

## Why can't I cool my kitchen by opening the refrigerator door?

Bobby Rohrkemper

May 4, 2003

Imagine it is a hot summer day. You're stuck at home without an air conditioner, so you decide to try to cool the kitchen off by opening the refrigerator door. Although this may seem like a good idea since the inside of a refrigerator is very cold and your kitchen is very warm, it will not work in practice. The reason can be explained without any specialized knowledge about how a refrigerator actually works. Consider the following schematic of your kitchen and refrigerator in an imaginary closed system where no heat is entering or leaving the kitchen by any means other than the refrigerator.

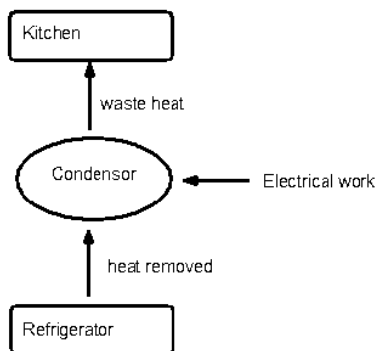


Figure 1: An energy-flow diagram of a refrigerator.

In order to run your refrigerator, you have to provide the refrigerator with energy by plugging it into the wall. This allows the refrigerator to do electrical work. This work goes into removing heat from your refrigerator (by making the metal coils inside very cold) and expelling the heat into the kitchen. The electrical work itself also generates heat, which is expelled into the kitchen. The relationship between these three quantities is  $waste\ heat = heat\ removed + electrical\ work$ . Therefore, the waste heat expelled into the kitchen is greater than the heat removed from the refrigerator. This shows that your kitchen will actually heat up rather than cool down in this scenario!

Now that you have learned this valuable lesson, you decide to go out and buy an air conditioner and place it in your kitchen. An air conditioner works in a similar way to a refrigerator. Obviously you cannot just set it on the

kitchen floor, or you will have the same problem as before! Instead, the air conditioner needs to go in the window because then both the waste heat and heat from electrical work will be disposed of outside. This leaves you with only the benefit of having heat removed from your kitchen. None of the waste heat will enter the kitchen. Thus the kitchen will cool down.

By simply thinking about the general concept of a refrigerator, we have been able to describe why a refrigerator cannot cool off a kitchen, and why an air conditioner must be placed in the window.