A1: THERMAL AND STATISTICAL PHYSICS
MT-2012

Andrew Boothroyd and Alexander Schekochihin

READING LIST

Textbook based on the Oxford course as taught up to 2011:
'Concepts in Thermal Physics,' S. J. Blundell and K. M. Blundell (2nd edition, OUP 2009)

More undergraduate textbooks:
'Fundamentals of Statistical and Thermal Physics,' F. Reif (Waveland Press 2008)
'Equilibrium Thermodynamics,' C. J. Adkins (3rd edition, CUP 1997)
'Statistical Physics,' F. Mandl (2nd edition, Wiley-Blackwell 2002)
'Elementary Statistical Physics,' C. Kittel (Dover)
'Thermodynamics and the Kinetic Theory of Gases,' W. Pauli (Volume 3 of Pauli Lectures on Physics, Dover 2003)

More advanced-level books:
'Statistical Thermodynamics,' E. Schroedinger (Dover 1989) [a beautiful and very concise treatment of the key topics in statistical mechanics, a bravura performance by a great theoretical physicist; may not be an easy undergraduate read, but well worth the effort!]
'Statistical Physics, Part I,' L. D. Landau and E. M. Lifshitz (3rd edition, Volume 5 of the Landau and Lifshitz Course of Theoretical Physics, Butterworth-Heinemann, 2000) [the Bible of statistical physics for theoretically inclined minds]
'Physical Kinetics,' E. M. Lifshitz and L. P. Pitaevskii (Volume 10 of the Landau and Lifshitz Course of Theoretical Physics, Butterworth-Heinemann, 1999)
'The Mathematical Theory of Non-uniform Gases: An Account of the Kinetic Theory of Viscosity, Thermal Conduction and Diffusion in Gases,' S. Chapman and T. G. Cowling (CUP 1991) [the Cambridge Bible of kinetic theory, not a page-turner, but VERY thorough]
'Statistical Physics of Particles,' M. Kardar (CUP 2007)

LECTURE PLAN 2012-13

(approximate, subject to real-time adjustments)

Week	Day	Lectures		Lecturer
MICHAELMAS TERM 2012				
IV	PART I. BASIC THERMODYNAMICS (7 lectures)			
	W	1	Concept of temperature, temperature scales, practical thermometry, Zeroth Law. Concepts of heat and work, First Law. Functions of state, exact differentials, equations of state, ideal gas law, heat capacity.	AB
	Th	2	Reversible and irreversible processes, isothermal and adiabatic expansions of ideal gas. Second Law (Clausius and Kelvin statements), heat engines, Carnot cycle.	AB
	F	3	Carnot's theorem, equivalence of Clausius and Kelvin statements, refrigerators and heat pumps, Clausius' Theorem, entropy, maximum entropy principle.	AB
	Problem Set 1 can be done after this.			
V	W	4	Fundamental equation of thermodynamics. Joule expansion, Gibbs' paradox, Maxwell's demon.	AB
	Th	5	Thermodynamic potentials, conditions for thermodynamic equilibrium, availability, Maxwell relations, reciprocal and reciprocity theorems.	AB
	F	6	Thermodynamic coefficients and moduli (heat capacities, bulk moduli, thermal expansion), heat capacity equations, internal energy equations.	AB
VI	W	7	Non-pV systems: elasticity, surface tension, paramagnetism, adiabatic demagnetisation	AB
	Problem Set 2 can be done after this.			
	PART II. KINETIC THEORY (6 lectures)			
	Th	8	Statistical description of a gas. Energy. Thermodynamic limit. Kinetic calculation of pressure. Particle distribution functions. Isotropic distributions.	AS
	F	9	Classical ideal gas. Maxwell's distribution. Temperature, pressure, equation of state for a classical ideal gas. Effusion.	AS
	Problem Set 3 can be done after this.			
VII	W	10	Collisions: cross-section, collision rate, mean free path. Local Maxwellian equilibrium. Transport equations: general form. Fluxes.	AS
	Th	11	Qualitative treatment of transport: empirical viscosity and heat conductivity coeffcients; qualitative discussion of diffusion; qualitative derivation of the fluxes in 1D.	AS
	F	12	Systematic derivation of the momentum and heat diffusion equations for a collisional ideal gas in 1D.	AS
VIII	W	13	Cont'd. Local and global equilibrium. Notion of steady state solutions to the diffusion equation.	AS
	Problem Set 4 (Vacation Work) can be done after this.			

HILARY TERM 2013 – Outline				
	PART III. FOUNDATIONS OF STATISTICAL MECAHNICS (7 lectures)			
		1-7		AS
	Problem Set 5 on the material of Part III			
	PART IV. APPLICATIONS OF STATISTICAL MECHANICS (3 lectures)			
		8-10		AB
	PART V. OPEN SYSTEMS (3 lectures)			
		11-13		AS
	Problem Set 6 on the material of Parts IV & V			
	PART VI. QUANTUM GASES (4+1 lectures)			
		14-17		AS
		18		AB
	Problem Set 7 on the material of Part VI			
	PART VII. THERMODYNAMICS OF REAL GASES (6 lectures)			
		19-24		AB
	Problem Set 8 (Vacation Work) on the material of Parts VI & VII			