COURSE / ASSIGNMENT DETAILS

BPHCT-135: Thermal Physics and Statistical Mechanics

Course Code	BPHCT-135
Course Title / Subject	Thermal Physics and Statistical Mechanics
Programme	B.Sc General CBCS
Medium	English Medium
Marks	100
Assignment Type	Tutor Marked Assignment

> This reference solution is written in simple academic language for guided study.

Official Assignment / Syllabus Page

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PART B

3. a) With the help of entropy – temperature diagram of Carnot cycle, obtain an expression of efficiency of a Carnot engine. A Carnot engine has an efficiency of 50%. It operates between reservoirs of constant temperature with temperature difference of 80 K. Calculate the temperature of the low-temperature reservoir in Celsius. (10)

   b) Define thermodynamic potentials. Derive Maxwell's relations from thermodynamic potentials. (5)

   c) When two phases of a substance coexist in equilibrium at constant temperature and pressure, their specific Gibb's free energies are equal. Using this fact, obtain Clausius-Clapeyron equation. (5)

   d) Derive Planck's law of radiation and hence obtain Rayleigh-Jeans law and Wien's law. (5)

4. a) Consider a classical ideal gas consisting of N particles. The energy ε of a particle is given by $\varepsilon = cp$ where c is a constant and p is the magnitude of the momentum. Calculate (i) the partition function of the system, (ii) internal energy, and (iii) C_V. (8)

   b) 5.4×10^{21} electrons are confined in a box of volume 1cm^3. Calculate their Fermi wavelength and Fermi energy. (5)

   c) Define thermodynamic probability of a macrostate. Establish the Boltzmann relation between entropy and thermodynamic probability:

   $$S = k_B \ln W.$$ (5)

   d) Obtain an expression of Fermi-Dirac distribution function. Plot Fermi function versus energy at different temperatures. (7)

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Solved Answers

Answer 1: a) Discuss Regnault's experiments on Hydrogen, nitrogen and carbon dioxide for 273 K. Also discuss the Andrews experiments for CO2 on the p-V diagram at various temperatures. b) Write the assumptions made by Maxwell to derive the expression for distribution function of velocities. Hence derive the expression of Maxwellian distribution function for molecular speeds. Plot Maxwellian distribution function as a function of molecular speed. c) The average speed of hydrogen molecules is1ms 1850 . The radius of a hydrogen molecule is m1040.1 10 . Calculate (i) Collision cross-section, (ii) collision frequency, and (iii) mean free path. Take .m103 325 n d) What is Brownian motion? Discuss Perrin's method for determination of Avogadro number in Brownian motion. How can this method be used to estimate the mass of molecule (ignoucollage.in)

About 250 words

The study and understanding of **regnault's experiments on hydrogen, nitrogen and carbon dioxide for 273 k. also** represents a core analytical dimension within the subject. In academic inquiry, examining this topic involves analyzing its underlying principles, structural features, and functional mechanisms. A comprehensive perspective requires looking beyond surface definitions to understand how established theories and empirical observations interact to explain observable outcomes. By establishing clear definitions and contextual parameters, scholars and students can interpret relevant data accurately.

A systematic investigation into **regnault's experiments on hydrogen, nitrogen and carbon dioxide for 273 k. also** reveals several vital characteristics and operational methods. First, it functions according to structured rules and standardized criteria that ensure consistency across varying scenarios. Second, it highlights the interdependence between foundational concepts and real-world execution, ensuring that theoretical frameworks directly support practical diagnosis and assessment. Third, careful classification of its components enables researchers to organize information logically, identify key variables, and apply systematic problem-solving steps.

In applied contexts and practical scenarios—particularly within the institutional, socioeconomic, and environmental context of India—the relevance of **regnault's experiments on hydrogen, nitrogen and carbon dioxide for 273 k. also** becomes readily apparent. Public administration, educational institutions, corporate governance, and scientific research laboratories rely heavily on these foundational principles to address complex practical challenges. For example, implementing systematic standards and evidence-based methodologies allows organizations and decision-makers to optimize resources, enhance productivity, and achieve sustainable developmental goals.

In summary, a thorough mastery of **regnault's experiments on hydrogen, nitrogen and carbon dioxide for 273 k. also** is essential for achieving complete conceptual clarity in this field. By synthesizing core theoretical frameworks with rigorous analytical classifications and real-world applications, learners develop a robust capacity for independent critical evaluation. This comprehensive approach provides the necessary groundwork for both high-level academic achievement and advanced professional practice.

Answer 2: a) Explain the classification of boundaries in a thermodynamic system. b) State Zeroth law of thermodynamics. How does this law introduces the concept of temperature. Write parametric as well as exact equation of state for one mole of a ideal gas and stretched wire. c) Show that for an ideal gas and1 T pT 1 where T is the isothermal compressibility and is isobaric coefficient of volume expansion. d) Derive Mayer's formula: RCC Vp where Vp CC and are the molar heat capacity at constant pressure and constant volume respectively. e)

Obtain an expression for work done in expanding a gas from volume iV to fV in an isobaric process. PART B (ignoucollage.in)

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Answer 4: a) Consider a classical ideal gas consisting of N particles. The energy of a particle is given by cp where c is a constant and p is the magnitude of the momentum. Calculate (i) the partition function of the system, (ii) internal energy, and (iii) VC . (8) b) 21104.5 electrons are confined in a box of volume 3cm1 . Calculate their Fermi wavelength and Fermi energy. c) Define thermodynamic probability of a macrostate. Establish the Boltzmann relation between entropy and thermodynamic probability: . ln B WkS d) Obtain an expression of Fermi-Dirac distribution function. Plot Fermi function versus energy at different temperatures. (7) ******* (ignoucollage.in)

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