Chapter 13

THE TRANSFER OF HEAT

PREVIEW

Heat can be transferred by *conduction*, *convection*, or *radiation*. *Conduction* is the transfer of heat through a material like a solid, in which there is no bulk movement of the material. *Convection* is the transfer of heat through materials such as liquids or gases. *Radiation* is heat transfer by electromagnetic waves.

The content contained in sections 1 – 3 (not including the equations) of chapter 13 of the textbook is included on the AP Physics B exam.

QUICK REFERENCE

Important Terms

blackbody
: a material which is a perfect absorber of heat, and also a perfect emitter of heat

convection
: heat transfer by the movement a heated substance, such as currents in a fluid

conduction
: heat transfer through a material, such as a solid, without bulk movement of the material

radiation
: the transmission of energy by electromagnetic waves

thermal conductor
: a material through which heat can easily flow

thermal insulator
: a material that conducts heat poorly

Equations and Symbols

No equations from this chapter are included on the AP Physics B exam.

Ten Homework Questions

Chapter 13 Conceptual Questions 1, 2, 3, 4, 8, 12, 14, 18, 20, 21

DISCUSSION OF SELECTED SECTIONS

There are three ways of transferring heat from one place to another:

13.1 Convection

Convection is the transfer of heat by the bulk movement of a fluid. If the air near the floor of a cool room is heated, it expands and becomes less dense than the air above it, causing it to rise. As it rises, it cools, becomes more dense again, and falls toward the floor. If the air near the floor is continually heated, the cycle will repeat itself. Water heated in a pan is an example of heat transfer by convection, since water near the bottom of the pan near the fire is heated, rises, cools, then falls again. If the temperature gets high enough, the water begins to boil as it cools itself by transferring heat to the air by convection.

13.2 Conduction

Conduction is the transfer of heat directly through a material, or by actual contact between two materials. Metals are typically good heat *conductors*. In fact, materials which are good electrical conductors are usually good heat conductors as well. A material which is not a good heat conductor, like wood or air, is called an *insulator*. If you place an iron skillet on a fire, heat is transferred by conduction to the handle of the skillet. If you grasp the iron handle with your bare hand, you will feel it transfer heat to your hand by conduction.

13.3 Radiation

Radiation is the process by which heat is transferred by electromagnetic waves. We receive heat from the sun by radiation principally in the form of light, infrared, and ultraviolet waves. Microwave ovens use microwaves to transfer heat to food. And if you stand near a roaring campfire, you will feel the heat radiating from the fire in the form of light and infrared rays.

CHAPTER 13 REVIEW QUESTIONS

For each of the multiple choice questions below, choose the best answer.

1. Cooking oil is poured into an iron pan which is heated over a flame. The heated oil begins rising to the top. The order of heat transfers during the entire process is
(A) conduction, convection, radiation
(B) convection, conduction, radiation
(C) radiation,convection,conduction
(D) conduction, radiation, convection
(E) radiation, conduction, convection,

2. Gases in the sun are heated and rise to the surface. A boy picks up a wrench which has been lying in the hot sun on a summer day. The order of heat transfers during the entire process is
(A) conduction, convection, radiation
(B) convection, radiation, conduction
(C) radiation,convection,conduction
(D) conduction, radiation, convection
(E) radiation, conduction, convection,

3. The air in a hair dryer is heated by
(A) convection
(B) conduction
(C) radiation
(D) insulation
(E) temperature

4. As water boils, the heat transfer through the water is best described as
(A) convection
(B) conduction
(C) radiation
(D) insulation
(E) temperature

5. Old houses were often built with high ceilings in the rooms so that they would be cooler in the warmer months. This was to take advantage of
(A) convection
(B) conduction
(C) radiation
(D) insulation
(E) temperature

ANSWERS AND EXPLANATIONS TO CHAPTER 12 REVIEW QUESTIONS

Multiple Choice

1. E
The flame heats the pan by radiation, heat is transferred through the pan by conduction, and heat rises through the oil by convection.
2. B
Hot gases rise to the surface of the sun by convection, heat is transferred through empty space by radiation, and heat is transferred from the wrench to the boy's hand by conduction.
3. C
The air is heated by a hot, glowing coil of wire which emits radiation.
4. A
The water is heated and rises to the top where it cools and sinks to the bottom again.
5. A
Warm air near the floor rises to the ceiling, leaving the space near the floor cooler.