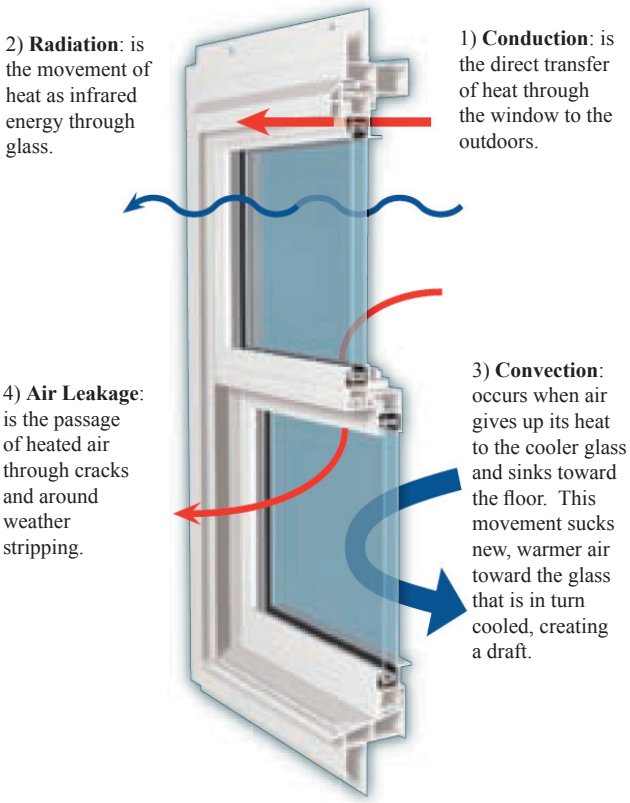
Radiation
Conduction
Convection

Convection is another way heat moves through windows. In a cold climate, heated indoor air rubs against the interior surface of window glass. The air cools, becomes more dense and drops toward the floor. As the stream of air drops, warm air rushes in to take its place at the glass surface. The cycle, a convective loop, is self-perpetuating. You recognize this movement as a cold draft and turn up the heat. Unfortunately, each 1 degree F increase in thermostat setting increases energy use 3%. Multiple panes of glass separated by low-conductance gas fillings and warm edge spacers, combined with thermally resistant frames, raise inboard glass temperatures, slow convection and improve comfort.

Radiant transfer is the movement of heat as long-wave heat energy from a warmer body to a cooler body. Radiant transfer is the warm feeling on your face when you stand near a woodstove. Conversely, your face feels cool when it radiates its heat to a cold sheet of window glass. But radiant-heat loss is more than a perception. Clear glass absorbs heat and reradiates it outdoors. Radiant-heat loss through windows can be greatly reduced by placing Low-E coatings on glass that reflect specific wavelengths of energy. In the same way, Low-E coatings keep the summer heat out.



Radiation, Conduction and Convection

Absorbed by the inside pane of a double-glazed window, heat moves to the cooler outside pane and is released to the outdoors. This heat loss through windows takes place through the glazing (by radiation); across the spacer material which seperates the two glazing lays at their edge and through the frame of the window (by conduction); through the movement of air in the space between the two glazings (by convection); and between the moveable or operable frame components (by air leakage).

Radiation losses through the window glass represent about two-thirds of the total heat loss in a standard window. Because ordinary glass readily emits head to colloer surfaces (ie., has a high emissivity), radiation losses can be reduced by lowering the emissivity of the glass (hence the term *low emissivity* or Lo-E glass).

Conduction losses in windows occur primarily through the edges and frames of the units. Advances in materials and designs that more effectively use insulating materials have dramatically reduced these losses.

Convection losses occur due to air movement between the spaces of multi-glazed windows. If the space is too small, conduction through the air is significant. If the air space is too large, the still air will begin to rise as it is heated on the warm interior side, and fall as it is cooled on the cold exterior side of the window. This convection movement of the air passes heat to the exterior. The best spacing to minimize convection losses is 12 to 16 mm between the glazings. Other gases (argon, krypton) are often used to reduce convection heat loss. Optimum spacing for these gasses can be different.

Information regarding convection, radiation, conduction, energy efficiency, condensation, and the proper selection of energy efficient windows can be found at the Department of Energy's website at www.doe.gov