School of Physics

PHYS 1901 Physics 1A (Advanced) – Semester 1, 2017

Module 2 – Thermal Physics

This module is one of 3 comprising PHYS 1901 Physics 1A (Advanced). This document describes details of this module and should be read in conjunction with the more general *Unit of Study Outline* for PHYS 1901 Physics 1A (Advanced).

GENERAL GOALS OF THIS MODULE

Thermal physics, the study of energy transfers by means of disordered processes, has played an important role in the development of our current technology and is an essential element of our understanding of the environment. Microscopic models for disordered processes led to our current understanding of the structure of matter and of quantum physics. The general goals of this module are:

- to investigate how energy is transferred between systems because of temperature differences;
- to relate these processes to processes at molecular level; and
- to demonstrate some of the important applications of thermal physics in environmental and industrial contexts.

MODULE DEFINITION – THERMAL PHYSICS

ASSUMED KNOWLEDGE

You will be assumed to understand the concepts of work, kinetic energy, potential energy, conservative force, and conservation of energy and be able to perform calculations with these quantities (see sections 6-2, 6-4, 7-2, 7-3 and 7-4).

SPECIFIC OBJECTIVES

Chapter 17 TEMPERATURE AND HEAT

Text sections: 1, 2, 3 (only Celsius temperatures), 4 (except Thermal Stress), 5 (only SI units), 6, and 7
Text examples: 2 to 3, 6 to 15
Recommended Discussion Questions: 1, 3, 7, 10, 16, 18, 23 and 27

Specific objectives - after studying this chapter you should be able to:

- Explain the concept of temperature and give examples of thermometric properties.
- Explain why the "Zeroth" Law of Thermodynamics is necessary.
- Give examples of thermal equilibrium.
- Explain the basis for the Kelvin temperature scale.
- Describe how temperature is measured.
- Calculate linear, areal and volumetric expansion.
- Explain the difference between temperature and heat.
- Explain the concept of heat capacity and define specific and molar heat capacities.
- Explain the concept of heat of transformation during phase changes.
- Use specific heat capacities and heats of transformation in numerical calculations.
- Describe the mechanisms of heat transfer (conduction, convection and radiation).
- Solve heat transfer problems.

Chapter 18 THERMAL PROPERTIES OF MATTER

Text sections: 1, (except the van der Waals Equation),
2 (only the definition of the mole and Avogadro's constant),
3 (Eqns 18-12, 18-14 and 18-19), 4 and 5 (only qualitative)
Text examples: 1 to 8
Recommended Discussion Questions: 4, 10, 12, and 16

Specific objectives - after studying this chapter you should be able to:

- Define the mole and explain the meaning of Avogadro's constant.
- Explain the concept of an ideal gas and use the ideal gas law in calculations.
- Sketch and use p - V diagrams.
- Explain the molecular origin of pressure.
- Understand the meaning of Eqns 18-12, 18-14 and 18-19.
- Explain what is meant by the degrees of freedom for a molecule.
- Use molar heat capacities in numerical calculations.
- Describe the distribution of molecular speeds in a gas.

Chapter 19 THE FIRST LAW OF THERMODYNAMICS

Text sections: 1 to 7, and 8 (Eqns 19-22, 19-24 and 19-26)
Text examples: 1, 2 (except conversion from non-SI unit), 3 to 8
Recommended Discussion Questions: 5, 6, 10, 15, 19 and 21

Specific objectives - after studying this chapter you should be able to:

- Explain what is meant by a thermodynamic system and by a thermodynamic process.
- Calculate the work done by an ideal gas in various thermodynamic processes.
- Discuss the relationship between heat and internal energy.
- Explain and use the First Law of Thermodynamics.
- Explain the difference between isothermal, adiabatic, isochoric (constant volume), isobaric (constant pressure), cyclic and free expansion processes.
- Explain and use the adiabatic ideal gas equations.

Chapter 20 THE SECOND LAW OF THERMODYNAMICS

Text sections: 1 to 8
Text examples: 1 (a) and (b) (remaining parts are interesting), 2 to 11
Recommended Discussion Questions: 1, 4, 6, 9, 15, and 23

Specific Objectives - after studying this chapter you should be able to:

- Explain the difference between reversible and irreversible processes.
- Describe the operation of real and ideal heat engines.
- Calculate the efficiency of a heat engine.
- Sketch and interpret the p - V diagram for the Carnot cycle.
- Compare the performance of real and ideal engines and refrigerators.
- Calculate the change in entropy for a reversible process.
- Explain the Second Law of Thermodynamics and its relation to entropy.
- Explain the relation between macroscopic entropy and microscopic disorder or complexity of a system.

