

3/PHY-201 (Th) Syllabus-2023

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(December)

FYUP : 3rd Semester Examination

MAJOR

PHYSICS

**(Heat and 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. What are the limitations of a perfect gas equation? Derive the van der Waals' equation of state of a gas.

2+5=7

2. (a) Explain the term 'degree of freedom'. How many degrees of freedom will a monoatomic and a diatomic molecule have in the absence of vibrator motion?

$1 + \frac{1}{2} + \frac{1}{2} = 2$

- (b) State the law of equipartition of energy. Show that for a gas possessing f degrees of freedom $\frac{C_p}{C_v} = 1 + \frac{2}{f}$. 1+4=5
3. (a) Define mean free path. Derive Clausius expression for mean free path on the basis of kinetic theory of gases. 1+4=5
- (b) Calculate the molecular diameter of a nitrogen molecule, given the number density of nitrogen 2.7×10^{25} molecules per m^3 and mean free path $= 8 \times 10^{-8}$ m. 2
4. (a) Derive an expression for the coefficient of viscosity of a gas in terms of its mean free path. Explain the effect of temperature and pressure on the coefficient of viscosity. 4+2=6
- (b) What is Brownian motion? 1
5. (a) What are thermodynamic variables? Define intensive and extensive variables with examples. 1+1½+1½=4
- (b) State and explain Zeroth law of thermodynamics. What is its importance? 2+1=3

6. (a) What are indicator diagrams? Show that the work done in an adiabatic process depends only on the initial and final temperatures. 1+3=4
- (b) What is internal energy of a system? Explain why internal energy is a state function and not a path function. 1+2=3
7. (a) From the first law of thermodynamics, prove that $C_p - C_v = R$, where the symbols carry usual meanings. 4
- (b) What are the limitations of the first law of thermodynamics? 1
- (c) What are reversible and irreversible process? 1+1=2
8. (a) State and prove Carnot's theorem. 1+3=4
- (b) A Carnot engine has an efficiency of 30% where the temperature of the sink is 27°C . What must be the change in temperature of the source to make its efficiency 50%? 3
9. (a) State and prove the principle of increase of entropy. 1+2=3
- (b) What do you mean by absolute zero in the thermodynamic scale of temperature? Why is absolute zero not attainable? 1+3=4

10. (a) What is regenerative cooling? Briefly discuss its principle. 1+2=3
- (b) Describe how cooling is achieved by adiabatic demagnetisation. 4
11. (a) A body at 1500 K emits maximum energy of wavelength 2000 nm. If the sun emits maximum energy of wavelength 550 nm, what would be the temperature of the sun? 2
- (b) State and explain Kirchhoff's law in black-body radiation. Mention one of its applications. 1+3+1=5
12. (a) Show that Planck's law reduces to Wien's law for shorter wavelengths and Rayleigh-Jeans law for longer wavelengths. $1\frac{1}{2}+1\frac{1}{2}=3$
- (b) State and derive the Stefan-Boltzmann law. 1+3=4

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