B.Sc. DEGREE EXAMINATION, APRIL 2024
BRANCH III PHYSICS
SECOND SEMESTER
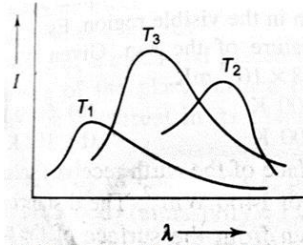
COURSE   : MAJOR CORE
PAPER   : THERMAL PHYSICS AND STATISTICAL MECHANICS
SUBJECT CODE: 23PH/MC/TS23
TIME   : 3 HOURS   MAX. MARKS: 100

Q. No.	SECTION A Answer ALL the questions 20 x 1 = 20 marks	CO	KL
1	The plots of intensity versus wavelength of three black bodies at temperatures T_1, T_2 and T_3 are shown in the figure below. Their temperatures are such that: _____ (a) $T_1 > T_2 > T_3$ (b) $T_1 > T_3 > T_2$ (c) $T_2 > T_3 > T_1$ (d) $T_3 > T_2 > T_1$	1	1
2	Under thermal equilibrium the temperature of a body ____ (a) increases with time (b) decreases with time (c) does not change with time and is the same at all points of the body (d) does not change with time but could be different at different points of the body.	1	1
3	The wavelength of the blackbody radiations depends on (a) The material of the body (b) The surface of the body (c) The temperature of the body (d) The cavity on the surface of the body	1	1
4	Which of the following is correct? (a) A body can be both a good absorber and a good reflector (b) A body cannot be both a good absorber and a good reflector (c) A body can be a good absorber (d) A body can be a good reflector	1	1
5	Which of the following is incorrect regarding the first law of thermodynamics? (a) It is the restatement of principle of conservation of energy (b) It is applicable to cyclic process (c) It introduces the concept of entropy (d) It introduces the concept of internal energy	1	1

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6	Which of the following statements is correct for any thermodynamic system?
	    (a) The internal energy changes in all processes
	    (b) Internal energy and entropy are state functions
	    (c) The change in entropy can never be zero
	    (d) The work done in an adiabatic process is always zero.
		1	1

7	"Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement as a consequence of
	    (a) Conservation of mass
	    (b) Conservation of momentum
	    (c) First law of thermodynamics
	    (d) Second law of thermodynamics
		1	1

8	A Carnot engine takes 3×10^6 cal. of heat from a reservoir at 627° C and gives it to a sink at 27° C. the work done by the engine is
	    (a) Zero (b) 4.2×10^6 J
	    (c) 8.4×10^6 J (d) 16.8×10^6 J
		1	1

9	An example for reversible process is
	    (a) Production of heat by friction
	    (b) Heat produced by the passage of current through a resistance
	    (c) Joule-Thomson effect
	    (d) Conversion of water at 0° C into ice at 0° C by removing certain quantity of heat
		1	1

10	The slope of an adiabatic is
	    (a) $(\gamma - 1)$ times the slope of isothermal
	    (b) $(\gamma + 1)$ times the slope of isothermal
	    (c) γ^2 times the slope of isothermal
	    (d) γ times the slope of isothermal
		1	1

11	Which of the following is correct?
	    (a) The entropy decreases if a system absorbs a quantity of heat at constant temperature
	    (b) The entropy increases if a system gives out a quantity of heat at constant temperature
	    (c) The change in entropy for an adiabatic process is zero
	    (d) The change in entropy for an adiabatic process is greater than zero
		1	1

12	If the steam engines A and B have their sources at 900K and 600K and their sinks at 450K and 300K respectively, then
	    (a) they are equally efficient
	    (b) A is less efficient than B
	    (c) A is more efficient than B
	    (d) their efficiencies cannot be determined
		1	1

13	For an isochoric adiabatic process, the internal energy of the system
	    (a) Remains constant (b) Zero
	    © Less than zero (d) Greater than zero
		1	1

14	The Helmholtz free energy of the system during isothermal isochoric process
	    (a) Zero (b) Remains constant
	    © Less than zero (d) Greater than zero
		1	1

15	In a reversible isobaric adiabatic process, the enthalpy (a) Zero (b) Less than zero © Remains constant (d) Greater than zero	1	1
16	The Gibb's function in an isothermal-isobaric process is (a) Zero (b) Less than zero © Greater than zero (d) Remains constant	1	1
17	Which of the following is correct regarding the statement "Helium is a unique liquid"? (a) It has the lowest critical temperature of all known gases (b) It has the lowest boiling point of 4.2 K at a pressure of 1 atmosphere (c) It has no triple point (d) All the above	1	1
18	The first law of thermodynamics is modified in the case of adiabatic demagnetization is (a) dQ = dU+PdV-BdI (b) dQ = dU-PdV-BdI (c) dQ = dU+PdV+BdI (d) dQ = dU-PdV-BdI	1	1
19	The total number of 'macro' and 'micro' states by distributing four particles in two compartments are (a) 4 and 15 (b) 4 and 16 © 5 and 15 (d) 5 and 16	1	1
20	Boltzmann's relation states that, in the equilibrium state, (a) The entropy is maximum if thermodynamic probability is minimum (b) The entropy is maximum if thermodynamic probability is maximum (c) The entropy is minimum if thermodynamic probability is maximum (d) All the above	1	1
Q. No.	**SECTION B** **Answer ALL the questions 10 x 2 = 20 marks**	CO	KL
21	Define coefficient of thermal conductivity.	2	2
22	What is solar constant?	2	2
23	What is the importance of the first law of thermodynamics?	2	2
24	It is impossible to construct a heat engine of 100% efficiency. Why?	2	2
25	How entropy changes in reversible and irreversible processes?	2	2
26	Write about heat death of universe.	2	2
27	Define Gibb's free energy.	2	2
28	Point out the applications of thermodynamic relations.	2	2
29	What is Joule-Kelvin effect?	2	2
30	What is Phase-Space?	2	2
Q. No.	**SECTION C** **Answer any TWO questions 2 × 20 = 40 marks**	CO	KL
31	(a) Draw and explain the T-S diagram.	3	3

	(b) Derive Planck's radiation law. Also deduce Wien's distribution law, Rayleigh-Jeans law, Stefan's law and Wien's displacement law.	4	4
32	(a) Explain the concept of heat using Zeroth law of thermodynamics.	3	3
	(b) Obtain Maxwell's thermodynamic relations.	4	4
33	(a) What principle is involved in the determination of thermal conductivity of a bad conductor? Explain Lee's method of determining thermal conductivity of a bad conductor.	3	3
	(b) Explain the theory and experiment for adiabatic demagnetization of a paramagnetic salt.	4	4
34	(a) Explain the statement that the absolute zero is unattainable from Nernst heat theorem.	3	3
	(b) Derive the Maxwell-Boltzmann distribution law for a system of 'N' distinguishable molecules of a gas.	4	4
Q. No.	**SECTION D** **Answer any FOUR questions 4 x 5 = 20 marks**	**CO**	**KL**
35	A quantity of an ideal gas at 17^0C is compressed to one tenth its initial volume, find the final temperature, if the gas is i) monoatomic ii) diatomic	5	5
36	Find the increase in the boiling point of water at 100°C when the pressure is increased by 1 atmosphere. Latent heat of vaporization of steam is 540 cal/g and 1 g of steam occupies a volume of 1677 cm^3.	5	5
37	50 g of water at 0°C is mixed with an equal mass of water at 80°C, calculate the resultant increase in entropy.	5	5
38	A Carnot's refrigerator takes heat from water at 0°C and discards it to a room temperature at 27°C. 1 kg of water at 0°C is to be changed into ice at 0°C. Calculate (i) Heat discarded to the room? (ii) Work done by the refrigerator (iii) Coefficient of performance of the machine	5	5
39	Use Stefan's law to show that the total radiant energy emitted by the sun per second is 3.95×10^{26} J. Also show that the rate at which energy is reaching the top of earth's atmosphere is 1.4 k Wm^{-2}. (Assume the sun to be a black body at temperature 5800 K)	5	5
40	An ice box is built of wood 1.75 cm thick. If the temperature of the inner surface of the cork is 0°C and that of the outer surface is 12°C, what is the temperature of the interface? (The thermal conductivity of wood and cork are 0.0006 and 0.00012 CGS units respectively)	5	5

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