C 20224 **(Pages : 3)** **Name.....**

Reg. No.....

SIXTH SEMESTER (CUCBCSS—UG) DEGREE EXAMINATION, MARCH 2022

Physics/Applied Physics

PHY 6B 10/APY 6B 11—THERMAL AND STATISTICAL PHYSICS

(2014 to 2018 Admissions)

Time : Three Hours Maximum : 80 Marks

Symbols used in this question paper have their usual meanings.

Section A (Answer in a word or phrase)

Answer **all** *questions.*
Each question carries 1 mark.

1. For an adiabatic process, the ———— of the system remains constant.
2. The source of a Carnot's engine can supply any amount of energy. (True *or* False)
3. The dimension of phase space for a single particle is ————.
4. An isochoric process is one in which ———— remains constant.
5. When heat is given to a system, its internal energy ————.
6. What is statistical probability ?
7. What is a canonical ensemble ?
8. What is a thermodynamic system ?
9. What are bosons ?
10. Explain the terms open system and closed system.

(10 × 1 = 10 marks)

Section B (Answer in a short paragraph three or four sentences)

Answer **all** *questions.*
Each question carries 2 *marks.*

11. Define entropy. Discuss the physical meaning of entropy.
12. Distinguish between microstates and macrostates.
13. Give the expressions for isothermal and adiabatic elasticity.

Turn over

14. Which are the *two* ways to represent the work done by the working substance in one complete cycle of a Carnot engine ?

15. State and explain the second law of thermodynamics.

16. Derive an expression for the work done in an isothermal process.

17. Explain the conditions under which FD statistics holds good.

(7 × 2 = 14 marks)

Section C (Answer in a paragraph of about half a page to one page)

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

18. Show that during a reversible adiabatic process, the entropy of the system remains constant.

19. Using Maxwell's thermodynamic relations, prove that for any substance, the ratio of the adiabatic and isothermal elasticities is equal to the ratio of the two specific heats.

20. What are the limitations of Maxwell-Boltzmann method ?

21. What is Bose-Einstein statistics ?

22. State the first law of thermodynamics. Express it mathematically and explain its physical significance.

23. Deduce the second latent heat equation of Clausius $C_2 - C_1 = (dL/dT) - (L/T)$ where C_1 and C_2 represent the specific heat of a liquid and its saturated vapour and L is the latent heat of the vapour.

24. State and explain the third law of thermodynamics.

(5 × 4 = 20 marks)

Section D (Problems–write all relevant formulas. All important steps carry separate marks)

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

25. Air at N.T.P is compressed to half of its volume. Calculate the change in its temperature.

26. A carnot's engine whose temperature of the source is 400 K takes 200 calories of heat at this temperature and rejects 150 calories of heat to the sink. What is the temperature of the sink ? Also calculate the efficiency of the engine.

27. 1 kg of water at 273K is brought in contact with a heat reservoir at 373K. What is the change in entropy of water as it reaches 373K ?

28. Prove that in a T-S diagram the slope of the isochoric curve is T/C_v and that of isobaric curve is T/C_p.

29. Calculate the change in temperature of boiling water when the pressure is increased by 27.12 mm of Hg. The normal boiling point of water at atmospheric pressure is 100°C. Latent heat of steam = 537 cal/g and specific volume of steam = 1674 m^3.

30. Calculate the rms velocity of H_2 at 27°C. Given $k = 1.38 \times 10^{-23}$ J/deg and mass of hydrogen molecule = 3.34×10^{-27}kg.

31. Using Maxwell's thermodynamic relations, prove that the ratio of the adiabatic to the isobaric coefficient of expansion is $1/(1-\gamma)$.

(4 × 4 = 16 marks)

Section E (Essays–Answer in about two pages)

Answer any **two** *questions.*
Each question carries 10 *marks.*

32. Derive Maxwell's four thermodynamic relations. Discuss the usefulness of these relations.

33. Define adiabatic process. Derive the equation for an adiabatic process of a perfect gas in terms of pressure, temperature and volume.

34. What is meant by Fermi energy of conduction electrons ? Derive an expression for the same.

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

(2 × 10 = 20 marks)

C 1264 (Pages : 3)

Name.....

Reg. No.....

SIXTH SEMESTER (CUCBCSS—UG) DEGREE EXAMINATION
MARCH 2021

Physics/Applied Physics

PHY 6B 10/APY 6B 11—THERMAL AND STATISTICAL PHYSICS

Time : Three Hours Maximum : 80 Marks

Section A (Answer in a word or phrase)

Answer **all** *questions.*
Each question carries 1 *mark.*

1. Isothermal elasticity of a gas is its ————.

   (a) Pressure. (b) Volume.

   (c) Entropy. (d) Temperature.

2. The slope of an adiabatic is ———— than that of isothermal.
3. The area under the indicator diagram of a thermodynamic system represents pressure. (True *or* False)
4. The entropy of a system ———— in an irreversible process.
5. In Carnot's cycle, the first step is ————.
6. Write down the FD distribution function.
7. What is Wiedmann Franz law ?
8. What is meant by thermodynamic equilibrium ?
9. What kinds of particles obey the Maxwell-Boltzmann statistics ?
10. What is an isobaric process ?

(10 × 1 = 10 marks)

Section B (Answer in a Short Paragraph- three or four sentences)

Answer at least **six** *questions.*
Each question carries 2 *marks.*
All questions can be attended.
Overall Ceiling 12.

11. How do you find the slope of an isotherm ?
12. State the first law of thermodynamics.

Turn over

13. What are the parts of a heat engine ?

14. Explain the difference between distinguishable and indistinguishable particles.

15. Give the expression for the efficiency of a diesel engine and explain the symbols.

16. What is T-S diagram ? Give its use.

17. What is the difference between a canonical ensemble and a microcanonical ensemble.

(6 × 2 = 12 marks)

Section C (Answer in a paragraph of about half a page to one page)

Answer at least **four** *questions.*
Each question carries 5 *marks.*
All questions can be attended.
Overall Ceiling 20.

18. Give two versions of the second law of thermodynamics.

19. State and prove the principle of increase of entropy.

20. Using Maxwell's thermodynamic relations, prove that the ratio of the adiabatic to the isobaric co-efficient of expansion is $1/(1 - \gamma)$.

21. Explain the term Helmholtz free energy. Show that in a natural isothermal change at constant volume, Helmholtz free energy decreases.

22. Draw the Maxwell-Boltzmann velocity distribution curve and state the features of the distribution curve.

23. Distinguish between Classical and Quantum Statistics.

24. From the first law of thermodynamics prove that $C_p - C_v = R$.

(4 × 5 = 20 marks)

Section D (Problems- write all relevant formulas)

Answer at least **three** *questions.*
Each question carries 6 *marks.*
All questions can be attended.
Overall Ceiling 18.

25. Find the most probable, average and root mean square speeds of nitrogen molecule at 27°C. Given the molecular mass of N_2 molecule = 2.8×10^{-3} kg/mol, the gas constant R = 8.31 J/mol K.

26. A quantity of air at 27°C is suddenly compressed to half its original volume. Find the final pressure and temperature. (Given $\gamma = 1.4$, $2^{1.4} = 2.64$).

27. Find the efficiency of a Carnot's engine working between 127°C and 27°C. It absorbs 80 cals of heat. How much heat is rejected?

28. When 50 g of water is heated from 10°C to 90°C, by how much does its entropy change ?

29. Calculate the specific heat of saturated steam. Given that the specific heat of water at 100°C = 1.01 and latent heat of vapourization decreases with increase in temperature at the rate of 0.64 cal/K. Latent heat of vapourization of steam is 540 cal.

30. Fermi energy of conduction electrons in silver is 5.48 eV. Calculate the number of such electrons per cm^3 given that $h = 6.62 \times 10^{-27}$ erg sec. and 1 eV = 1.62×10^{-12} erg.

31. Show that adiabatic curve is steeper than isothermal curve.

(3 × 6 = 18 marks)

Section E (Essays - Answer in about two pages)

Answer any **two** *question.*

Each question carries 10 *marks.*

32. Derive the two expressions for the work done in an adiabatic process.

33. State and prove the theorem of equipartition of energy. Give the merits of this theorem.

34. Discuss with necessary theory the construction and working of an Otto engine.

35. Derive Maxwell's four thermodynamic relations. Discuss the usefulness of these relations.

(2 × 10 = 20 marks)

C 80281 (Pages : 3)

Name.....

Reg. No.....

SIXTH SEMESTER B.A./B.Sc. DEGREE EXAMINATION, MARCH 2020

(CUCBCSS—UG)

Physics/Applied Physics

PHY 6B 10/APY 6B 11—THERMAL AND STATISTICAL PHYSICS

Time : Three Hours Maximum : 80 Marks

Symbols used in this question paper have their usual meanings.

Section A

(Answer in a word **or** *phrase).*
Answer **all** *questions.*
Each question carries 1 *mark.*

1. Isothermal elasticity of a gas is its ———.

   (a) Pressure. (b) Volume.

   (c) Entropy. (d) Temperature.

2. The slope of an adiabatic is ——— than that of isothermal.

3. The area under the indicator diagram of a thermodynamic system represents pressure.

   (True or False)

4. The entropy of a system ——— in an irreversible process.

5. In Carnot's cycle, the first step is ———.

6. Write down the FD distribution function.

7. What is Wiedmann Franz law ?

8. What is meant by thermodynamic equilibrium ?

9. What kinds of particles obey the Maxwell-Boltzmann statistics ?

10. What is an isobaric process ?

(10 × 1 = 10 marks)

Section B

(Answer in a short paragraph- three or four sentences).
Answer **all** *questions.*
Each question carries 2 *marks.*

11. How do you find the slope of an isotherm ?

12. State the first law of thermodynamics.

Turn over

13. What are the parts of a heat engine ?
14. Explain the difference between distinguishable and indistinguishable particles.
15. Give the expression for the efficiency of a diesel engine and explain the symbols.
16. What is T-S diagram ? Give its use.
17. What is the difference between a canonical ensemble and a microcanonical ensemble.

(7 × 2 = 14 marks)

Section C

(*Answer in a paragraph of about* **half a page** *to* **one page**).
Answer any **five** *questions.*
Each question carries 4 *marks.*

18. Give two versions of the second law of thermodynamics.
19. State and prove the principle of increase of entropy.
20. Using Maxwell's thermodynamic relations, prove that the ratio of the adiabatic to the isobaric coefficient of expansion is 1/(1 – Y).
21. Explain the term Helmholtz free energy. Show that in a natural isothermal change at constant volume, Helmholtz free energy decreases.
22. Draw the Maxwell-Boltzmann velocity distribution curve and state the features of the distribution curve.
23. Distinguish between Classical and Quantum Statistics.
24. From the first law of thermodynamics prove that $C_p - C_v = R$.

(5 × 4 = 20 marks)

Section D

(*Problems- write all relevant formulas. All important steps carry* **separate** *marks*)
Answer any **four** *questions.*
Each question carries 4 *marks*

25. Find the most probable, average and root mean square speeds of nitrogen molecule at 27°C. Given the molecular mass of N_2 molecule = 2.8×10^{-3} kg/mol, the gas constant R = 8.31J/mol K.
26. A quantity of air at 27°C is suddenly compressed to half its original volume. Find the final pressure and temperature. (Given $y = 1.4$, $2^{1.4} = 2.64$).

27. Find the efficiency of a Carnot's engine working between 127°C and 27°C. It absorbs 80 cals of heat. How much heat is rejected ?

28. When 50 g of water is heated from 10°C to 90°C, by how much does its entropy change ?

29. Calculate the specific heat of saturated steam. Given that the specific heat of water at 100°C = 1.01 and latent heat of vapourization decreases with increase in temperature at the rate of 0.64 cal/K. Latent heat of vapourization of steam is 540 cal.

30. Fermi energy of conduction electrons insilver is 5.48 eV. Calculate the number of such electrons per cm^3 given that $h = 6.62 \times 10^{-27}$ erg sec. and 1 eV = 1.62×10^{-12} erg.

31. Show that adiabatic curve is steeper than isothermal curve.

(4 × 4 = 16 marks)

Section E

(*Essays-Answer in about* **two pages**).
Answer any **two** *questions.*
Each question carries 10 *marks.*

32. Derive the two expressions for the work done in an adiabatic process.

33. State and prove the theorem of equipartition of energy. Give the merits of this theorem.

34. Discuss with necessary theory the construction and working of an Otto engine.

35. What is meant by Fermi energy of conduction electrons? Derive an expression for the same.

(2 × 10 = 20 marks)

C 60055 (Pages : 3) Name.....

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH 2019

(CUCBCSS)

Physics/Applied Physics

PHY 6B 10/APY 6B 11—THERMAL AND STATISTICAL PHYSICS

Time : Three Hours Maximum : 80 Marks

Section A

Answer in a word **or** *phrase.*
Answer **all** *questions.*
Each question carries 1 *mark.*

1. What do you mean by quasi static process ?
2. ———— diagram is also known as indicator diagram.
3. The rate of fall of temperature with distance is called ————.
4. In an isothermal process, heat absorbed by a system, ΔQ = ————.
5. The efficiency of petrol engine is greater than that of diesel engine. (True *or* False).
6. A sphere, a cube and a thin circular plate, all made of the same material and having the same mass are initially heated to a temperature of 3000°C. Which of these will cool fastest ?
7. Write down the Clausius -Clapeyron equation.
8. Write down the BE distribution function.
9. Give the Kelvin Plank statement for the second law of thermodynamics.
10. What is Nernst theorem ?

(10 × 1 = 10 marks)

Section B

Answer in a short paragraph three **or** *four sentences.*
Answer **all** *questions.*
Each question carries 2 *marks.*

11. Explain isothermal process.
12. What is phase space ?
13. Derive an expression for the efficiency of a Carnot's engine using TS diagram.

Turn over

14. State and explain the zeroth law of thermodynamics.
15. Draw Otto cycle and explain the various strokes.
16. Distinguish between microcanonical and grand canonical ensembles.
17. Explain the conditions under which BE statistics holds good.

(7 × 2 = 14 marks)

Section C

Answer in a paragraph of about **half a page to one page.**
Answer any **five** *questions.*
Each question carries 4 marks.

18. State the first law of thermodynamics. Give its physical significance. What are the limitations of first law ?
19. What is entropy ? Show that entropy remains constant in a reversible process, but increases in an irreversible process.
20. State and explain Nernst's heat theorem.
21. Deduce the second latent heat equation of Clausius $C_2 - C_1 = (dL/dT) - (L/T)$ where C_1 and C_2 represent the specific heat of a liquid and its saturated vapour and L is the latent heat of the vapour.
22. Show that for a perfect gas $(\partial U/\partial V)_T = 0$.
23. What do you mean by breakdown of equipartition theorem ? When does it occur ?
24. Compare the MB, FD and BE statistics.

(5 × 4 = 20 marks)

Section D

Problems- write all relevant formulas.
All important steps carry separate marks.
Answer any **four** *questions.*
Each question carries 4 marks.

25. Show that adiabatic curve is steeper than isothermal curve.
26. A motor car tyre has a pressure of 2 atmospheres at the room temperature of 27°C. If the tyre suddenly bursts find the resulting temperature.
27. Find the efficiency of a Carnot's engine working between the steam point and the ice point.
28. Calculate the increase in entropy of 10 kg of water at 100°C when it changes to vapour.

29. Calculate the specific heat of saturated steam at 100°C from the following data. L at 90°C = 545.25cal L at 100°C = 539.30cal L at 110°C = 533.17cal. Specific heat of water at 100°C = 1.013 cal/g.

30. Consider 100 molecules and 10 cells of equal energy. Find log Ω for (i) the most probable distribution ; (ii) the least probable distribution.

31. Calculate the root mean square speed of a molecule of hydrogen at N.T.P. The Boltzmann's constant is 1.38×10^{-16} erg per degree and Avogadro's number is 6×10^{23}g/mol.

(4 × 4 = 16 marks)

Section E (Essays)

Answer in about **two pages.**
Answer any **two** *questions.*
Each question carries 10 *marks.*

32. (a) What is an adiabatic process ?

(b) Derive an expression for the work done in an adiabatic process.

33. Derive Maxwell's four thermodynamic relations. Discuss the usefulness of these relations.

34. Describe with necessary theory the construction and working of a diesel engine. Explain its merits over Otto engine.

35. State and prove the theorem of equipartition of energy. Give the merits of this theorem.

(2 × 10 = 20 marks)

D 40049 (Pages : 3) Name.....

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH/APRIL 2018

(CUCBCSS—UG)

Physics/Applied Physics

PHY 6B 10/APY 6B 10—THERMAL AND STATISTICAL PHYSICS

Time : Three Hours Maximum : 80 Marks

The symbols used in this question paper have their usual meanings.

Section A

Answer in a word **or** *a phrase.*
Answer **all** *questions.*
Each question carries 1 *mark.*

1. The quantity that remains constant during an isobaric process is ————.
2. What happens to the boiling point of water when pressure increases ?
3. ———— of a system is a measure of the unavailability of energy from it.
4. ———— represents the free energy of the system in an isothermal process at constant pressure.
5. For a perfect black body, the emissivity is ————.

Questions 6 to 10 : write True **or** *False.*

6. A Carnot engine can have 100 percent efficiency.
7. If we keep the door of a refrigerator open for some time, the temperature of the room increases.
8. Entropy is an extensive property.
9. Electrons obey Bose-Einstein statistics.
10. The peak of the black body spectrum shifts to higher frequencies as the temperature is increased.

(10 × 1 = 10 marks)

Section B

Answer in two **or** *three sentences.*
Answer **all** *questions.*
Each question carries 2 *marks.*

11. Explain the zeroth law of thermodynamics.
12. What is the condition for a system to be in thermodynamic equilibrium ?

Turn over

13. What do you mean by a quasistatic process ? How can you realize a quasistatic process ?
14. What do you mean by a heat engine ? What are its essential parts ?
15. Draw the TS diagram of a Carnot cycle.
16. Draw the volume versus temperature curve for first and second order phase transitions.
17. Write down an expression for the distribution of molecular speeds in a classical ideal gas and plot it.

(7 × 2 = 14 marks)

Section C

Answer in a paragraph of about half a page to one page.
Answer any **five** *questions.*
Each question carries **4** *marks.*

18. Obtain the relation between isothermal and adiabatic elasticity of a gas.
19. Show that the slope of an adiabatic is y times that of an isothermal.
20. Write down the Planck and Clausius statements of the second law of thermodynamics.
21. Obtain an expression connecting the first and second laws of thermodynamics.
22. Discuss the equipartition theorem.
23. Explain Planck radiation law.
24. Explain the term degeneracy pressure and mention any of its astrophysical significance.

(5 × 4 = 20 marks)

Section D

Problems-write all relevant formulas, all important steps carry separate marks.
Answer any **four** *questions.*
Each question carries 4 *marks.*

25. A Carnot engine whose low temperature reservoir is at 7 degree Celsius has an efficiency of 50%. If it is desired to increase the efficiency to 70 %, by how many degrees should the temperature of the high temperature reservoir be increased ?
26. Air at NTP is compressed adiabatically to half of its volume. What is the change in its temperature ? Given, $\gamma = 1.4$.
27. Calculate the change in entropy when 0.0273 kg of ice at zero degree Celsius is converted into water at the same temperature. Given latent heat = 80 cal/g.
28. Using Clausius Clapeyron equation, prove that the boiling point of a liquid rises when the pressure increases.

29. Discuss the principle of increase of entropy.

30. Calculate the net rate of energy transfer between two closely spaced concentric spheres (black bodies) maintained at temperatures 200 K and 300 K. Assume that the space between the spheres is evacuated. Given, the Stefan's constant = 5.67×10^{-8} W/m^2.K^4.

31. Prove that the probability for two bosons to occupy the same state is twice the case if the particles are distinguishable.

(4 × 4 = 16 marks)

Section E

Essays-answer in about **two pages.**
Answer any **two** *questions.*
Each question carries 10 *marks.*

32. Obtain the relation between the specific heat at constant volume and pressure using the first law of thermodynamics.

33. Explain the Carnot cycle with a neat PV diagram. Obtain an expression for the work done in a Carnot cycle.

34. Obtain Maxwell's thermodynamic relations from thermodynamic potentials.

35. Discuss briefly the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Compare the three statistics.

(2 × 10 = 20 marks)

C 21078 (Pages : 3) Name.....

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH 2017

(CUCBCSS—UG)

Physics/Applied Physics

PHY 6B 10/APY 6B 11—THERMAL AND STATISTICAL PHYSICS

Time : Three Hours Maximum : 80 Marks

The symbols used in this question paper have their usual meanings.

Section A

(Answer in a word **or** *phrase.)*

Answer **all** *questions ; each question carries* 1 *mark.*

1. The physical quantity that determines whether a system is in thermal equilibrium with another system is ————.
2. In an otto engine, greater the compression produced before ignition, the ———— is the efficiency of the engine. (higher/smaller)
3. The change of entropy in a completely reversible thermodynamic cycle is ————.
4. Is there any change in internal energy of a perfect gas during an isothermal change in volume ?
5. Is it possible for two photons to occupy the same quantum state ?

Questions *6 to 10. Write True* **or** *False.*

6. Heat is a path function.
7. An infinitely slow adiabatic expansion is not a reversible process.
8. Entropy change can never be negative.
9. Classical particles obey Maxwell-Boltzmann statistics.
10. The emissivity of a substance depends on its temperature.

(10 × 1 = 10 marks)

Section B

(Answer in two **or** *three sentences)*

Answer **all** *questions.*

Each question carries 2 *marks.*

11. Define a thermodynamic system ? Give an example.
12. Distinguish between extensive and intensive variables.

Turn over

13. What do you mean by a quasistatic process ? How can you realize a quasistatic process ?

14. Distinguish between isobaric and isochoric processes.

15. Explain Clausius inequality.

16. Draw the entropy versus temperature curve of first and second order phase transitions.

17. Discuss the equipartition theorem.

(7 × 2 = 14 marks)

Section C

(Answer in a paragraph of about half a page to **one page***)*
Answer any **five** *questions ; each question carries* 4 *marks*

18. What are the features of a cyclic process ?

19. Show that the slope of an adiabatic is γ times that of an isothermal.

20. What are internal combustion engines ? Discuss the different classes.

21. What is the third law of thermodynamics ? Explain its outcome.

22. Show that the Joule-Kelvin co-efficient for a perfect gas is zero.

23. Compare the properties of fermions and bosons.

24. What do you mean by Fermi energy ? Write down an expression for the same.

(5 × 4 = 20 marks)

Section D

(Problems-write all relevant formulas, all important steps carry separate marks)
Answer any **four** *questions; each question carries* 4 *marks.*

25. A quantity of dry air at 300 K is compressed suddenly to one third of its volume. Determine the change in temperature. Given, $\gamma = 1.4$.

26. A Carnot engine whose low temperature reservoir is at 7 degree Celsius has an efficiency of 50 %. If it is desired to increase the efficiency to 70 %, by how many degrees should the temperature of the high temperature reservoir be increased ?

27. One mole of oxygen gas expands isothermally to four times of its initial volume. Determine the change in entropy. Given, the gas constant R = 8.314 J/mol/K.

28. Explain the working principle of a refrigerator.

29. Show that the different statements of the second of thermodynamics are equivalent to each other.

30. Calculate the rms velocity of hydrogen gas at 27°C.

31. Consider a system of two fermions 1 and 2 with two possible states a and b. Write down the expression for the wave function of the system. Prove that for this system, the presence of a particle in a certain state prevents any other particles from being in that state.

(4 × 4 = 16 marks)

Section E

(Essays-answer in about **two pages***)*

Answer any **two** *questions ; each question carries* 10 *marks.*

32. Using an indicator diagram, obtain expressions for work done during an isothermal and adiabatic processes.

33. Discuss the otto cycle and obtain an expression for the efficiency.

34. What are the basic thermodynamic potentials ? Obtain Maxwell's thermodynamic relations from the thermodynamic potentials.

35. Explain briefly the :

(i) Planck's radiation law ;

(ii) Wien's displacement law ; and

(iii) Stefan-Boltzmann law.

(2 × 10 = 20 marks)

C 1751 (Pages : 3) Name.....

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH/APRIL 2016

(UG—CCSS)

Core Course—Psysics

PH 6B 16—THERMAL AND STATISTICAL PHYSICS

(2009—2012 Admissions)

Time : Three Hours Maximum : 30 Weightage

Part A

Answer **all** *questions.*
Each questions carries ¼ weightage.

1. The first law of Thermodynamics is conservation of :
   (a) Momentum. (b) Energy.
   (c) Both (a) and (b). (d) None of these.
2. In a refrigerator the heat exhausted to the outer atmosphere is ———— that absorbed from the source.
3. Which of the following is correct ?
   (a) $\frac{T_1}{H_2}+\frac{H_2}{T_2}=-1$. (b) $\frac{H_1}{T_2}=\frac{H_2}{T_2}$.
   (c) $H_1 T_1 = -H_2 T_2$. (d) $H_1 T_1 + H_2 T_2 = 0$.
4. The change in internal energy of the gas is directly proportional to :
   (a) Change in volume. (b) Change in pressure.
   (c) Change in temperature. (d) Atomicity.
5. Two ends of a rod are kept at 12 degree and 227 degree when 2000 cal of heat flows in this rod the change in entropy is :
   (a) 1.0 cal/k. (b) 20 cal/k.
   (c) 6.9 cal/k. (d) 0.7 cal/k.
6. The enthalpy of unit mass for any system is :
   (a) H = U + PV + S. (b) H = U + PV – S.
   (c) H = U + PV. (d) H = U – PV.

Turn over

7. The average translational KE of the molecules of a gas will be doubled if :

   (a) A + constant volume, the pressure is doubled.

   (b) A + constant volume, pressure is halved.

   (c) A + constant temperature, the pressure is doubled.

   (d) A + constant temperature, pressure is halved.

8. The quantity remaining constant in the isothermal expansion of an ideal gas is :

   (a) Heat. (b) Internal energy.

   (c) Pressure. (d) Temperature and pressure.

9. The Clausius-Clapeyron equation indicates that an increase in pressure increases the melting point in case of substances that ———— on solidification.

10. In an isothermal, isobaric and reversible process the Gibb's function is :

    (a) Zero. (b) Infinity.

    (c) Constant. (d) Negative.

11. The average value of v_x in Maxwellian distribution is :

    (a) Zero. (b) $\sqrt{\frac{KT}{m}}$.

    (c) KT/m. (d) Infinity.

12. The quantum statistics reduces to classical statistics under the condition ————.

(12 × ¼ = 3 weightage)

Part B

Answer **all** *questions.*
Each question carries 1 *weightage.*

13. State the first law of thermodynamics. Give its importance.

14. How does temperature fall with height ?

15. Explain the terms reversible process and reversible cycle.

16. Define entropy. What is its significance ?

17. Define free energy and thermodynamic potential.

18. State and explain Nernst theorem.

19. Explain thermodynamic probability.

20. How is equilibrium state related to most probable state ?

21. Do electrons have zero energy at 0 Kelvin. Why ?

(9 × 1 = 9 weightage)

Part C

Answer any **five** *questions.*
Each question carries 2 weightage.

22. Explain thermodynamic state, thermodynamic coordinates, thermodynamic equilibrium and quasi static processes.
23. Derive an expression for the work done in adiabatic expansion. Find the work done in compressing adiabatically 1 gm of air initially at NTP to air at 360 K. Density of air = 0.0001293 gm/cc, r = 1.4, atmospheric pressure = 10^6 dyner.
24. Derive an expression for the efficiency of an otto engine.
25. Discuss adiabatic and isothermal elasticities of a perfect gas.
26. Calculate the change in temperature of the boiling point of water due to a change of pressure of 1 cm of mercury (L = 540 cals, vol of 1 gm of water at 100°C = 1 cc. Vol of 1gm saturated steam at 100°C = 1600 cc).
27. State and explain equipartition theorem.
28. Give a comparison between classical and quantum statistics.

(5 × 2 = 10 weightage)

Part D

Answer any **two** *questions.*
Each question carries **4** *weightage.*

29. Describe the Carnot's engine. Draw the P-V indicator diagram for a cycle of its operations between two given temperatures and derive an expression for the thermal efficiency of the engine.
30. With the help of Maxwell's thermodynamical relations, derive the specific heat equations.
31. Deduce expressions for null point energy as applied to electron gas according to Fermi-Dirac statistics.

(2 × 4 = 8 weightage)

C 1752 (Pages : 3) Name.....

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH/APRIL 2016

(UG–CCSS)

Physics

PH 6B 16—THERMAL AND STATISTICAL PHYSICS

(2013 Admissions)

Time : Three Hours Maximum : 30 Weightage

Section I (Objective Type Questions)

Answer **all** *questions.*

Each question carries ¼ weightage.

1. Loss of heat is :

   (a) A reversible process. (b) An isothermal process.

   (c) An irreversible process. (d) None of these.

2. An adiabatic process is one in which :

   (a) No heat enters or leaves the gas.

   (b) The temperature of the gas changes.

   (c) The change in internal energy is equal to the mechanical work done.

   (d) All the above.

3. When a gas is heated at constant volume, the heat supplied increases the internal energy of the gas ? Comment the statement.

   (a) True. (b) False.

   (c) Work will also be done. (d) Needs more data to make the above statement.

4. Work done in a free expansion is :

   (a) Finite. (b) Negative.

   (c) Zero. (d) Positive.

5. The most probable velocity of the gas molecules is :

   (a) $(kT/m)^{1/2}$. (b) $(2kT/m)^{1/2}$.

   (c) $(3kT/m)^{1/2}$. (d) None of these.

Turn over

6. The dimension of the phase space formed by a particle moving in straight wire is :

   (a) 0. (b) 1.

   (c) 2. (d) 3.

7. Maxwell Boltzman statistics is :

   (a) Quantum statistics. (b) Classical Statistics.

   (c) Semi classical statistics. (d) None of these.

8. Which of the following relation is correct ?

   (a) $dU = T\,dS + P\,d\,V$. (b) $dU = T\,dS - P\,dV$.

   (c) $dU = T\,dS + G\,dP$. (d) $dU = T\,dS - G\,dP$.

9. Entropy of the universe can reach a maximum value. This statement is :

   (a) Wrong.

   (b) Against 3rd law of thermodynamics.

   (c) Against 2nd law of thermodynamics.

   (d) Correct.

10. A white dwarf, which is a highly degerate system, can be studied using :

    (a) Maxwell–Boltzman Statistics. (b) Fermi-Dirac Statistics.

    (c) Bose-Einstein Statistics.

11. Electrons in a metal obey which statistics :

    (a) Fermi-Dirac Statistics. (b) Bose-Einstein Statistics.

    (c) Maxwell-Boltzman Statistics. (d) None of these.

12. At absolute zero, the value of entropy :

    (a) Is maximum. (b) Is negative.

    (c) Can be taken as zero. (d) Cannot be determined.

(12 × ¼ = 3 weightage)

Section II (Short Answer Type Questions)

Answer **all** *questions.*

Each question carries 1 *weightage.*

13. Is the specific heat an intensive variable ? Explain.

14. Write the equation of an adiabatic process.

15. State Carnot theorem.

16. Write Clausius–Claperon equation and explain the terms.
17. What is Clausius inequality ?
18. What is the net change in internal energy of a gas during free expansion (neglect heat capacity of the container) ?
19. Explain the term enthalpy.
20. Explain the concept of fermi energy.
21. Write one difference between Fermi Dirac and Bose-Einstein statistics.

(9 × 1 = 9 weightage)

Section III (Short Essay/Paragraph Questions)

Answer any **five** *questions.*
Each question carries 2 *weightage.*

22. The Fermi energy of a system is 15 Joules. Find the average ground state zero point energy.
23. Two bodies made of same material one sphere-shaped other cube-shaped having the same mass is heated to the same final temperature. Which body will have more rate of radiation ?
24. If the maximum wavelength of emission of a blackbody is 2×10^{-9} nm, find its temperature. The value of Weins constant is 0.002899 mK.
25. Find RMS velocity of the molecules of nitrogen at 20°C. Given Molar mass = 0.028 kg and gas constant R = 8.315 J/mol/K.
26. Calculate the change in entropy when 2 kg of ice melts into water at the same temperature. Given specific latent heat of water = 335×10^3 JKg^{-1}.
27. The efficiency of an ideal heat engine is 0.2. If the temperature of the sink is lowered by 20%, the efficiency becomes 0.25. Calculate the temperature of the source and sink.
28. Find the rise in boiling point of water at 373 K when the pressure is increased by two atmospheres. Specific latent heat of steam is 2256×10^3 Jkg and 1 kg of steam occupies a volume of $1677 \times 10^{-3} m^3$ and 1 kg of water occupies a volume of $10^{-3} m^3$.

(5 × 2 = 10 weightage)

Section IV (Essay Questions)

Answer any **two** *questions.*
Each question carries 4 *weightage.*

29. Derive Maxwell's thermodynamic relations.
30. Explain the laws of black body radiation with necessary graphs.
31. Derive the expression for work done in isothermal, adiabatic and isobaric processes.

(2 × 4 = 8 weightage)

C 80033 (Pages : 3) Name.....

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH/APRIL 2015

(U G–CCSS)

Core Course—Physics

PH 6B 16—THERMAL AND STATISTICAL PHYSICS

Time : Three Hours Maximum : 30 Weightage

Section I

Answer **all** *questions.*

Each question carries ¼ weightage.

1. For water below 4°C an increase of pressure will be accompanied by :

   (a) Heating. (b) Cooling.

   (c) Heating first and then cooling. (d) None of the above.

2. An ideal gas is isothermally expanded. Its internal energy will :

   (a) Increase. (b) Decrease.

   (c) Increases and then decreases. (d) Remains the same.

3. The slope of PV and V for an isobaric process will be :

   (a) – 1. (b) Zero.

   (c) + 1. (d) nRT.

4. The law of equipartition of energy was postulated by :

   (a) Maxwell. (b) Planck.

   (c) Boltzmann. (d) Einstein.

5. The total change in entropy of the working substance during a complete reversible process is :

   (a) 1. (b) Infinity.

   (c) Zero. (d) 1.4.

6. The work done in an isothermal expansion is given by :

   (a) $W = \frac{1}{R} \cdot \theta \log_e \left(\frac{u_2}{u_1}\right)$ (b) $W = R\theta \log_e \left(\frac{u_2}{u_1}\right)$.

   (c) $\frac{1}{R\theta} \log_e \left(\frac{u_1}{u_2}\right)$. (d) $W = R\theta r^{-1} \log_e \left(\frac{u_1}{u_2}\right)$.

Turn over

7. A refrigerator is :

   (a) Heat engine. (b) Melting of ice.

   (c) An electric motor. (d) Heat engine working backward.

8. The efficiency of a Carnot engine working between steam point and ice point is :

   (a) 16.8%. (b) 26.81%.

   (c) 36.8%. (d) 100%.

9. When an ideal diatomic gas is heated at constant pressure, the fraction of the heat energy supplied that increases the internal energy of the gas is :

   (a) $\frac{2}{5}$. (b) $\frac{3}{5}$.

   (c) $\frac{3}{7}$. (d) $\frac{5}{7}$.

10. A frictionless heat engine can be 100% efficient only if its exhaust temperature is :

    (a) 0°C. (b) 0°K.

    (c) Equal to its input temperature. (d) Equal to half its input temperature.

11. If two or more events are mutually independent of each other then the probability of all events happening simultaneously is the :

    (a) Sum of individual events. (b) Product of individual events.

    (c) Difference of individual events. (d) None of the above.

12. Fermions have :

    (a) Odd half integral spin. (b) Even half integral spin.

    (c) Full integral spin. (d) Zero spin.

(12 × ¼ = 3 weightage)

Section II

Answer **all** *questions.*

Each question carries 1 *weightage.*

13. Define Temperature.

14. What is a quasistatic process ?

15. How does temperature fall with height ?

16. Give *two* conditions for obtaining maximum amount of work.

17. Are spontaneous process reversible ? Justify your answer.

18. What is free energy ?
19. Define atomicity of a gas. On what factor does it depend ?
20. What is thermodynamic probability ?
21. What do you understand by phase space ?

(9 × 1 = 9 weightage)

Section III

Answer any **five** *questions.*
Each question carries 2 *weightage.*

22. An automobile car tyre has a pressure of two atmospheres at the temperature of 27°C. Find the resulting temperature if the tyre suddenly bursts.
23. Can an engine working between temperatures 600 K and 300 K be developed to have an efficiency of 56% ?
24. Calculate the change in entropy when 5 kg of water at 100°C is converted into steam at the same temperature.
25. Distinguish between internal and external latent heats.
26. Do electrons have zero energy at OK ? If not why ? Explain.
27. State and explain Wien's displacement law.
28. Two six faced dice each marked 1 to 6 are thrown. Calculate the probability that one of the dice shows 6 and the other shows 5.

(5 × 2 = 10 weightage)

Section IV

Answer any **two** *questions.*
Each question carries 4 *weightage.*

29. Define Entropy. What is its physical significance ? Show that the entropy of a perfect gas remains constant in a reversible process but increases in an irreversible process.
30. Calculate the work done in a Carnot's cycle of operations. Deduce the efficiency of a Carnot's engine in terms of the temperature between which it works.
31. Give the important characteristics of the Maxwell-Boltzmann, Bose Einstein and Fermi dirac statistics. What are the merits and demerits of the three statistics ?

(2 × 4 = 8 weightage)

C/60117 (Pages : 3) Name.....

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH 2014

(U.G.–CCSS)

Physics

PH 6B 16—THERMAL AND STATISTICAL PHYSICS

Time : Three Hours Maximum : 30 Weightage

Section A

Answer all **twelve** *questions.*

1. Which of the following is an intensive quantity ?

   (a) Volume. (b) Enthalpy.

   (c) e.m.f. (d) Surface area.

2. Name the process in which $dQ = dw$:

   (a) Isothermal. (b) Adiabatic.

   (c) Isochoric. (d) Isobaric.

3. One mole of mono atomic gas is mixed with 2 moles of diatomic gas, then C_v of mixture will be :

   (a) $\frac{3}{2}$R. (b) $\frac{5}{2}$R.

   (c) $\frac{13}{6}$R.

4. If mean speed, most probable speed, r.m.s. speed of ideal gas molecules are '*a*', '*b*' and '*c*' respectively. Then correct relation is :

   (a) $a = b = c$. (b) $a < b < c$.

   (c) $b < a < c$. (d) $b > a > c$.

5. In an isothermal isobaric process :

   (a) $dG = 0$. (b) $dU = 0$.

   (c) $dF = 0$. (d) $dS = 0$.

6. In thermo dynamic process change in entropy is :

   (a) $ds \geq 0$. (b) $ds = 0$.

   (c) $ds > 0$. (d) $ds \leq 0$.

Turn over

7. Thermal efficiency of a Carnot engine is 100%, then :

(a) Temperature of source = 0°C. (b) Temperature of sink = 0°C.

(c) Temperature of source = 0 K. (d) Temperature of sink = 0 K.

8. On increasing pressure, melting point of ice :

(a) Increase. (b) Decrease.

(c) Remain same. (d) Not predictable.

9. There are two furnaces, Furnace A with blue flame, Furnace B with yellow flame, which would have large temperature :

(a) Furnace A. (b) Furnace B.

(c) Both have same temperature. (d) Unpredictable.

10. Black body radiation can be explained by :

(a) Maxwell-Boltzmann statistics. (b) Bose-Einstein statistics.

(c) Fermi-Dirac statistics. (d) All the three.

11. Shape of T–S diagram for adiabatic process :

(a) Hyperbolic. (b) Parabolic.

(c) Circular. (d) Straight line.

12. If η is the thermal efficiency of Carnot engine, if it is reversed to operate as a refrigerator, its coefficient of performance is :

(a) $\frac{1+\eta}{\eta}$. (b) $\frac{1-\eta}{\eta}$.

(c) $\frac{\eta}{1+\eta}$. (d) $\frac{\eta}{1-\eta}$.

(12 × ¼ = 3 weightage)

Section B

Answer all **nine** *questions.*

13. State second law of thermodynamics.

14. Formulate first law of T.d. for a liquid surface.

15. Distinguish between reversible and irreversible process.

16. State the principle of increase of entropy.

17. What is meant by Gibb's function ?

18. Distinguish between Bosons and Fermions.

19. Can we drive a ship across ocean by utilising internal energy of ocean ?
20. What is meant by free expansion ?
21. Prove that entropy is a state function.

(9 × 1 = 9 weightage)

Section C

Answer any **five** *from seven questions.*

22. Prove that slope of adiabatic is γ times slope of isothermal.
23. 2 moles of O_2 at 0°C are compressed to one-forth of its initial volume at same temperature. Calculate the work done.
24. The efficiency of a Carnot engine is $\frac{1}{6}$, on reducing temperature of sink by 65°C efficiency becomes $\frac{1}{3}$. Find out initial temperatures of source and sink.
25. Calculate the change in entropy in an irreversible process.
26. Calculate average energy per molecule of an ideal gas by Maxwell-Boltzmann distribution.
27. Calculate the efficiency of Carnot engine from Temp-entropy diagram of Carnot cycle.
28. Find r.m.s. speed of O_2 molecule at 0°C. ($K = 1.38 \times 10^{-23}$ Jk^{-1}).

(5 × 2 = 10 weightage)

Section D

Answer any **two** *questions from three.*

29. Explain four thermo dynamic potentials. Derive Maxwell's T.d. relations from them.
30. Calculate change in entropy of a perfect gas in terms of temperatures and pressures.
31. State and prove Carnot's theorem.

(2 × 4 = 8 weightage)

C 40403 (Pages : 4) Name.....

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH 2013

(CCSS)

Physics

PH 6B 16—THERMAL AND STATISTICAL PHYSICS

Time : Three Hours Maximum : 30 Weightage

Section A

Answer all **twelve** *questions.*

1. If dQ = dW in a thermodynamic process, then process is :
   (a) Adiabatic. (b) Isothermal.
   (c) Isobaric. (d) Isochoric.
2. Which of the following is an extensive quantity ?
   (a) Enthalpy. (b) e.m.f.
   (c) Surface Tension. (d) Pressure.
3. Which of the following is fermions ?
   (a) Electron. (b) Helium.
   (c) Photon. (d) Graviton.
4. $C_p : C_v : R$ for monoatomic gas is :
   (a) 5 : 3 : 2. (b) 5 : 3 : 1.
   (c) 7 : 5 : 1. (d) 7 : 5 : 2.
5. If γ is the ratio of specific heats of gases and f is the degree of freedom, then correct relationship :
   (a) $\gamma = 1 + \frac{f}{2}$. (b) $\gamma = 1 + \frac{2}{f}$.
   (c) $\gamma = 1 - \frac{2}{f}$. (d) $\gamma = 1 - \frac{f}{2}$.
6. Most effective method for increasing efficiency of Carnot engine is :
   (a) Increase temperature of source. (b) Increase temperature of sink.
   (c) Decrease temperature of source. (d) Decrease temperature of sink.

Turn over

7. Adiabatic curves of oxygen and helium are drawn. Slope of adiabatic for oxygen is 'a' and that for helium is 'b', then $\frac{a}{b}$ = _____.

(a) 1. (b) $\frac{7}{5}$.

(c) $\frac{21}{25}$. (d) $\frac{35}{15}$.

8. The process in which enthalpy is a constant is :

(a) Isothermal isochoric. (b) Isothermal isobaric.

(c) Adiabatic isochoric. (d) Adiabatic isobaric.

9. Particles which obey Pauli's exclusion principle :

(a) Boson. (b) Boltzons.

(c) Fermions. (d) Photons.

10. Mean energy of monoatomic ideal gas molecule is :

(a) $\frac{1}{2}k\mathrm{T}$. (b) $\frac{3}{2}k\mathrm{T}$.

(c) $\frac{5}{2}k\mathrm{T}$. (d) $\frac{7}{2}k\mathrm{T}$.

11. Which of the following is mathematical formulation of second law of Thermodynamics ?

(a) $d\mathrm{Q} = dw$. (b) $d\mathrm{Q} = du$.

(c) $d\mathrm{Q} = \mathrm{T}ds$. (d) $d\mathrm{Q} = 0$.

12. Specific heat of a thermodynamic system in an adiabatic expansion :

(a) Infinity. (b) Zero.

(c) Finite. (d) None.

(12 × ¼ = 3 weightage)

Section B

Answer all **nine** *questions.*

13. Explain Zeroth law with its significance.

14. Distinguish between intensive and extensive parameters with examples.

15. State Carnot's theorem.

16. State the principle of increase of entropy.

17. Prove that entropy is a state function.

18. What are the conditions for reversibility ?

19. A thermos bottle containing coffee is vigorously shaken. What happends to its internal energy ?

20. What is free expansion ?

21. Can we drive a ship across ocean by utilising internal energy of ocean ? Explain.

(9 × 1 = 9 weightage)

Section C

Answer **five** *questions from seven.*

22. Prove the relation $\left(\frac{\partial C_p}{\partial P}\right)_T = -T\left(\frac{\partial^2 V}{\partial T^2}\right)_P$.

23. Calculate the maximum amount of energy lost per second by radiation by a sphere 10 cm diameter at 227°C when placed in an enclosure at 27°C.

$\left(\sigma = 5.67 \times 10^{-8}\ Wm^{-2}k^{-4}\right)$

24. Compare Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.

25. 1 kg of water at 100°C is dropped into Indian Ocean at 25°C. Calculate change in entropy of universe.

26. Calculate workdone in an isothermal expansion.

27. A Carnot engine with Cold reservoir at 17°C has 30% efficiency, by how much hot reservoir alone be raised in temperature to have 60% efficiency.

28. Calculate and write down the missing term in the given two process.

Process	Q_J	W_J	U_{iJ}	U_{fJ}	$dU_J = U_f - V_i$
I	25	10	?	–10	?
II	?	–20	80	?	20

(5 × 2 = 10 weightage)

Section D

Answer any **two** *questions from* 3.

29. Define the four thermodynamic potentials. Obtain Maxwell's T.d relations.

30. What is entropy-temperature diagram ? Mention its uses. Obtain the expression for efficiency of Carnot engine using temperature entropy diagram of Carnot cycle.

31. What is meant by adiabatic process ? Derive an expression for it in terms of P and V.

(2 × 4 = 8 weightage)

C 25711 (Pages : 3) Name.....

Reg. No.....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, MARCH 2012

(CCSS)

Physics—Core Course

PH 6B 16—THERMAL AND STATISTICAL PHYSICS

Time : Three Hours Maximum : 30 Weightage

Section A

Answer **all** *questions.*

1. Name the process in which $dQ = dU$ is

   (a) Isothermal. (b) Adiabatic.

   (c) Isobaric. (d) Isochoric.

2. An ideal monoatomic gas is heated at constant pressure. If heat given is 50 J, how much of this energy is converted into internal energy ?

   (a) 50 J. (b) 30 J.

   (c) 20 J. (d) $\frac{200}{3}$ J

3. $C_p : C_v : R$ for diatomic gas is :

   (a) 7 : 5 : 2. (b) 7 : 5 : 1.

   (c) 5 : 3 : 2. (d) 5 : 3 : 1

4. If coefficient of performance of Carnot refrigerator is 100% then temperature of Sink is :

   (a) 0K. (b) Equal to temperature of source.

   (c) Two times temperature of source. (d) Half the temperature of source.

5. Work done in free expansion of ideal gas :

   (a) dw= +ve. (b) dw = –ve.

   (c) $dw = 0$. (d) $dw \geq 0$

6. The behaviour of electron gas can be described by :

   (a) Maxwell Boltzman statistics. (b) Bose-Einstein statistics.

   (c) Fermi-Dirac statistics. (d) By all the three statistics.

7. In all thermodynamic process, the change in entropy ds is :

   (a) $ds = 0$. (b) $ds > 0$.

   (c) $ds \geq 0$. (d) $ds \leq 0$.

Turn over

8. $\frac{\text{slope of adibatic}}{\text{slope of isothermal}}$ for oxygen is :

(a) $\frac{5}{4}$. (b) $\frac{5}{3}$.

(c) $\frac{7}{5}$. (d) $\frac{7}{3}$.

9. Stefan's law for a black body at a temperature T in cold surroundings at T0K is :

(a) $E = \sigma T^4$ (b) $E = \sigma\left(T^4 - T_0^4\right)$

(c) $E = \sigma\left(T - T_0\right)^4$ (d) $E = \sigma\left(T^4 + T_0^4\right)$

10. If mean speed , most probable speed, and rms speed of ideal gas molecules are *a, b, c* respectively then :

(a) $a = b = c$. (b) $a < b < c$.

(c) $b < a < c$. (d) $b > a > c$.

11. On increasing pressure, melting point of ice :

(a) Remain same. (b) Decrease.

(c) Increase. (d) None of the above.

12. It is impossible to operate an aeroplane by utilising internal energy of air in atmosphere. This is due to :

(a) Zeroth law of thermodynamics. (b) First law of thermodynamics.

(c) Second law of thermodynamics. (d) Third law of thermodynamics.

(12 × ¼ = 3 weightage)

Section B

Answer all **nine** *questions.*

13. Give the concept of internal energy.

14. Distinguish between Isothermal and Adiabatic process.

15. Explain the principle involved in the function of refrigerator.

16. Draw T-S diagram for Carnot cycle.

17. Give the mathematical formulation of first law of thermodynamics.

18. Suggest the colour your clothes used in

    (a) Summer season. (b) Winter season.

19. Calculate workdone in isobaric expansion.

20. One mole of H_2 mixed with one mole of N_2 at same temperature. What would be the change in entropy pasitive negative or zero ? Explain.

21. What is Bose-Einstein distribution law ?

(9 × 1 = 9 weightage)

Section C

Answer any **five** *questions.*

22. Calculate workdone in adiabatic expansion.

23. A monoatomic gas 2 Pa and 27°C is compressed suddenly to get pressure 8 times initial pressure. Find out resulting temperature.

24. A 42 kW Carnot engine operating between 227°C and 177°C. Calculate the heat absorbed by the engine in one second.

25. Prove that slope of isochoric process in T-S diagram is r times slope of isobaric process.

26. Derive Clausius-Claperyon latent heat equation from Maxwell's equation.

27. Calculate most probable speed of ideal gas molecules by Maxwell-Boltzmann law.

28. Calculate the Maximum amount of heat lost in one second by radiation by a sphere of 10 cm diameter at 227°C in an enclosure at 27°C $\left[\sigma = 5.67 \times 10^{-8} \text{WK}^{-1}\text{K}^{-4}\right]$.

(5 × 2 = 10 weightage)

Section D

Answer **two** *questions.*

29. Explain the working of a Carnot engine. Derive an expression for its efficiency.

30. Derive first and second thermodynamics relations using Maxwell's equations.

31. What is meant by adiabatic process ? Derive an equation for it in terms of pressure and volume.

(2 × 4 = 8 weightage)