

3/PHY-201 (Th) Syllabus-2023

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(Nov-Dec)

FYUP : 3rd Semester Examination

MAJOR

PHYSICS

**(Heat & Thermodynamics and Experimental
Physics—IV)**

PHY-201

Marks : 56

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer *any eight* questions

1. Outline the essential features of the kinetic theory of gases and find the expression for the average translational kinetic energy per molecule of a gas at temperature T kelvins.

3+4=7

2. (a) Deduce the law of equipartition of energy.

6

(2)

- (b) Find the value of the ratio of specific heats (C_p / C_v) of a monoatomic gas using the law of equipartition of energy. 1
3. Outline the assumptions of the Langevin's theory of Brownian motion. Using this theory, obtain the expression for the mean value of the square of the displacement of a Brownian particle at time interval Δt . 2+5=7
4. Give an elementary theory of self-diffusion and show that diffusion is directly proportional to $T^{3/2}$ and inversely proportional to pressure p . Also, obtain the expression of the coefficient of diffusion. 5+2=7
5. (a) State the first law of thermodynamics. Discuss its physical significance and its limitations. 1+1½+1½=4
- (b) 1 gm of water becomes 1671 cc of steam when boiled at a constant pressure of 1 atmosphere. The heat of vaporization at this temperature is 540 cal/gm. Find the increase in internal energy. 3
6. (a) What is an isothermal process? Derive the expression for the work done during the isothermal expansion of an ideal gas. 1+3=4

(3)

- (b) If at 50 °C and 75 cm of mercury pressure, a definite mass of gas is compressed slowly to one-fourth of its initial volume, then find the final temperature and pressure of the gas. 3
7. (a) What are reversible and irreversible processes? Give one example of each. 2+2=4
- (b) Show that an increase in entropy is always followed by the loss of available energy. 3
8. (a) Why is the Kelvin scale known as the absolute scale of temperature? 2
- (b) A Carnot's engine absorbs heat of 10^5 k-cal from a source which is at 127 °C and transfer part of the heat to a sink at 27° C. Calculate the efficiency of the engine and the work done by it. 2+2=4
- (c) State the Kelvin-Planck statement of the second law of thermodynamics. 1
9. (a) State Stefan's law of radiation. 1
- (b) What is a blackbody? How can it be realized in practice? 1+2=3

- (c) Calculate the temperature (in K) at which a perfect blackbody radiates energy at the rate of 5.67 W/cm^2 .
Given : $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2/\text{K}$. 3
10. (a) What is regenerative cooling? Briefly discuss its principle. 1+2=3
(b) Describe how cooling is achieved by adiabatic demagnetization. 4
11. What is the Linde's air liquefier? On what principles does it operate on? Describe the steps involved in the liquefaction process. 1+3+3=7
12. (a) Show that the diffuse radiation exerts pressure on the walls of a container equal to $\frac{1}{3}$ of its energy density. 3
(b) What is the ultraviolet catastrophe? 2
(c) The surface temperature of a hot body is 1227°C . Find the wavelength at which it radiates maximum energy.
(Given : Wien's constant = 0.2898 cm-K) 2
