

Figure 4
An isothermal process can be approximated if energy is slowly removed from a system as work while an equivalent amount of energy is added as heat.

## isothermal process

a thermodynamic process that takes place at constant temperature

## Internal energy is constant in a constant-temperature process

Although you may think of a toy balloon that has been inflated and sealed as a static system, it is subject to continuous thermodynamic effects. Consider what happens to such a balloon during an approaching storm. (To simplify this example, we will assume that the balloon is only partially inflated and thus does not store elastic energy.) During the few hours before the storm arrives, the barometric pressure of the atmosphere steadily decreases by about 2000 Pa. If you are indoors and the temperature of the building is controlled, any change in outside temperature will not take place indoors. But because no building is perfectly sealed, changes in the pressure of the air outside also take place inside.

As the atmospheric pressure inside the building slowly decreases, the balloon expands and slowly does work on the air outside the balloon. At the same time, energy is slowly transferred into the balloon as heat. The net result of these two processes is that the air inside the balloon stays at the same temperature as the air outside the balloon. Thus, the internal energy of the balloon's air does not change. The energy transferred out of the balloon as work is matched by the energy transferred into the balloon as heat. This process is illustrated in **Figure 4.** 

This example is a close approximation of an **isothermal process.** In an isothermal process, the system's temperature remains constant and internal energy does not change when energy is transferred to or from the system as heat or work.

You may wonder how energy can be transferred as heat from the air outside the balloon to the air inside when both gases are at the same constant temperature. The reason that energy can be transferred as heat in an isothermal process may be seen if you consider the process as consisting of a large number of very gradual, very small, sequential changes, as shown in **Figure 5.** 

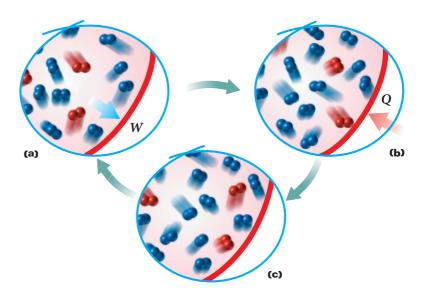


Figure 5

In an isothermal process in a partially inflated balloon, (a) small amounts of energy are removed as work. (b) Energy is added to the gas within the balloon's interior as heat so that (c) thermal equilibrium is quickly restored.