DEPARTMENT OF PHYSICS
NAMBOL L. SANOI COLLEGE, NAMBOL

Question Bank (2016- 2019)
Physics
(Elective)
Second Paper
PHY: SE 22 (Thermal Physics and Optics)

UNIT I: Thermodynamics

1 Mark Questions:

1. Explain briefly the concept of entropy. (2016)(2019)
2. Give one limitation of first law of thermodynamics. (2016)(2019)
3. What is meant by quasi-static process in thermodynamics? (2017)
4. Is a negative temperature possible on the absolute scale of temperature? (2018)

2 Mark Questions:

1. A Carnot engine whose sink is at 7 °C has an efficiency of 50%. It is desired to increase the efficiency to 70%. By how many degrees should the temperature of the source be increased? (2016)
2. Calculate the change in melting point of naphthalene for one atmosphere rise in pressure, given that its melting point is 80 °C. Latent heat of naphthalene is 4563 cal/mol and increase in volume on fusion is 18.7 cm 3 per [1 calorie = 4-2 × 107 ergs] mol. (2016)
3. Find the efficiency of Carnot engine working between the steam point and ice point. (2017)
4. What are second-order phase transitions? (2018)
5. Find the efficiency of a Carnot's engine working between 127 ^{o}C and 27 ^{o}C (2019)

3 Mark questions:

1. Show that for any reversible cyclic change of a system, the total change in entropy is zero. (2016)

5 Mark questions:

1. Explain what you understand by a thermodynamic scale of temperature. Show that it agrees with an ideal gas scale. (3+2=5) (2016)(2019)
2. Deduce the thermodynamic relations

   (i) $(\frac{\partial T}{\partial P})_S = (\frac{\partial V}{\partial S})_P$

   (ii) $(\frac{\partial V}{\partial T})_P = -(\frac{\partial S}{\partial P})_T$

   where the symbols have their usual meanings (2 1/2 +2 1/2 =5) (2016) (2019)
3. Define entropy. Show that the entropy of a perfect gas remains constant in a reversible process but increases in an irreversible process. (1+2+2=5) (2017)
4. State Carnot's theorem. Show how Kelvin used this theorem to define a new scale of temperature which is independent of the nature of the working substance. (1+4=5) (2017)
5. What is Joule-Thomson effect? Obtain an expression for the cooling produced in a van der Waals' gas. Explain why helium shows heating effect at ordinary temperatures.(1+3+1=5) (2017) (2019)
6. State and prove Carnot's theorem for a reversible heat engine. (2018)
7. Prove the thermodynamic relation

   $$(\frac{\partial S}{\partial V})_T = (\frac{\partial P}{\partial T})_V$$

   and hence, deduce Clapeyron's latent heat equation

   $$\frac{\partial P}{\partial T} = \frac{L}{T\,(V2-V1)}$$

   where the symbols have their usual meanings.(3+2=5) (2018)
8. Deduce the following thermodynamic relations: (2018)

UNIT II: Kinetic Theory of Gases and Radiation

1 Mark Questions:

1. What do you mean by transport phenomena in gases? (2016)
2. In what way a real gas differs from an ideal gas? (2017)
3. Define solar constant. (2018)
4. What do you mean by degrees of freedom in kinetic theory of gases? (2019)

2 Mark Questions:

1. Calculate the mean free path of a gas molecule, given that the molecular diameter is $2x10^{-8}$ cm and the number of molecules per cubic centimeter is $3x10^{19}$. (2016)
2. What is Brownian motion? Explain in brief. (2016)
3. How do you interpret 'temperature' on the basis of kinetic theory of gases? (2017)
4. Calculate the specific ratio γ of one gram molecule of a tri-atomic gas having six degrees of freedom. (2017)
5. What do you understand by a black body? State Wien's displacement law. (2017)

6. At what temperature, pressure remaining constant, will the r.m.s. velocity of a gas be halved its value at 0 °C? (2018)
7. What do you mean by ultraviolet catastrophe'? (2018)
8. Write down the critical pressure and critical temperature of a gas in terms of the constants of van equation. der Waals' equation. (2019)
9. What is virial of a system? Write the virial equation. (2019)

3 Mark questions:

1. Write a note on ultraviolet catastrophe. (2016)
2. Calculate the critical constants of a gas in terms of the constants of van der Waals' equation. (2017)
3. Explain in brief the transport of momentum, energy and mass on the movement of gas atoms or molecules. (2017)
4. Derive an expression for mean free path of the molecules of a gas.(2018)
5. What are transport phenomena? Name them. (2019)

5 Mark Questions:

1. Discuss the distribution of energy in the spectrum of a blackbody. (2016)
2. On the basis of kinetic theory of gases, derive an expression for thermal conductivity of a gas. Show that thermal conductivity of a gas is proportional to the square root of its absolute temperature.(4+1=5) (2018)
3. What are critical constants of a gas? Calculate the values of these constants in terms of the van der Waals' equation. (2+3=5) (2018)

6 Mark Questions:

1. On the basis of kinetic theory, deduce an expression for the viscosity of a gas in terms of mean free path of its molecules. Show that it is independent of pressure but depends on the temperature of the gas.(5+1=6) (2016)
2. Explain in brief outlines the reason which led van der Waals to his gas equation
$$(P+a/V^2)(V-b) = RT$$
where the symbols have their usual meanings. (2+4=6) (2016)
3. Using Maxwell's law of distribution of speeds of molecules in a gas, obtain the expression for most probable speed, average speed and r.m.s. speed. (2+2+2=6) (2017) (2019)
4. What is black-body radiation? Derive Plank's law of black-body radiation. (1+5=6) (2017) (2019)
5. Discuss Wien's displacement law and Rayleigh-Jeans law. How is Planck's law applicable for all wavelengths?(2+2+2=6) (2018)
6. What are the shortcomings of ideal gas equation? Derive van der Waals' equation of state for real gases. (2+4=6)(2019)

UNIT III: Interference and Diffraction

1 Mark Questions:

1. What happens in the diffraction pattern due to single slit when the slit width is gradually increased? (2016)
2. State clearly Huygens' Principle of wave propagation. (2017)
3. What is the basic difference between Fresnel and Fraunhofer classes of diffraction? (2018)
4. What are coherent sources? (2019)

2 Mark Questions:

1. In Michelson interferometer, 100 fringes cross the field of view when the movable mirror is displaced through 0-02948 mm. Calculate the wavelength of the monochromatic light used. (2016)
2. A biprism is kept at a distance of 5 cm from a narrow slit illuminated by two sodium light. Distance between virtual sources formed by the biprism is 0-05 cm. If the distance of the screen from the biprism be 75 cm, calculate the fringe width. (2016)
3. State the conditions for observing a good and sustained interference pattern. (2017)
4. What is meant by diffraction grating? What will happen if the number of rulings per centimeter is decreased in the case of a diffraction experiment? (2017)
5. The fringes of equal thickness are formed when two glass plates are kept over each other with a small gap in between. If a parallel beam of light of wavelength 6000 Å is used and fringe separation is 3 mm, then what is the angle between the plates? (2018)
6. State the conditions for observing a good and sustained interference pattern. (2018)
7. The diameter of the m th Newton's ring changes from 1.2 cm to 1 cm, when the air space between the lens and the plate is replaced by a transparent liquid. Find the refractive index of the liquid.(2019)
8. Distinguish between magnifying power and resolving power of an optical instrument, say a telescope. (2019)

3 Mark Questions:

1. In Newton's ring experiment, a source emitting two wavelengths $\lambda_1 = 6x10^{-7}$ m and $\lambda_2 = 5.3x10^{-7}$ m, it is found that mth dark ring due to one wavelength coincides with (m+1)th dark ring due to the other. Find the diameter of the mth dark ring if the radius of curvature of the lens is 0.9 m. (2017)
2. Write down Fresnel's integrals. How are3 they parametrically represented Cornu's spiral? (2+1=3) (2018)
3. In a plane transmission grating, the angle of diffraction for the second-order maximum for wavelength 5x107 m is 30. Calculate the number of lines per centimeter of the grating. (2019)

5 Mark Questions:

1. How does the interference by the reflected pattern take place in thin films? What do you mean by fringes of equal thickness and fringes of equal inclination? (3+2=5) (2016) (2019)
2. Explain the construction and working of Fabry-Perot interferometer.(2+3=5) (2016)
3. Discuss, in detail, the diffraction pattern obtained when a sharp straight edge is held in the path of a monochromatic beam of light. (2017)(2019)
4. What are Newton's rings? Explain how such rings are formed. Deduce an expression for diameter of the nth dark ring. (2018)

6 Mark Questions:

1. Give the theory of plane diffraction grating and obtain an expression for its resolving power.(4+2=6) (2016)
2. Describe how the wavelength of a monochromatic beam of light can be measured by Newton's rings experiment. Derive the working formula. (2+4-6) (2016)
3. Explain the construction and working of Michelson's interferometer with the help of a diagram.(3+3=6) (2017)(2019)
4. Show that the resolving power of a diffraction grating is given by the product of the total number of rulings and the order number of the spectrum.
5. In a plane transmission grating, the angle of diffraction for the second order maximum for wavelength 5×10-7 m is 30°, calculate the number of lines per centimeter of the grating.(4+2=6) (2017)
6. What is plane diffraction grating? Discuss its theory and derive the condition for secondary maxima or minima.(1+3+2=6) (2018)
7. Derive an expression for the intensity of the fringe system formed by the transmitted light in a Fabry-Perot interferometer. What are the effects of reflectance and multiple beams on the pattern?(4+2=6) (2018)

UNIT IV: Polarisation

1 Mark Questions:

1. "Light waves can be polarized but sound waves cannot." Why? (2016)
2. What is dichroism? (2017)
3. Explain double refraction. (2019)

2 Mark Questions:

1. What is optical activity? Define specific rotation. (2016)
2. The critical angle of light in a certain substance is 45°. What is its polarizing angle? (2018)
3. What is optical activity? Define specific rotation of an optically active substance. (2019)

3 Mark Questions:

1. How will you convert a plane polarized light into a circularly polarized light? (2016)
2. Show, by Brewster's law, that light incident on a transparent substance at polarizing angle gives reflected and refracted rays at right angles to each other.(2017)
3. How would you analyze plane polarized, circularly polarized and elliptically polarized light? (2018)

5 Mark Questions:

1. Give an account of the Huygens theory of double refraction in a uniaxial crystal. What are positive and negative crystals? Name a crystal of each type.(3+2=5) (2016)
2. What are meant by elliptically and circularly polarized lights? Explain them with necessary theory. (2 ½ +2 ½ =5) (2017)
3. Describe the construction and explain the working of Babinet compensator. What is its advantage over a λ/4 or λ/2 plate? (2+2+1=5) (2017)(2019)
4. What do you understand by double refraction? What are ordinary and extraordinary rays? How will you show that these are plane polarized? (1+2+2=5) (2018)
5. What is polarization? Give the analytical treatment of elliptically polarized light. (1+4=5) (2019)

UNIT V: Elements of Quantum Optics

1 Mark Questions:

1. Write the full form of the acronym LASER.(2017)
2. What do you understand by metastable state' in the production of laser? (2018)
3. Explain stimulated emission' in laser action. (2018)

2 Mark Questions:

1. Write any two characteristic properties of a laser beam.(2016)
2. Why do we need population inversion in the production of lasers?(2017)
3. Explain the difference between spontaneous and stimulated emissions.(2017)
4. Explain what are population inversion and pumping in the production of lasers. (2018)
5. Why do you need population inversion in a laser? (2019)

3 Mark Questions:

1. What is population inversion? Discuss any one method of achieving population inversion.(1+2=3) (2016)
2. What is stimulated absorption? Explain the difference between spontaneous and stimulated emissions. (1+2=3) (2019)

5 Mark Questions:

1. Describe the construction and working of He-Ne laser.(2016)
2. Discuss with suitable diagrams the principle, construction and working of ruby laser. (2017) (2019)
3. Discuss with suitable diagrams, the construction and working of He-Ne laser. (2018)

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