Fluid Mechanics & Thermal Physics

B. Temperature and Heat *(Ch 10 & 11)*

Mechanical Equivalent of Heat:

Students should understand the "mechanical equivalent of heat" so they can:

- Determine how much heat can be produced by the performance of a specified quantity of mechanical work. *(11.1 – 11.4)*

Heat Transfer and Thermal Expansion:

Students should understand heat transfer and thermal expansion so they can:

- Calculate how the flow of heat through a slab of material is affected by changes in the thickness or area of the slab, or the temperature difference between the two faces of the slab. *(11.5)*
- Analyze what happens to the size and shape of an object when it is heated. *(10.3)*
- Analyze qualitatively the effects of conduction, radiation, and convection in thermal processes. *(11.5 – 11.7)*

Equations – Temperature and Heat *(Ch 10 & 11)*:

$$\Delta l = \alpha \cdot l_0 \cdot \Delta T \qquad H = \frac{k \cdot A \cdot \Delta T}{L}$$

C. Kinetic Theory and Thermodynamics *(Ch 10 & 12)*

Ideal Gases:

Students should understand the kinetic theory model of an ideal gas so they can:

- State the assumptions of the model. *(10.6)*
- State the connection between temperature and mean translational kinetic energy, and apply it to determine the mean speed of gas molecules as a function of their mass and the temperature of the gas. *(10.6)*
- State the relationship among Avogadro's number, Boltzmann's constant, and the gas constant R, and express the energy of a mole of a monatomic ideal gas as a function of its temperature. *(10.6)*
- Explain qualitatively how the model explains the pressure of a gas in terms of collisions with the container walls, and explain how the model predicts that, for fixed volume, pressure must be proportional to temperature. *(10.6)*

C. Kinetic Theory and Thermodynamics *(Ch 10 & 12)* - CONT

Ideal Gases: ***(cont)***

Students should know how to apply the ideal gas law and thermodynamic principles so they can:

- Relate the pressure and volume of a gas during an isothermal expansion or compression. *(12.2 - 12.3)*
- Relate the pressure and temperature of a gas during constant-volume heating or cooling, or the volume and temperature during constant-pressure heating or cooling. *(12.2 - 12.3)*
- Calculate the work performed on or by a gas during an expansion or compression at constant pressure. *(12.2)*
- Understand the process of adiabatic expansion or compression of a gas. *(12.2)*
- Identify or sketch on a *PV* diagram the curves that represent each of the above processes. *(12.2 - 12.3)*

Equations – Ideal Gases *(Ch 10 & 12)*:

$$W = -P \cdot \Delta V \qquad P \cdot V = n \cdot R \cdot T = N \cdot k_B \cdot T$$

$$K_{avg} = \frac{3}{2} \cdot k_B \cdot T \qquad v_{rms} = \sqrt{\frac{3 \cdot R \cdot T}{M}} = \sqrt{\frac{3 \cdot k_B \cdot T}{\mu}}$$

Laws of Thermodynamics:

Students should know how to apply the 1st Law of Thermodynamics so they can:

- Relate the heat absorbed by a gas, the work performed by the gas, and the internal energy change of the gas for any of the processes above. *(12.2 - 12.3)*
- Relate the work performed by a gas in a cyclic process to the area enclosed by a curve on a *PV* diagram. *(12.2 - 12.3)*

Students should understand the 2nd Law of Thermodynamics, the concept of entropy, and heat engines and the Carnot cycle so they can:

- Determine whether entropy will increase, decrease, or remain the same during a particular situation. *(12.7 - 12.8)*
- Compute the maximum possible efficiency of a heat engine operating between two given temperatures. *(12.6)*
- Compute the actual efficiency of a heat engine. *(12.4)*
- Relate the heats exchanged at each thermal reservoir in a Carnot cycle to the temperatures of the reservoirs. *(12.4 - 12.6)*

Equations – Laws of Thermodynamics *(Ch 10 & 12)*:

$$\Delta U = Q + W \qquad e = \left| \frac{W}{Q_H} \right| \qquad e_c = \frac{T_H - T_C}{T_H}$$

*** AP Course Outline information is taken from the Teacher's Guide to Advance Placement Courses in Physics, published by the College Entrance Examination Board and Educational Testing Service. ***