

Reg. No. : .....

Name : .....

**Second Semester B.Sc. Degree Examination, September 2022**

**First Degree Programme under CBCSS**

**Physics**

**Core Course**

**PY 1241 : HEAT & THERMODYNAMICS**

**(2020 Admission Onwards)**

Time : 3 Hours

Max. Marks : 80

**SECTION – A**

Answer **all** questions in **one** or **two** sentences. Each question carries **one** mark :

1. Define Heat.
2. Name the method to find conductivity of poorly conducting material.
3. What is the value of Stefan-Boltzmann constant?
4. What is mean by isothermal process?
5. Define the term Thermal equilibrium.
6. What is entropy in thermodynamic system?
7. State Clausius theorem.
8. Which are the factors affecting solar constant?
9. What is the principle of Carnot engine?
10. Give the mathematical formula of first law of thermodynamics.

**(10 × 1 = 10 Marks)**

P.T.O.

## SECTION – B

Answer **any eight** questions: not exceeding a paragraph. Each question carries **two** marks.

11. How to find the thermal conductivity of powdered sample?
12. Define closed and open systems.
13. Explain thermodynamic process.
14. Distinguish Reversible and Irreversible Process.
15. Which are the different modes of heat transfer? Explain.
16. State Zeroth law of thermodynamics.
17. Explain Stefan's law.
18. Derive first law of thermodynamics for a closed system undergoing a change of state.
19. Define Heat capacity of a system.
20. What is Enthalpy of a thermodynamic system?
21. What are the limitations of first law of thermodynamics?
22. Define Heat engine and its efficiency.
23. State and explain Clausius statement.
24. Draw phase diagram.
25. Imagine a Carnot engine which is reversible and any other irreversible engine working between the same two reservoirs and adjusted so that they both deliver the same amount of work. Compare them.
26. Draw idealised diesel cycle for oil fired engine and write the expression for its efficiency.

(8 × 2 = 16 Marks)



## SECTION – C

Answer **any six** questions: not exceeding a paragraph. Each question carries **four** marks.

27. One end of a 0.25 m long metal bar is in steam and the other in contact with ice. It  $15 \times 10^{-3}$  kg of ice melts per minute, what is the thermal conductivity of the metal? Given cross section of the bar is  $7 \times 10^{-4} \text{ m}^2$  and latent heat of ice is 80 cal/kg.
28. One of the possible mechanisms of heat transfer in human body is conduction through body fat. Suppose that heat travels through 0.03 m of fat in reaching the skin, which has a total surface area of  $1.7 \text{ m}^2$  and a temperature of  $34^\circ\text{C}$ . Find the amount of heat that reaches the skin in half an hour, if the temperature at the body, interior is maintained at the normal value  $37^\circ\text{C}$ ? Thermal conductivity of body fat is  $k = 0.2 \text{ J/s.m.}^\circ\text{C}$ .
29. A square slab having a thickness of 4cm and measuring 25 cm on a side has a  $40^\circ\text{C}$  temperature difference between its faces. How much heat flow through it per hour? The conductivity  $K$  is  $0.0025 \text{ cal/s.cm.}^\circ\text{C}$ .
30. Calculate the change in entropy when 1gm of ice changes in to steam at  $T_s^\circ\text{K}$ .
31. Show that during a reversible isothermal expansion of an ideal gas from volume  $V_1$  to volume  $V_2$  the change of entropy is,  $\Delta S = \int_{V_1}^{V_2} \left( \frac{\partial P}{\partial T} \right)_V dV$ .
32. A Carnot type engine is designed to operate between 480K and 300K. Assuming that the engine actually produces 1.2kJ of mechanical energy per kilocalorie of heat absorbed, compare the actual efficiency with a theoretical maximum efficiency.
33. If the Carnot cycle is run backward, we have an ideal refrigerator. A quantity of heat  $Q_2$  is taken in at the lower temperature  $T_2$  and a quantity of heat  $Q_1$  is given out at the temperature  $T_1$ . The difference is the work  $W$  that must be supplied to run the refrigerator. Show that  $W = Q_2 \left( \frac{T_1 - T_2}{T_2} \right)$ .
34. An ideal Carnot engine takes heat from a source at  $371^\circ\text{C}$ , does some external work, and delivers the remaining energy to a heat sink at  $117^\circ\text{C}$ . If 500 k cal of heat is taken from the source, how much work is done? How much heat is delivered to the sink?

35. The gas is compressed from an initial state of  $0.53 \text{ m}^3$  and  $105 \text{ kPa}$  to a final state of  $0.14 \text{ m}^3$  and to the same pressure. Determine change in internal energy of a gas which transfers  $38 \text{ kJ}$  of heat.
36. In an engine, the charge is at  $105 \text{ kPa}$  and  $310 \text{ K}$  at the beginning of compression. It reaches  $2.5 \text{ MPa}$  after compression by following the law  $PV^\gamma = c$ . Calculate the temperature at the end of compression, compression ratio and work done.
37. A heat engine working on Carnot cycle converts one-fifth of the heat input into work. When the sink temperature is reduced by  $70^\circ\text{C}$ , the heat engine efficiency gets doubled. Determine temperature of source and sink.
38. An inventor claims to have developed a heat engine with specifications as follows; Power developed =  $76 \text{ kW}$ , Fuel burnt =  $4.8 \text{ kg/hr}$ , Heating value of fuel =  $73000 \text{ kJ/kg}$ , Temperature limits =  $980 \text{ K}$  and  $393 \text{ K}$ . How would you evaluate his claim is valid?

**(6 × 4 = 24 Marks)**

#### SECTION - D

Answer **any two** questions. Each question carries **15** marks.

39. Obtain an expression for the thermal conductivity of a cylindrical tube of internal radius  $r_1$  and external radius  $r_2$ . The temperature of the inner and outer surfaces are  $\theta_1$  and  $\theta_2$  respectively and the heat flow is radially out.
40. Define the terms Thermal reservoir, Heat engine, Heat pump and Refrigerator with suitable diagrams.
41. Deduce the expression for work done when a ideal gas undergoes expansion adiabatically and isothermally.
42. State and prove Clausius theorem.
43. Discuss the working of Otto engine.
44. (a) What are the corollaries of second law of thermodynamics?  
(b) Define Carnot heat pump with diagram.

**(2 × 15 = 30 Marks)**