and using this equation obtain critical constants. (5)

2. a) Define the following terms with example:

   i) Intensive and Extensive variables, ii) Quasistatic process, iii) Isochoric process iv) Adiabatic boundary, v) Irreversible process (5)

   b) Prove that for a *PVT* system:

   $$\frac{dV}{V} = \alpha\, dT - \beta_T\, dp$$

   where α = isobaric coefficient of volume expansion, β_T = isothermal compressibility. (5)

   c) A resistor initially at 300 K has a heat capacity of 10 J K^{-1}. It is thermally insulated from its surrounding and is connected to a battery from which it takes 1200 J through an electric current. Calculate the change in entropy of (i) the resistor, (ii) the surroundings. (5)

   d) Calculate the work done during an adiabatic expansion of an ideal gas from volume V_i to V_f. (5)

   e) One gram mole of a monoatomic perfect gas $\left(\gamma = \frac{5}{3}\right)$ at 27°C is adiabatically compressed from an initial pressure of 1 atm to final pressure of 50 atm. Calculate the resulting final temperature. (5)

3. a) A Carnot's engine whose low temperature reservoir is at 7°C has an efficiency 50%. By how many degrees should the temperature of the high temperature reservoir be increased to increase the efficiency to 70%? (5)

   b) Derive Clausius-Clapeyron equation and explain its significance. (5)

   c) Distinguish between the first and second order phase transitions. (5)

   d) What is adiabatic demagnetization? Explain the variation of entropy of a paramagnetic salt with temperature and magnetic field. (5)

   e) Using the Maxwell's relations, obtain the energy equations. (5)

4. a) Establish the relation $S = k \ln W$ between Thermodynamic probability (W) and entropy (S). (5)

   b) What is a Gibbs paradox? How can it be resolved? (5)

   c) Explain the phenomenon of Fountain effect exhibited by He II using the Bose Einstein treatment. (5)

   d) Derive an expression for Planck's law of black body radiation. Use this law to obtain Wien's displacement law and Stefan's law. (10)

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