

(Pages : 4)



P - 1246

Reg. No. : .....

Name : .....

Second Semester B.Sc. Degree Examination, September 2022

First Degree Programme Under CBCSS

Physics

Core Course

PY 1241 : HEAT AND THERMODYNAMICS

(2018 & 2019 Admission)

Time : 3 Hours

Max. Marks : 80

SECTION - A

Answer **all** questions in **one** or **two** sentences. Each question carries 1 mark.

1. State first law of thermodynamics.
2. Express Clausius inequality.
3. What is the unit of entropy?
4. State Weidmann and Franz law.
5. In a thermodynamic process  $dU = -dW$ , then process is:
6. In diesel engine the combustion of fuel takes place at constant \_\_\_\_\_.
7. Write down the equation for the change in entropy when a liquid at its boiling point is converted to its vapour at the same temperature.
8. Find the efficiency of a heat engine that absorbs 2000 J of energy from a hot reservoir and exhausts 1500 J to a cold reservoir.

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9. Can you design a heat engine with 100% efficiency?
10. Give an example for second order phase transition.

(10 × 1 = 10 Marks)

### SECTION – B

Answer any eight questions, not exceeding a paragraph. Each question carries 2 marks.

11. Explain how temperature of Sun is calculated from the solar constant.
12. Discuss the relation between entropy and disorder.
13. Sketch indicator diagram of isothermal and adiabatic process. Indicate the steepness of the curve.
14. Formulate second law of thermodynamics in terms of entropy.
15. Explain why the temperature of a gas drops in adiabatic expansion.
16. Which is more effective way to increase the efficiency of Carnot engine (a) Increase  $T_1$  keeping  $T_2$  constant (b) decrease  $T_2$  keeping  $T_1$  constant? Give the reason.
17. Explain Nernst heat theorem.
18. State and explain Kelvin statement of second law of thermodynamics.
19. Explain change in entropy during reversible process.
20. Briefly explain the principle of refrigerator.
21. Sketch PV diagram of Otto engine and mark process involved.
22. Write the expression for thermal conductivity of bad conductor determined by Lee's disc method. Explain the terms involved.

(8 × 2 = 16 Marks)

## SECTION – C

Short Essay Questions (Not to exceed 120 words). Answer any six questions. Each question carries 4 marks.

23. A steam engine works between a hot reservoir at  $100^{\circ}\text{C}$  (373 K) and cold reservoir at  $0^{\circ}\text{C}$  (273 K).
- (a) What is the maximum possible efficiency of this engine
- (b) If the engine is run backward as a refrigerator, what is its maximum coefficient of performance?
24. A blackbody is placed in an enclosure whose walls are kept at 300 K. Compare the rate at which the heat is gained or lost by the body when its temperature is (a) 500 K and (b) 200 K.
25. Air at STP ( $0^{\circ}\text{C}$ , 1 atm) is compressed (a) slowly and (b) suddenly to half of its volume. Calculate the change in its temperature. The ratio of specific heat is 1.4.
26. A perfect gas at 300 K occupies a volume  $0.2\text{m}^3$  at a pressure of  $5.0 \times 10^6 \text{ Nm}^{-2}$ . It is allowed to expand isothermally to a volume  $0.5 \text{ m}^3$ . Then the gas is compressed isobarically to its original volume. Finally, the pressure is increased isobarically and returns to its original state. Calculate the work done during this cycle. Take  $R=8.3 \text{ Jmol}^{-1}\text{K}^{-1}$ .
27. Water boils at  $100^{\circ}\text{C}$  under pressure of 76 cm of Hg. In your laboratory, you observe that atmospheric pressure is 74 cm. Calculate the change in boiling point using following data.  $L(\text{steam}) = 2257 \text{ kJ. Kg}^{-1}$ .  $\rho(\text{Hg}) = 13.6 \times 10^3 \text{ kgm}^{-3}$ , specific volume of steam =  $1.677 \text{ m}^3\text{kg}^{-1}$ , specific volume of water =  $1 \times 10^{-3} \text{ m}^3\text{kg}^{-1}$  and  $g = 9.80 \text{ m.s}^{-2}$ .
28. A petrol engine using ideal air as working substance has its compression ratio raised from 5 to 6. Find the % increase in efficiency.
29. Briefly explain is the thermal conductivity of rubber determined by radial heat flow method.
30. Write a short note on entropy and available energy.
31. 10gm of water is heated from  $40^{\circ}\text{C}$  to  $80^{\circ}\text{C}$ . Calculate the change of entropy. Specific heat of water =  $4.2 \times 10^3 \text{ J/ (kg K)}$ .

(6 × 4 = 24 Marks)

## SECTION – D

Long Essay Question. Answer **any two** questions. Each question carries **15** marks.

32. Distinguish between isothermal and adiabatic process. Obtain the expression for work done in (a) isothermal process (b) adiabatic process.
33. State and explain Stefan's law. With necessary theory explain an experiment to determine Stefan's constant.
34. What is Carnot engine? Describe its operation with the help of PV diagram and derive expression for its efficiency.
35. (a) Derive Clausius Clapeyron equation for first order phase transition and apply it to explain the effect of change of pressure on the melting point and boiling point.  
(b) Distinguish first and second order phase transitions.

(2 × 15 = 30 Marks)