C 20224 (Pages : 3) Name...

Reg. No.....................................

SIXTH SEMESTER (CUCBCSS—UG) DEGREE EXAMINATION, MARCH 2022

Physics/Applied Physics

PHY 6B 10/APY 6B 11—THERMAL AND STATISTICAL PHYSICS

(2014 to 2018 Admissions)

Time : Three Hours Maximum : 80 Marks

Symbols used in this question paper have their usual meanings.

Section A (Answer in a word or phrase)

*Answer **all** questions.*
Each question carries 1 mark.

1. For an adiabatic process, the ———— of the system remains constant.

2. The source of a Carnot's engine can supply any amount of energy. (True *or* False)

3. The dimension of phase space for a single particle is ————.

4. An isochoric process is one in which ———— remains constant.

5. When heat is given to a system, its internal energy ————.

6. What is statistical probability ?

7. What is a canonical ensemble ?

8. What is a thermodynamic system ?

9. What are bosons ?

10. Explain the terms open system and closed system.

(10 × 1 = 10 marks)

Section B (Answer in a short paragraph three or four sentences)

*Answer **all** questions.*
Each question carries 2 marks.

11. Define entropy. Discuss the physical meaning of entropy.

12. Distinguish between microstates and macrostates.

13. Give the expressions for isothermal and adiabatic elasticity.

Turn over

14. Which are the *two* ways to represent the work done by the working substance in one complete cycle of a Carnot engine ?

15. State and explain the second law of thermodynamics.

16. Derive an expression for the work done in an isothermal process.

17. Explain the conditions under which FD statistics holds good.

$(7 \times 2 = 14 \text{ marks})$

Section C (Answer in a paragraph of about half a page to one page)

Answer any **five** *questions.*
Each question carries 4 *marks.*

18. Show that during a reversible adiabatic process, the entropy of the system remains constant.

19. Using Maxwell's thermodynamic relations, prove that for any substance, the ratio of the adiabatic and isothermal elasticities is equal to the ratio of the two specific heats.

20. What are the limitations of Maxwell-Boltzmann method ?

21. What is Bose-Einstein statistics ?

22. State the first law of thermodynamics. Express it mathematically and explain its physical significance.

23. Deduce the second latent heat equation of Clausius $C_2 - C_1 = (dL/dT) - (L/T)$ where C_1 and C_2 represent the specific heat of a liquid and its saturated vapour and L is the latent heat of the vapour.

24. State and explain the third law of thermodynamics.

$(5 \times 4 = 20 \text{ marks})$

Section D (Problems–write all relevant formulas. All important steps carry separate marks)

Answer any **four** *questions.*
Each question carries 4 *marks.*

25. Air at N.T.P is compressed to half of its volume. Calculate the change in its temperature.

26. A carnot's engine whose temperature of the source is 400 K takes 200 calories of heat at this temperature and rejects 150 calories of heat to the sink. What is the temperature of the sink ? Also calculate the efficiency of the engine.

27. 1 kg of water at 273K is brought in contact with a heat reservoir at 373K. What is the change in entropy of water as it reaches 373K ?

28. Prove that in a T-S diagram the slope of the isochoric curve is T/C_v and that of isobaric curve is T/C_p.

29. Calculate the change in temperature of boiling water when the pressure is increased by 27.12 mm of Hg. The normal boiling point of water at atmospheric pressure is 100ºC. Latent heat of steam = 537 cal/g and specific volume of steam = 1674 m^3.

30. Calculate the rms velocity of H_2 at 27ºC. Given $k = 1.38 \times 10^{-23}$ J/deg and mass of hydrogen molecule = 3.34×10^{-27} kg.

31. Using Maxwell's thermodynamic relations, prove that the ratio of the adiabatic to the isobaric coefficient of expansion is $1/(1-\gamma)$.

(4 × 4 = 16 marks)

Section E (Essays–Answer in about two pages)

Answer any **two** *questions.*
Each question carries 10 *marks.*

32. Derive Maxwell's four thermodynamic relations. Discuss the usefulness of these relations.

33. Define adiabatic process. Derive the equation for an adiabatic process of a perfect gas in terms of pressure, temperature and volume.

34. What is meant by Fermi energy of conduction electrons ? Derive an expression for the same.

35. What is T-S diagram ? What is its importance ? Find the expression for efficiency of a reversible Carnot's engine with the help of T-S diagram.

(2 × 10 = 20 marks)