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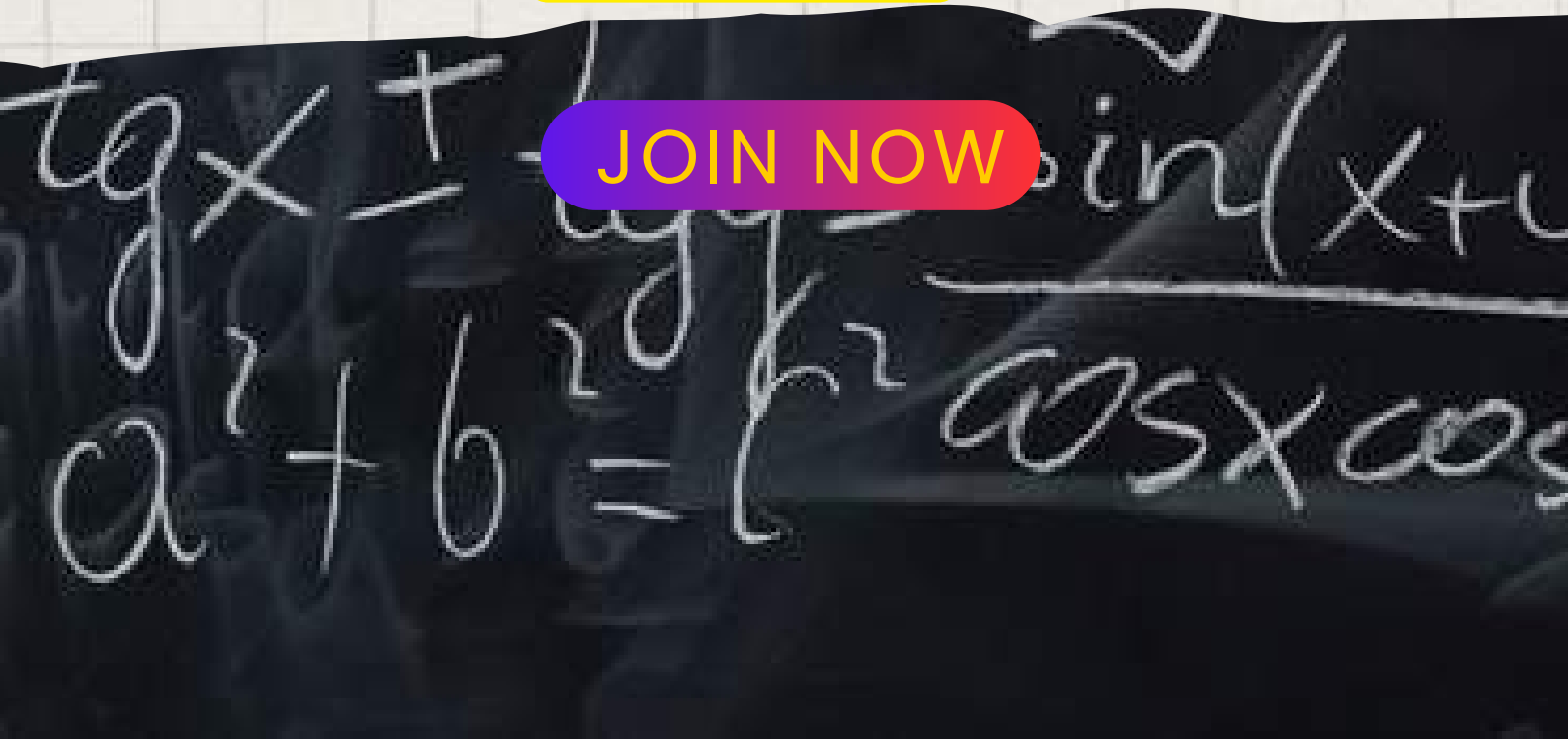

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(Pages : 4) R – 3108

Reg. No. : .....

Name : .....

Second Semester B.Sc. Degree Examination, September 2023

First Degree Programme under CBCSS

Physics

Complementary Course for Mathematics

PY 1231.1 : THERMAL PHYSICS AND STATISTICAL MECHANICS

(2018 Admission onwards)

Time : 3 Hours Max. Marks : 80

SECTION – A

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

1. What is solar constant?
2. Which are the modes of heat transfer from one point to another?
3. What is the purpose of bolometer?
4. State Wien's law.
5. State the postulate of equal a priori probability.
6. How does entropy change in reversible and irreversible processes?
7. Give the statement by Clausius for the second law of thermodynamics.
8. What are isoentropics?

9. Does the efficiency of a perfectly reversible engine depend on working substance. Explain.

10. Express the first law of thermodynamics for an isochoric process.

(10 × 1 = 10 Marks)

SECTION – B

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

11. Distinguish between thermal conductivity and thermometric conductivity.

12. State the postulates of Planck's quantum hypothesis.

13. What are the characteristics of a black body?

14. State and explain Wiedemann Franz law.

15. Plot the blackbody spectrum for at least three temperatures with respect to frequency.

16. Explain the concept of phase space.

17. Distinguish between open and isolated systems with example.

18. How does the internal energy of a system originate?

19. Draw the indicator diagram for a diesel engine.

20. Give the mathematical formulation of the first law of thermodynamics and its related ideas.

21. Briefly the strokes of petrol engine.

22. How is entropy related to the disorder of the system? What is its dimension?

(8 × 2 = 16 Marks)

SECTION – C

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

23. Derive Rayleigh Jeans law from Planck's law.

24. A brass bar and copper bar of same length and same cross sectional area are joined together. The free ends of copper and brass are kept at temperatures 100°C and 0°C respectively. Find the temperature of the joint in the condition of steady state. Do calculations based on the following assumptions. Heat loss due to radiation is neglected. Thermal conductivity of brass is 4 times of copper.

25. Calculate the average energy of an oscillator of frequency 60 THz at 1800 K, treating it as (a) Planck's oscillator and (b) classical oscillator.

26. Compare the various statistical ensembles.

27. Show that the adiabatic curve has a steeper negative slope than an isothermal curve at the same point.

28. Determine the work done when one litre of monatomic perfect gas at NTP is compressed isothermally to half its volume. $\gamma = 1.66$

29. Air at 27°C is suddenly compressed to $\frac{1}{4}$ of its original volume. Find the resulting rise in temperature. For air $\gamma = 1.4$

30. A Carnot's engine is working between steam point and ice point. How much should be the temperature of the sink must be lowered to obtain an efficiency of 30%?

31. When 200 g of water is heated from 10°C to 90°C, by how much does its entropy change?

(6 × 4 = 24 Marks)

SECTION – D

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

32. Describe the Lee's disc method for finding the conductivity of bad conductors.

33. Explain the Maxwell Boltzmann energy distribution.

34. Analyse the working of a Carnot's engine.

35. Establish the relation between the second law of thermodynamics and entropy. Analyse the change in entropy when ice is converted into steam.

(2 × 15 = 30 Marks)

(Pages : 4) **P – 1243**

Reg. No. : .....

Name : .....

Second Semester B.Sc. Degree Examination, September 2022

First Degree Programme under CBCSS

Physics

Complementary Course for Mathematics

PY 1231.1 — THERMAL PHYSICS AND STATISTICAL MECHANICS

(2020 Admission Onwards)

Time : 3 Hours Max. Marks : 80

PART – A

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

1. State Wiedmann-Franz law.
2. Mention a practical application of conduction of heat.
3. What does statistical mechanics deal with?
4. Define a macrostate.
5. What is an adiabatic process?
6. Write down the equation of state of an isothermal process.
7. Define entropy.
8. Give an expression for the efficiency of heat engine.

P.T.O.

9. State Plank's statement of second law of thermodynamics.

10. Draw a T-S diagram for a Carnot cycle.

(10 × 1 = 10 Marks)

PART – B

Answer any **eight** questions in about **one** paragraph. Each question carries **2** marks.

11. Define solar constant. Name the instrument used to measure the solar constant.

12. What are postulates of statistical mechanics?

13. Derive an expression for entropy.

14. Discuss the change in entropy during a reversible process.

15. Prove that entropy is a state function.

16. What are the characteristics of a black body?

17. Explain the concept of phase space.

18. State principle of increase of entropy.

19. State and explain Rayleigh-Jeans law.

20. Define probability. When will be the probability be zero?

21. A heat engine cannot attain 100% efficiency. Explain why?

22. Explain the work done by an ideal gas in an isothermal process.

23. Define temperature gradient and thermal conductivity.

24. Define an ensemble.

25. What is meant by reversible and irreversible process?

26. Write a note on microcanonical ensemble.

(8 × 2 = 16 Marks)

PART – C

Answer any **six** questions. Each carry **4** marks.

27. Find the change in entropy when a perfect gas expands isothermally and adiabatically.

28. Give the concept of ensemble. Calculate the number of states per unit volume of phase space.

29. Show that the adiabatic curve has a steeper negative slope than does an isothermal curve at the same point.

30. A Carnot's engine has an efficiency of 30% when the temperature of the sink is 27°C. What must be the change in temperature of the source to make its efficiency 50%.

31. Obtain the expression for change in entropy when ice changes to steam.

32. A Carnot engine takes 200 calories of heat from a source at temperature 400K and rejects 150 calories of heat to the sink. What is the temperature of the sink? Also calculate the efficiency of the engine.

33. The efficiency of an ideal engine is 0.2. If the temperature of the sink is lowered by 20°C, the efficiency becomes 0.25. Find the temperature of the source and sink.

34. If a black body at a temperature 6174 K emits 4700 A° with maximum energy; calculate the temperature at which it will emit a wavelength of 1.4×10^{-5} m with maximum energy.

35. Four molecules are to be distributed in 2 cells. Find the number of macrostates and microstates.

36. Derive maxwell's law of distribution of velocities of the molecules of an ideal gas.

37. Ten particles are distributed in two equal sized cells. Find the number of macrostates and microstates.

38. A thermal conductor in the form of a long bar is heated at one end at constant temperature. Discuss the distribution of temperature along the bar before and after the steady state is reached.

(6 × 4 = 24 Marks)

PART – D

Answer any **two** questions. Each carry **15** marks.

39. Derive Maxwell-Boltzmann distribution Law.

40. Describe the distribution of energy of a black body at different temperatures by drawing the graphs. Discuss briefly the different laws which explain the above energy spectrum.

41. Describe with necessary theory, the construction and working of petrol engine.

42. Describe Carnot's cycle and obtain an expression for the efficiency of an ideal heat engine.

43. Explain the Lee's disc experiment to measure thermal conductivity.

44. What are Kelvin-plank and Clausius statement of second law of thermodynamics? Prove that they are correct in terms of principle of increase of entropy.

(2 × 15 = 30 Marks)

(Pages : 4) **P – 1239**

Reg. No. : .....

Name : .....

Second Semester B.Sc. Degree Examination, September 2022

First Degree Programme under CBCSS

Physics

Complementary Course for Mathematics

PY 1231.1 : THERMAL PHYSICS AND STATISTICAL MECHANICS

(2018 & 2019 Admission)

Time : 3 Hours Max. Marks : 60

SECTION – A

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

1. What is the dimension and unit of thermometric conductivity?
2. State Wiedemann Franz law.
3. What are pyrheliometers?
4. What is the speciality of Wien's displacement law?
5. Is pressure a macroscopic quantity? Explain.
6. What is the difference between isochoric and isobaric processes?
7. "Entropy is considered as an extensive property". Why?
8. What is a heat engine?

9. Write down the Kelvin's statement for the second law of thermodynamics.

10. What is an isolated system?

(10 x 1 = 10 Marks)

SECTION – B

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

11. Explain why it is necessary to sandwich the experimental disc between 2 copper discs in the Lee's disc experiment.

12. Draw the blackbody spectrum for three temperatures with emissive power as a function of wavelength.

13. List out the assumptions made in stating Rayleigh Jeans law.

14. What are the properties of thermal radiation?

15. What is ultraviolet catastrophe?

16. Which are the steps involved in the procedure for determining the most probable statistical distribution?

17. Explain the TS diagram of a Carnot's cycle.

18. List out the features of entropy.

19. What are the significances and limitations of first law of thermodynamics?

20. Is it possible to get a Carnot's engine with 100% efficiency? Explain.

21. Show that for the whole system on which the Carnot engine operates, the algebraic sum of the entropy changes for the whole cycle is zero.

22. Explain why adiabatic compression causes heating.

(8 x 2 = 16 Marks)

SECTION – C

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

23 The solar radiation with maximum energy is found to be at 490 nm. If the Wien's constant is 0.002898, find the temperature of the sun. Also find the temperature of the moon, if the 14 μm radiations are the most intense from the moon.

24. How can the surface temperature of sun be determined from the measurement of solar constant?

25. A bar of length 20 cm and uniform area of cross section 4 cm^2 is made up of two equal halves of copper and aluminium welded together. The free end of copper is maintained at steam point and the free end of aluminium is at ice point. The sides of the bar are thermally isolated. Find the rate of flow of heat along the bar when the steady state is reached. Thermal conductivity of copper is 386 $Wm^{-1}K^{-1}$ and that of aluminium is 237 $Wm^{-1}K^{-1}$.

26. Show that the value of v_x is $(2kT/m)^{0.5}$ for which the probability falls to 1/e times the maximum value.

27. Find the change in entropy when a perfect gas expands isothermally and adiabatically.

28. Determine the work done when one litre of monatomic perfect gas at NTP is compressed adiabatically to half its volume. $\gamma = 1.66$.

29. Find the adiabatic compression ratio for a Diesel engine if the combustion expansion ratio is 4. Given the efficiency of the engine as 52.0% and $\gamma = 1.4$.

30. A Carnot's engine is working between room temperature and boiling point of water. Find its efficiency. Compare the efficiency of another Carnot's engine working between room temperature and ice point.

31. Calculate the change in entropy when 1 g ice at 0°C is converted to steam at 100°C. Given latent heat of melting = 3.34×10^5 Jkg^{-1}; latent heat of steam = 2.257×10^6 Jkg^{-1}; specific heat of water = 4.2×10^3 $Jkg^{-1}K^{-1}$.

(6 × 4 = 24 Marks)

SECTION – D

Answer any two questions. Each question carries 15 marks.

32. Derive Planck's radiation law.

33. What are ensembles? Explain the statistical ensembles and their uses.

34. Discuss briefly about entropy of reversible and irreversible processes. Differentiate between these two processes.

35. Describe the working of petrol engine with schematic diagram and theory. Derive the expression for its efficiency.

(2 × 15 = 30 Marks)

98/2/22

(Pages : 4) **M – 2341**

Reg. No. : .....

Name : .....

Second Semester B.Sc. Degree Examination, December 2021

First Degree Programme Under CBCSS

Physics

Complementary Course for Mathematics

PY 1231.1 — THERMAL PHYSICS AND STATISTICAL MECHANICS

(2020 Admission Regular)

Time : 3 Hours Max. Marks : 80

SECTION – A

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

1. What are the desirable thermal properties of material to be used for constructing cooking utensils?
2. Give an estimate on the temperature of photosphere and core of the sun.
3. Plot the TS diagram of a Carnot's cycle.
4. How does entropy vary in reversible and irreversible processes?
5. What does the second law of thermodynamics represent?
6. Entropy is considered as an extensive property. Why?
7. Why do we call thermal radiation as infrared radiation?
8. Differentiate between isochoric and isobaric processes.
9. What is the main objective of statistical mechanics?
10. What is a pyrheliometer?

(10 × 1 = 10 Marks)

SECTION – B

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

11. Explain the molecular theory for heat conduction.
12. Work out the analogy between black body radiation and a perfect gas.
13. In a furnace, two iron pieces are heated to the same temperature. One piece is then taken out. Which piece will appear brighter just at this instant? Explain.
14. Draw the blackbody spectrum for three temperatures with emissive power as a function of wavelength.
15. Distinguish between closed and isolated systems with example.
16. Give the important properties of entropy.
17. How does the internal energy of a system develop?
18. List the significances and limitations of first law of thermodynamics.
19. Draw the PV diagram for a diesel engine.
20. Mention the important characteristics of heat engine cycles.
21. Make a comparison on reversible and irreversible processes.
22. Show that for the whole system on which the Carnot engine operates, the algebraic sum of the entropy changes for the whole cycle is zero.
23. Explain why adiabatic compression causes heating.
24. What is a phase space?
25. What are the assumptions made in stating Rayleigh Jean's law?
26. What is a black body? What are its characteristics?

(8 × 2 = 16 Marks)

SECTION – C

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

27. Distinguish between thermometric conductivity and thermal conductivity.
28. Thermal conductivity of brass is 4 times of copper. Two bars, one of brass and the other of copper of same length and same cross sectional area are joined together. The free ends of copper and brass are kept at steam point and ice point respectively. Find the temperature of the joint in the condition of steady state. Heat loss due to radiation is neglected.

29. Calculate the work done when one litre of monatomic perfect gas at NTP is compressed adiabatically to half its volume. $\gamma = 1.66$.

30. Show that there is no change in entropy for reversible cycle.

31. For a Diesel engine, find the adiabatic compression ratio if the combustion expansion ratio is 4. Given the efficiency of the engine as 52.0% and $\gamma = 1.4$

32. Calculate the average energy of Planck's oscillator for $(h\omega/KT)$=0.01, 0.1, 1.0 and 10.0.

33. The solar radiation with maximum energy is found to be at 490 nm If the Wien's constant is 0.002898, find the temperature of the sun. Also find the temperature of the moon, if the 14 μm radiations are the most intense from the moon.

34. Compare the ensembles.

35. Prove that the adiabatic curve is steeper than the isothermal curve at a point where the two curves intersect each other.

36. The electrical conductivity of a copper wire of length 500 m and diameter 0.2 mm at room temperature is $5.9 \times 10^7\ \Omega^{-1}\ m^{-1}$. Find its thermal conductivity if the Lorentz number is $2.32 \times 10^{-8}\ W\Omega K^{-2}$.

37. A wooden ice box of 1.8 cm thick, lined inside with cork 4 cm thick. If the temperature of the inner surface of the cork is 0°C and that of the outer surface of wood is 10°C, what is the temperature of the interface? The thermal conductivity of wood is 0.12 $Wm^{-1} K^{-1}$ and that of cork is 0.037 $Wm^{-1} K^{-1}$.

38. Show that the value of v_x is $(4.6\ kT/m)^{0.5}$ for which the probability falls to 0.1 times the maximum value.

(6 × 4 = 24 Marks)

SECTION – D

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

39. Discuss the Lee's disc method for finding the conductivity of bad conductors.

40. Derive the expressions for the work done during isothermal and adiabatic processes. Distinguish between adiabatic and isothermal elasticities.

41. Explain the energy distribution in black body radiation. Discuss the success and limitations of the classical theory in explaining it. Derive Planck's radiation formula and explain how it overcomes the short comings of the classical theory.

42. Briefly describe the Maxwell Boltzmann energy distribution and velocity distribution laws.

43. With necessary theory describe the working of petrol engine. Derive the expression for its efficiency.

44. Establish the relation between the second law of thermodynamics and entropy. Analyse the entropy change when ice is converted into steam.

(2 × 15 = 30 Marks)

28/2/22

(Pages : 3) **M – 2338**

Reg. No. : .....

Name : .....

Second Semester B.Sc. Degree Examination, December 2021.

First Degree Programme under CBCSS

Physics

Complementary Course for Mathematics

PY 1231.1 – THERMAL PHYSICS AND STATISTICAL MECHANICS

(2018 and 2019 Admission)

Time : 3 Hours Max. Marks : 80

PART – A

Answer **all** questions. Answer should not exceed **two** sentences.

Each question carries **1** mark.

1. Define the term Microstate with the help of an example.
2. Explain the term grand canonical ensemble.
3. State Clausius statement of second law of thermodynamics.
4. State equipartition of energy theorem.
5. What is diffusion?
6. Explain the term thermodynamic probability.
7. Define coefficient of performance. Is it greater than one? Explain
8. Explain the term Adiabatic Process.
9. What is the unit of entropy?
10. State Zeroth law of thermodynamics.

(10 × 1 = 10 Marks)

P.T.O.

PART – B

Answer **any eight** questions. Answer should not exceed **one** small paragraph.

Each question carries **2** marks

11. Distinguish between Accessible and Inaccessible Macrostates.
12. Discuss Lee's disc method for finding the coefficient of thermal conductivity for bad conductors.
13. Deduce the expression for work done during isothermal processes.
14. Show that there is always an increase of entropy in an irreversible cycle.
15. What is an indicator diagram? State its importance.
16. What is the effect of pressure on thermal conductivity?
17. Derive the equation for adiabatic elasticity.
18. Explain the concept of entropy and available energy.
19. Explain the term Thermal Diffusivity or thermometric conductivity.
20. Discuss the distribution of energy in the spectrum of black body on the basis of the spectrum obtained in the experiment performed by Lummer and Pringsheim.
21. State the principle of increase of entropy.
22. Mention the physical significance and properties of entropy.

(8 × 2 = 16 Marks)

PART – C

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

23. Calculate the surface temperature of sun and moon if the wavelength corresponding to the maximum intensity of radiations from them are 4235 A^0 and 15μ_m respectively (Wien's constant b = .2892 × 10^{-2} mk)
24. A quantity of air at 27°C and at atmospheric pressure is suddenly compressed to half its original volume. Find the final
    (a) pressure and
    (b) temperature. Given $\gamma = 1.4$.
25. Calculate the probability that in tossing a coin 5 times. we get 3 heads and 2 tails.

26. Calculate the radiant emittance of a black body at a temperature of

(a) 400K

(b) 4000K Given $\sigma = 5.672 \times 10^{-8}$ M.K.S. units.

27. When 50gm of water is heated from 100C to 900C, by how much does its entropy change?

28. Compare the radiant emittance of a black body at 20K and 200K. Given $\sigma = 5.672 \times 10^{-8}$ S units.

29. Find the, efficiency of the Carnot's engine working between the steam point and the ice point.

30. A bar of length 30 cm and uniform area of cross section 5 cm^2 consists of two halves AB of copper and BC of iron welded together at B. The end A is maintained at 200°C and the end C at 0°C. The sides of the bar are thermally insulated. Find the rate of flow of heat along the bar when the steady state is reached. Thermal conductivity of copper is 0.9 and thermal conductivity of iron is 0.12 CGS units.

31. Calculate the increase in entropy of 10kg of water at 100°C when it changes to vapour. Given Latent heat of steam = 540 cal/gram.

(6 × 4 = 24 Marks)

PART – D

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

32. Define solar constant. Describe an experiment to determine the solar constant using a pyrheliometer.

33. Show that the probability of a molecule to have its velocity component between v_x, and $v_x + dv_x$ is given by $P(v_x)dv_x = \left(\frac{m}{2\pi kT}\right)^{\frac{1}{2}} e^{\frac{-mv_x^2}{2kT}} dv_x$.

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

35. Calculate the work done in a Carnot's Cycle of operations. Deduce the efficiency of a Carnot's engine in terms of the temperatures between which it works.

(2 × 15 = 30 Marks)