

STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2015-16 & thereafter)

SUBJECT CODE: 15PH/MC/TS24

B.Sc. DEGREE EXAMINATION APRIL 2018
BRANCH III - PHYSICS
SECOND SEMESTER

COURSE : MAJOR – CORE
PAPER : THERMAL PHYSICS AND STATISTICAL MECHANICS
TIME : 3 HOURS. MAX. MARKS: 100

SECTION – A

ANSWER ALL QUESTIONS: (30 x 1 = 30)

I CHOOSE THE CORRECT ANSWER:

- Average energy of a Planck's oscillator is
a) $E = hv$ b) $E = nhv$ c) $E = mc^2$ d) $E = \frac{hv}{e^{hv/kT}-1}$
- Rayleigh-Jeans law of radiation
a) applies to smaller wavelengths b) applies to longer wavelengths
c) applies to all wavelengths d) does not apply to any wavelength
- Electromagnetic radiation is emitted by
a) all bodies at all temperatures b) all bodies at 100°C
c) all bodies at absolute zero d) only a few bodies at all temperatures.
- In Carnot's engine when heat is taken by a perfect gas from the hot source, the temperature of the source
a) decrease b) increase
c) first decrease and then increase d) remains constant
- Transfer of heat from a body at low temperature to a body at high temperature
a) is possible by keeping both bodies in contact
b) is impossible
c) is possible by doing external work
d) none of these
- The physics underlying the working of the refrigerator closely resembles the physics underlying
a) ice formation b) vaporization of water
c) heat engine d) vapor compression machine
- When water vapor condense into water its entropy
a) decreases b) increases c) first decreases and increases d) remains unchanged
- The expression connecting first and second law of thermodynamics is
a) $TdS=dV+PdU$ b) $TdS=dU+PdV$
c) $TdS=dU+2PdV$ d) none of the above
- Entropy is a measure of
a) available energy b) unavailable energy
c) perfect order d) disorder

10. Four thermodynamic potentials are
- Pressure, volume, temperature and internal energy function
 - Pressure, volume, internal energy and Helmholtz function
 - internal energy function, Helmholtz function, enthalpy and Gibb's function
 - none of these
11. The Clausius-Clapeyron equation is
- $\frac{dp}{dT} = \frac{L}{T(V_2 - V_1)}$
 - $\frac{dp}{dT} = \frac{T}{L(V_2 - V_1)}$
 - $\frac{dp}{dT} = TL(V_2 - V_1)$
 - none of these
12. In isothermal-isobaric process, Gibbs free energy (G) tends to be
- maximum
 - minimum
 - constant
 - zero
13. Using adiabatic demagnetization, the minimum temperature produced is
- 1 K
 - 10^{-4} K
 - 10^{-5} K
 - 10^{-3} K
14. The particles obeying Maxwell-Boltzmann statistics are
- Identical
 - identical and distinguishable
 - distinguishable
 - photons
15. The number of most probable macrostates for a system having odd number of particles is
- 1
 - 2
 - 3
 - 4

II FILL IN THE BLANKS:

16. Black body emits _____ spectrum.
17. Internal energy of the ideal gas depends only on _____.
18. The unit of entropy is _____.
19. In first T.ds equation the entropy of a pure substance is taken as a function of temperature and _____.
20. A combination of position space and _____ space is known as phase space.

III STATE WHETHER TRUE OR FALSE:

21. According to Wein's law, the radiation energy is proportional to $1/\lambda^5$.
22. For a system to be in thermal equilibrium there should be no temperature difference between the system and the surroundings.
23. The entropy of the system changes during the adiabatic process.
24. Maxwell's thermodynamic relation is given by $\left(\frac{\partial S}{\partial T}\right)_P = \left(\frac{\partial P}{\partial V}\right)_T$
25. The thermodynamical probability of a particular macro-state is equal to number of microstates corresponding to the macro-state.

IV ANSWER BRIEFLY:

26. State Stefan-Boltzmann law of radiation.
27. What is heat engine?
28. State third law of thermodynamics.
29. What are thermodynamic variables?
30. What is an ensemble?

SECTION – B**ANSWER ANY FIVE QUESTIONS:****(5 x 5 = 25)**

31. Calculate the radiant emittance of a black body at a temperature of i) 400 K ii) 4000 K. [$\sigma = 5.672 \times 10^{-8} \text{ M.K.S. units}$]
32. Show that Planck's radiation law reduces to Wien's law for shorter wavelength and Rayleigh-Jeans law for longer wavelengths.
33. A Carnot engine working as a refrigerator between 260 K and 300 K receives 500 calories of heat from the reservoir at the low temperature. Calculate the amount of heat rejected to the reservoir at the high temperature. Calculate also the amount of work done in each cycle to operate the refrigerator. (1 calorie = 4.2 Joules)
34. 1 gram of water at 293 K is converted into ice at -10°C at constant pressure. Heat capacity of one gram of water is 4.2 J/g.K and that of ice is 2.1 J/g.K. Heat of fusion of ice at $0^\circ \text{C} = 335 \text{ J/g}$. Calculate the total change in the entropy of the system.
35. A Carnot engine whose low temperature reservoir is at 7°C has an efficiency of 50 %. It is desired to increase the efficiency to 70 %. By how many degrees should the temperature of the high temperature reservoir be increased?
36. Use Maxwell's relations to obtain $C_p - C_v = R$ for an ideal gas.
37. Calculate the cooling produced by adiabatic demagnetisation of a paramagnetic salt as the field is reduced from 10,000 oersted to zero at initial temperature of 2K. (Given: Curie constant per gm. mol per c.c = $0.042 \text{ erg degree/gm oersted}^2$ and $C_H = 0.42 \text{ Joule gm}^{-1} \text{ deg}^{-1}$).

SECTION – C**ANSWER ANY THREE QUESTIONS:****(3 x 15 = 45)**

38. What is meant by a perfect black body? With a neat graph, explain the distribution of energy of a black body at different temperatures and discuss the important results.
39. a) Explain the terms (i) Isochoric process (ii) Isobaric process (iii) Cyclic process and (iv) Isothermal process.
b) Prove that adiabatic elasticity of a gas is γ times the isothermal elasticity.
40. What is T-S diagram? With the help of T-S diagram, obtain the expression for external work done and efficiency of a reversible Carnot's cycle.
41. Deduce Maxwell's four thermodynamic relations.
42. Discuss K. Onnes method for the liquefaction of helium. Explain the peculiar properties of helium II.
